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electromotive force thermodynamic alexander stone macnow md áine lorié phd derek rusnak ma kaplan mcat faculty laura l. ambler kaplan mcat faculty krista l. buckley md kaplan mcat faculty kristen l. russell pamela willingham msw melinda contreras ms kaplan mcat faculty kaplan mcat faculty jason r. selzer kaplan mcat faculty m. dominic eggert faculty reviewer editor elmar r. aliyev james burns jonathan cornfield alisha maureen crowley nikolai dorofeev md benjamin downer ms colin doyle christopher durland m. dominic eggert marilyn engle eleni m. eren raef ali fadel elizabeth flagge adam grey rohit gupta jonathan habermacher tyra hall pogar phd justine harkness phd scott huff samer t. ismail ae ri kim phd elizabeth a. kudlaty

kelly kyker snowman ms ningfei li john p. mahon brandon mckenzie matthew a. meier nainika nanda caroline nkemdilim opene kaitlyn e. prenger uneeb qureshi jason selzer allison st. clair bela g. starkman phd chris sun michael paul tomani ms bonnie wang ethan weber lauren k. white nicholas m. white allison ann wilkes ms kerranna williamson mba tony yu thank eric chiu tim eich tyler fara owen farcy dan frey robin garmise rita garthaffner joanna graham beth hoffberg aaron lemon strauss keith lubeley diane mcgarvey petros minasi camellia mukherjee denise pangia john polstein deeangelee pooran kublall md mph rochelle rothstein md larry rudman sylvia tidwell scheuring carly schnur karin tucker lee weiss countless project get start checklist register free online asset include full- length test science review video additional create study calendar ensure complete content review sufficient practice test day finish chapter online practice chapter check table content register mcat www.aamc.org/mcat

set aside time prep sure rest application personal statement recommendation material ready moment admire complete checklist business preppe start long fruitful journey wear white coat proudly wear white coat hopefully motivation read book want healer go medical school likely familiar importance mcat medical school admission holistic review process put additional weight experience extracurricular activity personal attribute fact remain gpa mcat score

remain important component application portfolio early admission process additional point score mcat push thousand student make attractive applicant mcat simply obstacle overcome opportunity school strong student future leader medicine kaplan job seriously aim help student success mcat future physician work learning science expert ensure date teaching technique resource multiple member team hold advanced degree medicine associate biomedical science commit high level medical education kaplan work mcat 50 year commitment premed student unflagging fact stanley kaplan create company difficulty accept medical school unfair quota system exist time stand beginning new era medical education citizen 21st century world healthcare charge create patient orient culturally competent cost-conscious universally available technically advanced research- focus healthcare system run compassionate provider suffice easy task problem base learning integrated curriculum class interpersonal skill response demand excellent workforce workforce soon thrill choose help journey reach share challenge concern success shape future medicine united states abroad look forward help doctor deserve alexander stone macnow md department pathology laboratory medicine hospital university pennsylvania ba musicology boston university 2008 md perelman school medicine university world premier science technology magazine old continuously publish magazine united states scientific american commit bring important development modern science medicine technology worldwide audience understandable credible provocative found 1845 cutting edge scientific american boast 175 nobel laureate author include albert einstein marie curie francis crick

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scientific american continue cover promising stride inevitable setback challenge new medical discovery unfold anatomy mcat general overview structure test day chemical physical foundations critical analysis reasoning skills cars lunch break optional biological biochemical foundations psychological social biological foundations behavior satisfaction survey optional structure section mcat show chemical physical foundations biological systems 44 question passage base 15 discrete score 118 132 test general chemistry 30 organic chemistry 15 critical analysis reasoning skill cars question passage base discrete stand question score 118 132

chemical physical foundations biological systems test social science 50 foundation comprehension 30 reasoning text 30 reasoning text 40 biological biochemical foundation living system 44 question passage base 15 discrete score 118 132 test general chemistry 5 organic chemistry 5 psychological social biological foundation behavior 44 question passage base 15 discrete score 118 132 test 375 minute 6 hour 15 minute total seat time 447 minute 7 hour 27 minute chemical physical foundation biological systems 472 528 scientific inquiry reasoning skill sirs aamc define scientific inquiry reasoning skills sirs test science section mcat 1 knowledge scientific concept principle 35 2 scientific reasoning problem solving 45 question 3 reasoning design execution research 10 4 data base statistical reasoning 10 question let break specific test day behavior note bullet point specific objective sirs take directly official guide mcat exam description behavior mean sample question stem write kaplan skill 1 knowledge scientific concept principle probably surprising sir testing science knowledge signature quality mcat skill 1 question require follow recognize correct scientific principle identify relationship closely relate concept identify relationship different representation concept verbal symbolic graphic identify example observation illustrate scientific use mathematical equation solve problem kaplan simply science knowledge skill 1 question way think skill 1 question step problem single step realize scientific concept question stem suggest concept state question stem identify answer choice accurate application skill 1 question particularly prominent discrete question associate passage question opportunity gain quick

point test day know science concept attach question test day 35 question science section skill 1 sample skill 1 question stem proponent james lange theory emotion interpret finding study cite passage following accurately describe function fsh human menstrual cycle product reaction 1 reaction 2 combine solution result reaction form ionic bond maintain following force skill 2 scientific reasoning mcat science section course test straightforward science

2 scientific reasoning mcat science section course test straightforward science knowledge skill 2 question common way kaplan critical thinking question skill 2 question require reason scientific principle theory model analyze evaluate scientific explanation prediction evaluate argument cause consequence bring theory observation evidence draw recognize scientific finding challenge invalidate scientific theory model determine use scientific formula solve problem skill 1 question think step problem skill 2 question step problem difficult skill 2 question require step question require wide spectrum reasoning skill include integration multiple fact passage combination multiple science content area prediction experiment result skill 2 question tend ask science content actually mention example question describe result experiment ask predict result second experiment actually tell underlie scientific principle work question difficulty figure principle apply order correct answer test day 45 question science section skill 2 question sample skill 2 question stem following experimental condition likely yield result similar figure 2 follow conclusion support information passage likely cause anomalous result find impact person chest quickly reduce volume lung 70 initial value air escape mouth percentage force outward air pressure increase 2 cm2 portion inner surface compress lung skill 3 reason design execution research mcat interested ability critically appraise analyze research important day day task physician question skill 3 experimental research design question short skill 3 question require following identify role theory past finding observation identify testable research question hypothesis distinguish sample population distinguish result support generalization population identify independent dependent variable reason feature research study suggest association variable causal

relationship temporality random assignment identify conclusion support research result determine implication result real world situation reason ethical issue scientific research year aamc receive input medical school require practical research skill mcat test taker skill 3 question response demand skill unique outside knowledge need answer skill 3 question teach undergraduate course instead research design

answer skill 3 question teach undergraduate course instead research design principle need answer question learn gradually science class especially laboratory work complete note skill 3 comprise 10 question science section test day sample skill 3 question stem dependent variable study describe major flaw method measure disease susceptibility experiment 1 follow procedure important experimenter follow order study maintain proper randomized sample research subject researcher like test hypothesis individual urban area adulthood likely car live urban area birth follow study well test skill 4 data base statistical lastly science section mcat test ability analyze visual numerical result experiment study data statistical analysis question skill 4 question require following use analyze interpret datum figure graph table evaluate representation sense particular scientific observation datum use measure central tendency mean median mode measure dispersion range interquartile range standard deviation describe datum reason random systematic error reason statistical significance uncertainty interpret statistical significance level interpret use datum explain relationship variable use datum answer research question draw conclusion skill 4 include mcat physician researcher spend time examine result study study important legitimate conclusion sound judgment base datum mcat test skill 4 science section graphical representation datum chart bar graph numerical one table list result summarize sentence paragraph form test day 10 question science section skill 4 question sample skill 4 question stem accord information passage inverse conclusion well support finding display medical test rare type heavy metal poisoning return positive result 98 affect individual 13 unaffected individual following type error prevalent test fourth trial experiment 1 run yield result 54 compliance follow true discuss sir

test mcat daunting prospect give nature skill tend conversation abstract practice able identify skill quickly able apply proper strategy solve problem test day need quick reference remind sir guideline help skill 1 science knowledge question ask remember science content skill 2 critical

science knowledge question ask remember science content skill 2 critical thinking question ask remember science content apply novel situation answer question cleverly combine multiple content area time skill 3 experimental research design question ask let forget science content insight experimental research method involve situation skill 4 data statistical analysis question ask let forget science content accurately read graph table moment conclusion extrapolation base critical analysis reasoning skills cars critical analysis reasoning skills cars section mcat test discrete family textual reasoning skill family require high level reasoning skill follow 1 foundation comprehension 30 question 2 reasoning text 30 question 3 reasoning text 40 question skill test humanities- social science theme passage approximately 5 7 question passage let depth look skill bullet point specific objective cars take directly official guide mcat exam description behavior mean sample question stem write kaplan foundation comprehension questions skill ask basic fact simple inference passage question similar see reading comprehension section standardized exam like sat ® act ® foundations comprehension question require following understand basic component text infer meaning rhetorical device word choice text admittedly cover wide range potential question type include main idea detail inference definition context question find correct answer foundations comprehension question follow basic understanding passage point view author occasionally voice passage sample foundations comprehension question main idea author primary purpose passage detail base information second paragraph follow accurate summary opinion hold schubert critic scatter detail accord passage follow false literary review 1920s inference implication)—which following phrase passage suggestive author personal bias narrative record history inference assumption)—in put argument passage author likely assume definition context word obscure paragraph 3 reference historian action nearly reason text

foundation comprehension question usually depend interpret single piece information passage understand passage reasoning text question require thought ask identify purpose particular piece information context passage ask piece information relate

purpose particular piece information context passage ask piece information relate reasoning text question require integrate different component text draw relevant cars section ask judge certain part passage judge author question fall reasoning text skill ask identify authorial bias evaluate credibility cite source determine logical soundness argument identify importance particular fact statement context passage search relevant evidence passage support give conclusion category include function strengthen weaken passage question smattering related rare sample reasoning text question stem function author discussion effect socioeconomic status social mobility primarily serve following function strengthen weaken passage)—which following fact passage prominent piece evidence favor author conclusion strengthen weaken passage)—based role play author argument possessed reasoning text distinguish factor reasoning text question title skill word question test skill large share cars section question skill introduce completely new situation present passage question ask determine influence reasoning text question require apply extrapolate idea passage new context assess impact introduce new factor information condition idea passage reasoning text skill divide apply strengthen weaken passage question rarely appear question type sample reasoning text question stem apply document locate demonstrate berlioz intend include chorus 700 grande messe des morts author likely respond apply follow good example virtuous rebellion define passage strengthen weaken passage)—suppose jane austen write letter sister strong character force circumstance confront basic question society live relevance passage strengthen weaken passage)—which follow sentence add end passage weaken author conclusion paragraph foundations comprehension skill cars section test reading skill build grade school albeit context challenging doctorate level passage skill reasoning text reason text mcat demand understand deep structure passage argument advanced level course test

tight timing restriction 102 second question include time spend read passage quick reference guide car skill foundation comprehension question ask understand passage main idea passage particular true author reasoning text question ask logical relationship idea argue author thesis reasoning

text question ask logical relationship idea argue author thesis reasoning text question ask principle passage apply new new piece information influence argument passage section mcat score 118 132 median approximately 125 mean total score range 472 528 median 500 peculiar number aamc stress scale emphasize importance central portion score distribution student score 125 section 500 total put undue focus high end note wrong answer penalty mcat select answer question aamc release 2018–2020 correlation scale score percentile show follow page note percentile scale adjust renormalize time shift slightly year year percentile rank update release aamc 1 year source aamc 2021 summary mcat total section score access december 2021 https://www.aamc.org/services/mcat-admissions- information score reporting include end section test mcat policies procedures strongly encourage download late copy mcat ® essentials available aamc website ensure late information registration test day policy procedure document update annually brief summary important rule provide way register mcat online access aamc registration system www.aamc.org/mcat able access site approximately month test day aamc designate

registration zones”—gold silver bronze register gold zone opening registration approximately month test day provide flexibility low test fee silver zone run approximately week test day flexibility high fee bronze zone run approximately week test day flexibility high fee fee fee assistance program payment test registration mastercard visa describe early fee register mcat reschedule exam change testing center increase approach test day addition uncommon test center fill advance registration deadline reason recommend identify preferred test day soon possible register ancillary benefit have set test day know date work study hard likely push

exam aamc offer fee assistance program fap student financial hardship help reduce cost take mcat american medical college application service

amcas ® application information fap find test day require present qualifying form id generally current driver license united states passport sufficient consult aamc website list qualifying criterion register care spell name middle name suffix prefix require verify test day precisely appear id failure provide id test center difference spelling registration id consider no- receive refund exam test day registration identity datum collect include digital palm vein scan test day photo digitization valid id signature testing center use metal detection wand ensure prohibit item bring testing room prohibited item include electronic device include watch timer calculator cell phone form record equipment food drink include water cigarette smoking paraphernalia hat scarf religious purpose book note study material require medical device insulin pump pacemaker apply accommodate testing break allow access food drink electronic device include cell phone testing center video surveillance aamc potential violation testing security lightly line know rule break student disability medical condition apply accommodate testing documentation disability condition require request month approve reason recommend begin process apply accommodate testing early possible information apply accommodate testing test mcat matter feel good leave test center celebrate nap watch movie exercise plan trip outing neglect friend message social media snack drink people like sure absolutely think hard deserve rest relaxation importantly discuss specific detail test important let stress test day relive exam inhibit able significantly examinee agreement sign beginning exam specifically prohibit discuss disclose exam content aamc know seek individual violate agreement retain right prosecute individual discretion mean circumstance discuss exam person phone individual include kaplan post information question exam content facebook student doctor network online social media permit comment general exam experience include feel exam overall individual section fine line summary certain discuss aspect test let silly facebook post stop doctor deserve score typically release approximately month test day

release stagger afternoon

score typically release approximately month test day release stagger afternoon evening end 5 p.m. eastern standard time mean examinee receive score exactly time score report include scale score section 118 132 total combine score 472 528 score give confidence interval section confidence interval approximately give score ±1 total score approximately give score ±2 give correspond percentile rank section score total score aamc contact information question contact mcat team association american medical colleges mcat resource center association american medical colleges kaplan mcat review project begin shortly

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content book earn high score test day maximize score improve reading test taking skill mcat style question practice test beginning section find short list objective describe skill cover section learning objective text develop conjunction kaplan learning science team design specifically focus attention task concept likely mcat learning objective function means guide study indicate information relationship focus section start section read learning objective carefully allow assess exist familiarity content provide goal orient focus studying experience mcat concept checks end section find open ended question use assess mastery material mcat concept checks introduce numerous conversation kaplan learning science team research demonstrate repeatedly introspection self analysis improve mastery retention recall material complete mcat concept checks ensure get key point section move science mastery assessments beginning chapter find 15 mcat style practice question design help assess understanding chapter begin read chapter guidance provide assessment determine good way review chapter base personal strength weakness question science mastery assessments focus scientific inquiry reasoning skills knowledge scientific concepts principles occasional question fall second fourth sirs scientific reasoning problem solving data base statistical reasoning respectively addition online resource find test like passage set cover content study ensure apply knowledge way mcat expect follow guide type sidebar find kaplan mcat general chemistry review bridge sidebar create connection

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series cover list official mcat content list topic list cover level detail common undergraduate postbaccalaureate class consider prerequisite mcat note premedical class include topic discuss book depth book additional exposure science content bad thing content knowledge expect walk test day cover book chapter profile page chapter represent holistic look content chapter include pie chart text information pie chart analysis base directly datum release aamc rough estimate importance chapter relation book text portion chapter profiles include aamc content category cover chapter reference directly aamc mcat exam content listing available testmaker website new high yield badge scatter section book chapter 1.1 amino acid find protein note terminology stereochemistry amino acid structure amino acid hydrophobic hydrophilic amino amino acid abbreviation 1.2 acid base chemistry amino acid protonation deprotonation titration amino acid 1.3 peptide bond formation peptide bond formation peptide bond hydrolysis 1.4 primary secondary protein 1.5 tertiary quaternary protein folding solvation layer 1.1 amino acid find chapter 1.1 able badge represent 100 topic test aamc word accord testmaker experience resource high yield badge mean question test day book contain thorough glossary index easy navigation text end book write margin draw diagram highlight key point necessary help high score look forward work

highlight key point necessary help high score look forward work achieve dream doctor deserve study book addition provide good practice question test strategy kaplan team learn scientist dedicate research test good method get study time tip improve retention review multiple topic study session counterintuitive we’re practice skill time order improve skill research show weave topic lead increase learning consideration mcat include topic single question study integrated manner effective way prepare test customize content draw attention difficult critical content ensure overlook read read section good way visual highlight tab use stickie work recommend highlight important difficult section text selective highlighting 10 text give chapter great emphasize part text highlighting opposite effect repeat topic time people try memorize concept repeat succession research show retention improve

space repeat time mix order study content example try read chapter different order second time revisit practice question answer incorrectly new sequence information review recently help well understand question solution struggle past moment reflect finish read section time stop think read jot thought margin note content important topic come mind read associate learning memory fantastic way retain information work answer question answer question moment think step take arrive solution lead answer choose understand step take help good decision answer addition resource locate text additional online resource await www.kaptest.com/booksonline sure log advantage free practice resource note access online resource limit original owner book year medical school frenzied experience student meet requirement rigorous work schedule student learn prioritize time fall hopelessly surprise mcat test specifically design predict success medical school high speed time- intensive test mcat demand excellent time management skill endurance grace pressure test prepare have solid plan attack stick key give confidence structure need succeed create study plan good time create study plan beginning mcat preparation use calendar want start purchase planner print free calendar internet use

calendar want start purchase planner print free calendar internet use build calendar app smart device track interactive online calendar pick option practical likely calendar able start plan study schedule following step 1 fill obligation choose day write school extracurricular work obligation class session work shift meeting attend add personal obligation appointment lunch date family social time etc make appointment calendar hang friend go movie strange plan social activity advance help achieve balance personal professional obligation life get busy have happy balance allow focused productive come time study stay rounded neglect important addition schedule personal professional obligation plan time take time important study kaplan recommend take day week ideally study obligation minimum study mcat 2 add study block obligation establish calendar framework add study block obligation keep study schedule consistent possible day week study time day official test ideal promote recall

possible fit study block studying efficient possible block short frequent period study time week learning perspective study hour day day week valuable study hour day week specifically kaplan recommend study long hour sitting hour block plan minute break hour use break seat quick stretch snack drink clear mind minute break 50 minute study sound like lot break allow deal distraction rest brain 50- minute study block remain fully engaged 3 add length practice test want add length practice test want test early prep spread remain length practice test evenly test date stagger test way allow form baseline comparison determine area focus right away provide realistic feedback prep perform test day plan calendar aim finish length practice test majority studying week test day allow spend final week complete brief review know online resource find sample study calendar different test day timeline use start point sample calendar include focus need area fit timeline test day need customize study calendar need step total

timeline test day need customize study calendar need step total time spend study week depend schedule personal prep need time test day recommend spend range 300–350 hour prepare take official mcat way break study hour day day week month approach study day week hour day study long period time time study week matter plan ensure complete practice feel completely comfortable mcat content good sign ready test day begin earn goal score consistently practice study mcat cover large material study test day initially daunting combat tip control studying control content practice require mcat break content specific goal week instead attempt approach test goal want increase overall score 5 point big abstract difficult measure small scale reasonable goal read chapter day week goal like overwhelming help break studying manageable piece book information familiar probably see content careful familiarity subject necessarily translate knowledge mastery subject assume recognize concept actually know apply quickly appropriate level passively read book instead read actively use free margin space jot important idea draw diagram chart read highlighting excellent tool use sparingly highlight sentence active reading color frequently stop ask question read e.g. main

point fit overall scheme thing thoroughly explain make connection focus grand scheme ensure know essential content prepare level critical thinking require mcat focus area great limit have minimal time prepare test day focus big area opportunity area opportunity topic area highly test master likely will time detailed note page book instead use result practice material determine area big opportunity seek take full- length test sure performance report well identify area opportunity skim content matter demonstrate proficiency pause read thoroughly look unfamiliar particularly difficult begin science mastery assessment beginning chapter question correct reasonable time able quickly skim chapter question prove difficult need spend time read chapter certain subsection chapter thoroughly practice review tracking leave time review

certain subsection chapter thoroughly practice review tracking leave time review practice question length test tempt practice push ahead cover new material quickly possible fail schedule ample time review actually throw away great opportunity improve performance brain rarely remember see carefully review question solve explanation process retrieve information reopen reinforce connection build brain build long term retention repeatable skill set exactly need beat mcat review note specific reason miss question get wrong guess spreadsheet like add miss sheet wimis complete practice question periodically review wimis identify pattern consistently miss question certain content area fall testmaker trap mcat prep adjust study plan base available study time result review strength weakness likely change course prep address area important score shift focus area change help review make length test include miss sheet template sure check video resource online syllabus miss need memorize read answer choice slow scope forget research study overlook aspect study environment learning actually occur study home student choice problem arise environment chief distraction studying mentally drain process time pass distraction tempting escape route considerable willpower reason stay focused hard need instead study home head library quiet coffee shop new location possible eliminate usual distraction promote efficient studying

instead study home course entire day stay library hour effective studying enjoy rest day mcat matter study practice like test day possible require official test snack chew gum study block turn music television phone practice computer online resource simulate computer base test environment complete practice question work scratch paper noteboard sheet write directly print material will option test day memory tie sense test like study environment easy test day recall information put work learn pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure

mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read corresponding subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 follow correct electron configuration zn2 + 2 following quantum number set possible a. n = 2 l = 2 ml = 1 b. n = 2 l = 1 ml = 1

c. n = 2 l = 0 ml = 1 d. n = 2 l = 0 ml = 1 3 maximum number electron allow single atomic energy level term principal quantum number n b. 2n + 2 d. 2n2 + 2 4 following equation describe maximum number electron fill subshell a. 2l + 2 b. 4l + 2 d. 2l2 + 2 5 following atom pair electron ground state 6 electron return excited state ground state emit photon λ = 500 nm magnitude energy change mole photon emit note h = 6.626 × 1034 j s na = 6.02 × a. 3.98

× 1021 j b. 3.98 × 1019 j c. 2.39 × 103 j d. 2.39 × 105 j 7 suppose electron fall n = 4 ground state n = 1 following effect likely a. photon absorb b. photon emit c. electron move p orbital d. electron move d orbital 8 following isotope carbon likely find nature 9 follow well explain inability measure position momentum exactly simultaneously accord heisenberg uncertainty a. imprecision definition meter kilogram b. limit accuracy exist scientific instrument c. error variable increase attempt measure d. discrepancy masse nucleus component 10 follow electronic transition result great gain energy single hydrogen electron a. electron move n = 6 n = 2 b. electron move n = 2 n = 6 c. electron move n = 3 n = 4 d. electron move n = 4 n = 3 11 suppose atom fill orbital show electron configuration clearly illustrate follow law atomic physics a. hund rule b. heisenberg uncertainty principle c. bohr model d. rutherford model 12 total electron 133cs cation 13 atomic weight hydrogen 1.008 amu percent composition hydrogen isotope assume hydrogen isotope 1h a.

92 h 8 d b. 99.2 h 0.8 d c. 99.92 h 0.08 d d. 99.992 h 0.008 d 14 consider set quantum number show table describe different electron atom following term well describe electron 15 following specie represent electron configuration a. b. ii c. ii iii d. ii iii chapter 1.1 subatomic particle 1.2 atomic mass vs. atomic weight 1.3

rutherford planck bohr application bohr model 1.4 quantum mechanical model atom content chapter relevant 7 question general chemistry mcat chapter cover material following aamc content category 4e atom nuclear decay electronic structure atomic chemical behavior chemistry investigation atom molecule body possession food eat world different branch chemistry test directly mcat general inorganic chemistry organic chemistry biochemistry ultimately investigation chemistry seek answer question confront form shape structure mode essence physical world surround student feel similarly general chemistry physics premed need know good doctor need know mcat recognize effective doctor understand physical building block human body pharmacologic treatment base chemistry diagnostic test day

detect change chemistry let business learn remember principle physical world help understand stuff work behave way molecular macroscopic level process read chapter apply knowledge practice question prepare success chemical physical foundations biological systems section mcat future career physician chapter start review general chemistry consideration fundamental unit matter atom focus subatomic particle proton neutron electron review bohr quantum mechanical model atom particular focus similarity difference building block atom building block knowledge general chemistry concept test mcat understand particle able use knowledge nucleus understanding general chemistry 1.1 subatomic particle chapter 1.1 able identify subatomic particle important determine trait atom include charge atomic number isotope determine number proton neutron electron isotope 14c encounter university level chemistry class subatomic particle quark lepton gluon mcat approach atomic structure simple subatomic particle understand proton neutron electron proton find nucleus atom show figure 1.1 proton charge equal fundamental unit charge e = 1.6 × 1019 c denote fundamental unit charge +1 e simply +1 proton proton mass approximately atomic mass unit amu atomic number z element show figure 1.2 equal number proton find atom element act unique identifier element element define number proton contain example atom oxygen contain proton atom gadolinium contain 64 proton atom give

oxygen contain proton atom gadolinium contain 64 proton atom give element atomic number necessarily mass discussion isotope figure 1.1 matter macroscopic microscopic figure 1.2 potassium periodic table potassium symbol k latin kalium atomic number 19 atomic weight approximately 39.1 neutron imply neutral charge neutron mass slightly large proton proton neutron nucleus entire mass atom atom characteristic mass number sum proton neutron atom nucleus give element variable number neutron atom element atomic number necessarily mass number atom share atomic number different mass number know isotope element show figure 1.3 example carbon z = 6 naturally occur proton neutron proton seven neutron proton neutron convention atomic number z

mass number atom x. figure 1.3 isotope hydrogen atom element atomic number z = 1 vary mass number = 1 2 3

electron space surround nucleus associate vary level energy electron charge equal magnitude proton opposite negative sign denote 1 e simply 1 mass electron approximately proton subatomic particle masse small electrostatic force attraction unlike charge proton electron far great gravitational force attraction base respective electron nucleus vary distance correspond vary level electrical potential energy electron close nucleus low energy level high electron shell high energy electron farth nucleus strong interaction surround environment weak interaction nucleus electron call valence electron likely involve bond atom experience electrostatic pull nucleus generally speak valence electron determine reactivity atom discuss chapter 3 mcat general chemistry review sharing transferring valence electron bond allow element fill high energy level increase stability neutral state equal number proton electron lose electron result atom gain positive charge gain electron result atom gain negative charge positively charge atom call cation negatively charge atom call anion valence electron important general organic chemistry know tightly held electron allow understand atom property interact atom especially bonding bonding important discuss chapter 3 mcat general chemistry review mcat organic chemistry review basic feature subatomic particle show table 1.1 subatomic particle example determine number proton neutron electron nickel-58 atom nickel-60 +2 cation solution 58ni atomic number 28 mass number 58 58ni 28 proton 28 electron 58 28 30 60ni2 + number proton neutral 58ni atom 60ni2 + positive charge lose electron ni2 + 26 electron mass number unit high 58ni atom difference mass extra neutron total 32 neutron solution concept check give chapter mcat general chemistry review find near end chapter concept check locate follow concept summary chapter mcat concept check 1.1 assess understanding material 1 subatomic particle important determine follow property atom 2 nuclear medicine isotope create purpose instance 18o create 18f.

determine number proton neutron electron specie 1.2 atomic mass vs. atomic chapter 1.2 able describe atomic mass atomic weight recall unit molar mass predict number proton neutron electron give isotope different term chemist describe heaviness element atomic mass mass number essentially synonymous atomic weight atomic weight constant give element report periodic table atomic mass mass number vary isotope section carefully compare contrast different definition term similar easy mix mcat see mass proton approximately amu size atomic mass unit define exactly carbon-12 atom approximately 1.66 × 1024 g. carbon-12 nucleus proton neutron amu approximately equal mass proton neutron difference mass proton neutron extremely small fact approximately equal mass electron atomic number z = number proton mass number = number proton + number neutron number proton = number electron neutral atom electron include mass calculation small atomic mass atom amu nearly equal mass number sum proton neutron reality mass lose bind energy discuss chapter 9 mcat physics math review atom element vary mass number call isotope greek place isotope differ number neutron refer element follow mass number example carbon-12 iodine-131 isotope hydrogen show figure 1.3 give unique name protium greek proton atomic mass 1 amu deuterium second proton neutron atomic mass 2 amu tritium proton neutron atomic mass 3 amu isotope number proton electron generally exhibit similar chemical property nature element exist isotope isotope usually present proportion sample naturally occur element weighted average different isotope refer atomic weight number report periodic table example chlorine main naturally occur isotope chlorine-35 chlorine-37 chlorine-35 time abundant chlorine-37 atomic weight chlorine close 35 37 periodic table list 35.5 figure 1.4 illustrate half-life

different isotope element half life correspond stability help determine relative proportion different isotope figure 1.4 half life different isotope element half life marker stability generally long last isotope abundant element isotope isotope mass exactly equal element

atomic weight bromine example list periodic table have mass 79.9 amu average naturally occur isotope bromine-79 bromine-81 occur equal proportion bromine atom actual mass 79.9 amu utility atomic weight represent mass average atom element amu mass mole element gram mole number thing atom ion molecule equal avogadro number na = 6.02 × 1023 example atomic weight carbon 12.0 amu mean average carbon atom mass 12.0 amu carbon-12 far abundant carbon-13 carbon-14 6.02 × 1023 carbon atom combine mass 12.0 gram atomic mass nearly synonymous mass number atomic weight weight average naturally occur isotope element example element q consist different isotope b c. isotope atomic mass 40 amu account 60 percent naturally occur q. isotope b atomic mass 44 amu account 25 percent q. finally isotope c atomic mass 41 amu account 15 percent q. atomic weight element q solution atomic weight weight average naturally occur isotope element 0.60 40 amu + 0.25 44 amu + 0.15 41 amu = 24.00 amu + 11.00 amu + 6.15 amu = 41.15 amu mcat concept check 1.2 assess understanding material 1 definition atomic mass atomic weight 2 molar mass typically write gram mole ratio mole gram 3 calculate compare subatomic particle follow 1.3

rutherford planck chapter 1.3 able calculate energy transition valence electron jump energy calculate wavelength emit photon give energy emit calculate energy photon give wavelength high yield badge section indicate content frequently test 1910 ernest rutherford provide experimental evidence atom dense positively charge nucleus account small portion atom volume year early max planck develop quantum theory propose energy emit electromagnetic radiation matter come discrete bundle call quanta energy quantum determine give planck relation e = hf h proportionality constant know planck constant equal 6.626 × 1034 j s f designate greek letter nu ν frequency radiation recall chapter 8 mcat physics review speed light wave calculate ν = fλ speed light c equation incorporate equation quantum energy provide different derivation 1913 danish physicist niels bohr work rutherford planck develop model electronic structure hydrogen atom start rutherford finding bohr assume hydrogen atom consist central proton electron travel circular orbit postulate centripetal force act

electron revolve nucleus create electrostatic force positively charge proton negatively charge electron bohr planck quantum theory correct certain assumption classical physics pathway electron classical mechanic postulate object revolve circle electron assume infinite number value radius velocity angular momentum l = mvr kinetic object value incorporate planck quantum theory model bohr place restriction possible value angular momentum bohr predict possible value angular momentum electron orbit hydrogen nucleus formula review test day focus ratio relationship simplify calculation conceptual understanding usually lead right answer mcat tend

ask change variable affect variable plug chug application complex equation n principal quantum number positive integer h planck constant variable principal quantum number angular momentum electron change discrete amount respect principal quantum number note similarity quantize angular momentum planck concept quantize energy bohr relate permitted angular momentum value energy electron obtain rh experimentally determine rydberg unit energy like angular momentum energy electron change discrete amount respect quantum number value zero energy assign state proton electron separate completely mean attractive force electron quantize state atom attractive force proton represent negative sign equation 1.3 ultimately thing energy equation say energy electron increase negative far nucleus locate increase n important point magnitude fraction get small actual value represent get large negative glance clear energy e directly proportional principal quantum number n equation 1.3

notice negative sign cause value approach zero negative value n increase increase energy negative sign important variable location fraction come determine proportionality think concept quantize energy similar change gravitational potential energy experience ascend descend flight stair unlike ramp infinite number step associate continuum potential energy change staircase allow certain change height result allow certain discrete quantize change potential energy bohr come describe structure hydrogen atom nucleus proton form dense

core single electron revolve define pathway orbit discrete energy value transfer energy exactly equal difference orbit result electron jump orbit high energy orbit increase radius orbit small lowest- energy radius define ground state n = 1 generally ground state atom state low energy electron low possible orbital bohr model electron promote orbit large radius high energy atom say excited state general atom excited state electron move subshell high normal energy bohr liken model hydrogen atom planet orbit sun planet travel roughly circular pathway set distance energy value sun bohr nobel prize- win model reconsider decade remain important conceptualization atomic behavior particular remember know electron restrict specific pathway tend localize certain region space note system tend minimal energy mcat atom element generally exist ground state subject extremely high temperature application bohr model bohr model hydrogen atom electron system he+ li2 + useful explain atomic emission absorption spectra atom electron low energy level high energy level ahed distant nucleus atomic emission spectra room temperature majority atom sample ground state electron excite high energy level heat energy form yield excite state lifetime excited state brief electron return rapidly ground state result emission discrete amount energy form photon show figure 1.5 figure 1.5 atomic emission photon result ground state transition electromagnetic energy photon determine following equation h planck constant c speed light vacuum λ wavelength radiation note equation 1.4 combination equation e = hf c

radiation note equation 1.4 combination equation e = hf c = f λ electron atom excite different energy level electron return ground state emit photon wavelength characteristic specific energy transition undergo describe energy transition form continuum quantize certain value spectrum compose light specify frequency call line spectrum line emission spectrum correspond specific electron transition element electron excite different set distinct energy level possess unique atomic emission spectrum fingerprint element particular application atomic emission spectroscopy analysis star planet physical sample impossible procure light star resolve component wavelength match know line spectra element show figure 1.6 figure

1.6 line spectrum transition wavelength celestial body emission electron drop excited state ground state rise fluorescence color emit light bohr model hydrogen atom explain atomic emission spectrum hydrogen simple emission spectrum element group hydrogen emission line correspond transition energy level n 2 n = 1 know lyman series group correspond transition energy level n 3 n = 2 know balmer series include wavelength visible region lyman series include large energy transition balmer series short photon wavelength uv region electromagnetic spectrum paschen series correspond transition n 4 n = 3 energy transition serie see figure 1.7 figure 1.7 wavelength electron orbital transitions energy inversely proportional wavelength energy associate change principal quantum number high initial value ni low final value nf equal energy photon predict planck quantum theory combine bohr planck calculation derive complex appear equation essentially say energy emit photon correspond difference energy high energy initial state low energy final state strange equation initial minus final equation usually final minus initial ultimately equation design work like expect atom emit photon equation give negative value energy indicate decrease easily check ni = 2 nf = 1 atomic absorption spectra electron excite high energy level absorb exactly right energy transition mean excite electron particular element

absorb exactly right energy transition mean excite electron particular element result energy absorption specific wavelength addition unique emission spectrum element possess characteristic absorption spectrum surprisingly wavelength absorption correspond exactly wavelength emission difference energy level remain unchanged identification element gas phase require δe absorption emission energy level accord conservation energy discuss chapter 2 mcat physics math review energy photon light absorb emit atomic emission absorption spectrum complex topic takeaway element characteristic set energy level electron low energy level high energy level absorb right energy absorb energy form light similarly electron high energy level low energy level emit energy form light absorption basis color compound color light absorb compound mcat concept check 1.3 assess understanding

material note question try estimate calculation calculator mimic test day condition double check answer calculator refer answer confirmation result 1 valence electron lithium atom jump energy level n = 2 n = 4 energy transition joule ev 2 electron emit 3 ev energy correspond wavelength emit photon note 1 ev = 1.60 × 1019 j h = 6.626 × 1034 j s 3 calculate energy photon wavelength 662 nm note h = 6.626 × 1034 j s 1.4 quantum mechanical model chapter 1.4 able identify quantum number potential range value relationship electron represent compare orbital diagram neutral atom sulfur s ion s2 differentiate paramagnetic diamagnetic compound determine number valence electron give atom bohr model mark significant advancement understanding structure atom model ultimately prove inadequate explain structure behavior atom contain electron model failure result take account repulsion multiple electron surround nucleus modern quantum mechanic lead rigorous generalizable study electronic structure atom important difference bohr model modern quantum mechanical model bohr postulate electron follow clearly define circular pathway orbit fix distance nucleus modern quantum mechanic show case understand electron rapidly localize region space nucleus call orbital confidence bohr time

rapidly localize region space nucleus call orbital confidence bohr time believe identify location pathway electron replace modest suggestion good describe probability find electron give region space surround nucleus current quantum mechanical model impossible pinpoint exactly electron give moment time express well heisenberg uncertainty principle impossible simultaneously determine perfect accuracy momentum position electron want assess position electron electron stop remove momentum want assess momentum electron move change position see visually figure 1.8 figure 1.8 heisenberg uncertainty principle known momentum uncertain position left know position uncertain momentum right λ = confidence interval position px = confidence interval momentum modern atomic theory postulate electron atom completely describe quantum number n l ml ms furthermore accord pauli exclusion principle electron give atom possess set quantum number position energy electron describe quantum

number know energy state value n limit value l turn limit value ml word give value n particular value l permissible give value l particular value ml permissible value quantum number qualitatively information size shape orientation orbital examine quantum number closely pay attention especially l ml tend student think quantum number specific go n l ml ms like address live particular state n particular city l particular street ml particular house number ms principal quantum number quantum number commonly know principal quantum number denote letter n.

quantum number bohr model theoretically positive integer value large integer value n high energy level radius electron shell shell capacity hold certain number electron maximum number electron shell = 2n2 n principal quantum number difference energy shell decrease distance nucleus increase energy difference function example energy difference n = 3 n = 4 energy difference n = 1 n = 2 shell see figure 1.7 remember electron travel precisely define orbit simplify visual representation electron motion remember large integer value principal quantum number indicate large radius high energy similar gravitational potential energy discuss chapter 2 mcat physics review high far object earth high potential energy azimuthal quantum number second quantum number call azimuthal angular momentum quantum number designate letter l. second quantum number refer shape number subshell give principal energy level shell azimuthal quantum number important important implication chemical bonding bond angle value n limit value l following way give value n range possible value l 0 n 1 example principal energy level n = 1 possible value l 0 second principal energy level n = 2 possible value l 0 1 simple way remember relationship n value tell number possible subshell subshell l = 0 principal energy level subshell l = 0 1 second principal energy level subshell l = 0 1 2 principal energy level principal quantum number n n possible value l range 0 n 1 spectroscopic notation refer shorthand representation principal azimuthal quantum number principal quantum number remain number azimuthal quantum number designate letter l = 0 subshell call s l = 1 subshell call p l = 2 subshell call d l = 3 subshell call f. electron

shell n = 4 subshell l = 2 say 4d subshell

spectroscopic notation subshell demonstrate figure 1.9 figure 1.9 spectroscopic notation subshell periodic table subshell capacity hold certain number electron give maximum number electron subshell = 4l + 2 l azimuthal quantum number energy subshell increase increase l value energy subshell different principal energy level overlap example 4s subshell low energy 3d figure 1.10 provide example computer generate probability map electron cloud hydrogen atom provide rough visual representation shape different figure 1.10 electron cloud subshell magnetic quantum number quantum number magnetic quantum number designate ml magnetic quantum number specify particular orbital subshell electron likely find give moment time orbital hold maximum electron possible value ml integer l + l include 0 example s subshell l = 0 limit possible ml value 0 single value ml orbital s subshell p subshell l = 1 limit possible ml value 1 0 +1 value ml orbital p subshell d subshell orbital 2 +2 f subshell seven orbital 3 +3 shape orbital like number orbital dependent

subshell find orbital s subshell spherical orbital p subshell dumbbell shaped align x- y- z axis fact p orbital refer px py pz orbitals—1 2 2px 2py 2pz demonstrate figure 1.11 note similarity image figure 1.11 atomic orbital value l 2l + 1 possible value ml n produce n2 orbital value n maximum 2n2 electron orbital shape orbital d f subshell complex mcat expect answer question appearance shape orbital define term concept call probability density likelihood electron find particular region space look 2p block periodic table mention 2p contain orbital orbital contain electron electron add course fill 2p orbital atomic number increase number electron assume species neutral surprise p block contain group element s block contain element row periodic table d block contain element f block contain fourteen element spin quantum number fourth quantum number call spin quantum number denote m classical mechanic object spin axis infinite number possible value angular momentum apply electron spin orientation designated electron orbital opposite spin case refer pair electron different

orbital ms value say parallel quantum number orbital second principal energy level maximum number electron note parenthesis show table 1.2 table 1.2 quantum number second principal energy level give atom ion pattern subshell fill number electron principal energy level subshell designate electron configuration electron configuration use spectroscopic notation number denote principal energy level letter designate subshell superscript give number electron subshell example 2p4 indicate electron second p subshell second principal energy level imply energy level 2p 1 2 fill show figure 1.12 figure 1.12 electron subshell flow diagram remember shorthand describe electron configuration derive directly quantum number write atom electron configuration need know order subshell fill electron fill lower- higher- energy subshell accord aufbau principle call build principle subshell fill completely electron begin enter order need memorize helpful way recall n + l rule

order need memorize helpful way recall n + l rule rank subshell increase energy rule state low sum value second quantum number n + l low energy subshell helpful rule remember test day subshell possess n + l value subshell low n value low energy fill electron example fill 5d subshell 6s subshell solution 5d n = 5 l = 2 n + l = 7 6 n = 6 l = 0 n + l = 6 6s subshell low energy fill alternative way approach electron configuration simply read periodic table remember low s subshell 1s low p subshell 2p low d subshell 3d low f subshell 4f see figure 1.9 simply read periodic table element interest fill subshell way know correct position lanthanide actinide series f block show figure 1.13 representation periodic table f block pull place rest table purely effect graphic design place f block correct location result lot excess white space page figure 1.13 periodic table lanthanide actinide series insert f block fit s block d block periodic table general chemistry course teach flow diagram figure 1.12 method determine order subshell filling electron configuration test day time consume error prone result incorrect electron configuration learn read periodic table describe good method electron configuration abbreviate place noble gas precede element interest bracket example electron configuration element period start potassium abbreviate start ar example electron configuration osmium z

= 76 solution noble gas come osmium xenon z = 54 electron configuration begin xe continue periodic table pass 6s subshell cesium barium 4f subshell lanthanide series remember position periodic table 5d subshell osmium sixth element 5d subshell configuration xe 6s24f145d6 method work neutral atom write electron configuration ion negatively charge ion anion additional electron fill accord rule example fluorine electron configuration 2s22p5 f 2s22p6 positively charge ion cation bit

electron configuration 2s22p5 f 2s22p6 positively charge ion cation bit complicated start neutral atom remove electron subshell high value n multiple subshell tie high n value electron remove subshell high l value example electron configuration fe3 + solution electron configuration iron ar 4s23d6 electron remove 4s subshell 3d subshell high principal quantum number fe3 + configuration ar 3d5 subshell contain orbital 2p subshell orbital orbital fill accord hund rule state give subshell orbital fill maximum number half fill orbital parallel spin like find seat crowded bus electron prefer seat orbital force double electron course basis preference electron repulsion electron orbital tend close repel electron place different orbital example accord hund rule orbital diagram nitrogen solution nitrogen atomic number 7 electron configuration 1s22s22p3 accord hund rule s orbital fill completely p orbital contain electron parallel spin iron atomic number 26 determine early electron configuration ar 4s23d6 electron fill subshell 3d contain orbital parallel upward spin orbital electron spin direction subshell list order fill 4s 3d subshell principal quantum number group show method correct important corollary hund rule half fill fully fill orbital low energy high stability state create notable exception electron configuration test mcat chromium element group copper element group chromium z = 24 electron configuration

ar 4s23d4 accord rule establish early move electron 4s subshell 3d subshell allow 3d subshell half fill ar 4s13d5 remember s subshell hold electron d subshell hold move 4s electron 3d-orbital energetically unfavorable extra stability make 3d subshell half fill outweigh cost

similarly copper z = 29 electron configuration ar 4s13d10 ar 4s23d9 d subshell outweigh cost move electron 4s subshell element group similar behavior move electron high s subshell high d subshell similar shift see f subshell observe p subshell extra stability outweigh cost presence paired unpaired electron affect chemical magnetic property atom molecule material compose atom unpaired electron orient spin alignment magnetic field material weakly attract magnetic field material consider paramagnetic example show figure 1.14 set iron orb influence magnet metallic sphere close induce magnet attract magnet figure 1.14 attraction paramagnetic iron sphere magnet remember paramagnetic mean magnetic field cause parallel spin unpaired electron cause attraction material consist atom pair electron slightly repel magnetic field say diamagnetic figure 1.15 piece pyrolytic graphite suspend air strong neodymium magnet electron allotrope configuration carbon pair covalent bonding layer material oppose reorient give sufficiently strong magnetic field beneath object diamagnetic substance levitate figure 1.15 diamagnetic pyrolytic graphite concept maglev magnetic levitation long science fiction powerful magnetic field strongly diamagnetic material transportation system develop frictionless high speed rail network japan scmaglev valence electron atom electron outermost energy shell easily remove available bonding word valence electron active electron atom large extent dominate chemical behavior atom element groups ia iia groups 1 2 high s subshell electron valence electron element groups iiia viiia group 13 18 high s p subshell electron valence electron transition element valence electron high s d subshell different principal quantum number lanthanide actinide series valence electron high s f subshell different principal quantum number element period start sodium accept electron

different principal quantum number element period start sodium accept electron d subshell allow hold electron valence shell allow violate octet rule discuss chapter 3 mcat general chemistry review valence electron configuration atom help understand property ascertainable periodic table cheat sheet available mcat test day able access periodic table click button label periodic table left screen use need example electron valence electron elemental vanadium

elemental selenium sulfur atom sulfate ion solution vanadium valence electron 4s subshell 3d subshell selenium valence electron 4s subshell 4p subshell selenium 3d electron valence shell sulfur sulfate ion 12 valence electron original plus oxygen bond sulfur 3 3p subshell contain 12 electron electron enter sulfur atom 3d subshell normally elemental sulfur mcat concept check 1.4 assess understanding material 1 give follow quantum number element(likely refer note assume quantum number describe valence electron element 2 write compare orbital diagram neutral oxygen o atom o2 ion 3 magnetic resonance angiography mra technique resolve defect like stenotic narrowed artery contrast agent like gadolinium manganese inject blood stream interact strong magnetic field mri device produce image base orbital configuration contrast agent paramagnetic 4 determine valence electron come subshell total valence electrons total valence electrons congratulation chapter cover topic relate fundamental unit matter atom you’re set advance understanding physical world complex way chapter describe characteristic behavior subatomic particle proton neutron electron addition compare contrast model atom bohr model adequate describe structure electron system hydrogen atom helium ion fail adequately describe structure complex atom quantum mechanical model theorize electron find discrete orbit cloud probability orbital predict likelihood find electron give region space surround nucleus theory tell energy level available electron infinite discrete energy difference level precise call quantum quantum number completely describe location energy electron give atom finally learn simple recall method order electron fill shell subshell atom valence electron reactive

method order electron fill shell subshell atom valence electron reactive electron atom chapter look element organize periodic table turn attention bonding behavior base valence electron chapter 3 mcat general chemistry review review content test knowledge critical thinking skill complete test like passage set online resource proton positive charge mass 1 amu neutron charge mass 1 amu electron negative charge nucleus contain proton neutron electron nucleus atomic number number proton give element mass number sum element proton neutron

atomic mass vs. atomic weight atomic mass essentially equal mass number sum element proton neutron isotope atom give element atomic number different mass number differ number neutron isotope identify element follow mass number carbon-12 carbon-13 carbon-14 isotope hydrogen different name protium deuterium atomic weight weight average naturally occur isotope element periodic table list atomic weight atomic masse rutherford planck bohr rutherford postulate atom dense positively charge nucleus small fraction volume atom bohr model atom dense positively charge nucleus surround electron revolve nucleus orbit distinct energy difference energy level call quantum describe planck quantization mean infinite range energy level available electron electron exist certain energy level energy electron increase far nucleus atomic absorption spectrum element unique electron jump low energy level high absorb energy precisely equal energy difference level electron return excited state ground state emit energy exactly equal energy difference level element characteristic atomic emission spectrum electromagnetic energy emit correspond frequency visible light range quantum mechanical model atom quantum mechanical model posit electron travel define orbit localize orbital orbital region space nucleus define probability find electron region heisenberg uncertainty principle state impossible know electron position momentum exactly time quantum number number completely describe electron atom principal quantum number n describe average energy shell azimuthal quantum number l describe subshell give principal energy level s p d f magnetic quantum number ml specify particular

s p d f magnetic quantum number ml specify particular orbital subshell electron likely find give moment time spin quantum number m indicate spin orientation electron orbital electron configuration use spectroscopic notation combine n l value number letter respectively designate location example 1s22s22p63s2 electron configuration magnesium neutral magnesium atom 12 electron s subshell energy level s subshell second energy level p subshell second energy level s subshell energy level electron 3s subshell valence electron magnesium atom electron fill principal energy level subshell accord increase energy

determine n + l rule electron fill orbital accord hund rule state subshell multiple orbital p d f fill electron orbital subshell get electron get second paramagnetic material unpaired electron align magnetic field attract material magnet diamagnetic material pair electron easily realign repel magnet valence electron electron outermost shell available interaction bonding atom representative element group 1 2 1318 valence electron find s- and/or p orbital transition element valence electron find s- d- atom interact atom form bond complete octet valence shell answer concept check 1 charge determine number electron present atomic number determine number proton isotope determine number neutron proton mass number number neutron explain variability isotope 2 18o 8 p+ 10 n0 8 e–. 18f 9 p+ 9 n0 9 e–. 1 atomic mass slightly sum masse proton neutron give atom element atom element different mass number isotope atomic weight weight average naturally occur isotope element 2 ratio equivalent concept acceptable long unit cancel dimensional analysis 2p b c n o f ne 3 na mg 5f actinide series 4d y zr nb mo tc ru rh pd ag cd 2 o o2 fully fill 1s- 2 orbital o electron 2p subshell pair orbital o2 electron 2p subshell pair p- 3 molecule unfilled valence electron shell relatively pair electron paramagnetic science mastery assessment remember electron remove element form cation remove subshell high n value zn0 30 electron electron configuration 1s22s22p63s23p64s23d10 4s subshell high principal quantum number empty form 1s22s22p63s23p64s03d10 b imply electron pull d subshell c present configuration uncharged zinc atom d show configuration exist electron remove azimuthal quantum number l high n 1

rule ml number describe chemical magnetic property integer value l l. equal ±1 l = 0 imply s subshell orbital 1 0 1 know rule c d value n maximum 2n2 electron orbital determine periodic table element h valence electron n = 1 shell element li ne valence electron n = 2 shell equation match pattern formula describe number electron term azimuthal quantum number l range 0 n 1 n principal quantum number table maximum number electron subshell azimuthal quantum number l number electron answer choice unpaired electron ground state helium recall

chapter diamagnetic substance identify lack unpaired electron shell substance unpaired electron like helium magnetize external magnetic field actually slightly repel element come end block group iia group contain zn noble gas notably pair electron problem require mcat favorite equation h = 6.626 × 1034 j s planck constant speed light λ wavelength light question ask energy mole photon multiply avogadro number na = 6.02 × 1023 mol1 setup round calculation find answer choice closely match value d close match electron move n = 1 shell subshell available 1s subshell eliminate c d energy change electron lose energy return minimum- energy ground state require emit radiation form photon recall superscript refer mass number atom equal number proton plus number neutron present element text list atomic number z subscript mass number a. accord periodic table carbon contain proton atomic number 6 isotope number proton differ number neutron atom z > 1 neutron carbon likely mass number 12 proton neutron b c d possible isotope neutron 12c. 6c isotope unlikely mean 6 proton 0 neutron show figure 1.4 highly limitation place heisenberg uncertainty principle cause limitation inherent measuring process particle move momentum try measure momentum necessarily create uncertainty position exact definition meter perfect measuring device b able

measure position momentum simultaneously exactly electron gain energy absorb energy photon jump high energy level big jump n = 2 n = 6 n = 3 n = 4

mcat cover topic chapter qualitatively quantitatively critical able distinguish fundamental principle determine electron organization usually know name scientist discover postulate heisenberg uncertainty principle b refer inability know momentum position single electron simultaneously bohr model c early attempt describe behavior single electron hydrogen atom rutherford model d describe dense positively charged nucleus element show phosphorus demonstrate hund rule contain half fill p subshell hund rule explain electron fill orbital double electron orbital quick way solve problem use periodic table find proton cs atom 55 neutral cs

atom 55 electron stable cs cation single positive charge unpaired s electron translate few electron number proton 54 electron easy way approach problem set system algebraic equation h d percentage h mass = 1 amu d mass = 2 amu respectively setup look like following system h + d = 1 percent h + percent d = 100 1 h + 2 d = 1.008 atomic weight calculation rearrange equation substitute second yield 1 d + 2d = 1.008 d = 0.008 0.008 0.8 0.8 d. term answer choice refer magnetic spin electron quantum number ms represent property measure electron intrinsic spin electron spin parallel spin align direction specie deal ion directly approach electronic configuration base number electron currently hold examine neutral atom configuration determine electron remove neutral atom configuration cr0 ar 4s13d5 mn0 ar 4s23d5 mn+ ar 4s13d5 fe0 ar 4s23d6 fe2 + ar 4s03d6 stability half fill d orbital neutral chromium assume electron configuration ar 4s13d5 mn lose electron initial configuration mn+ cation electron come 4s subshell accord rule electron remove come high energy shell fe lose electron fe2 + lose orbital way fe2 + hold configuration question stem d electron s electron lose consult online resource additional practice equation remember 1.1

planck relation frequency e = hf 1.2 angular momentum electron bohr model 1.3 energy electron bohr model 1.4 planck relation wavelength 1.5 energy electron transition bohr model 1.6 maximum number electron shell 2n2 1.7 maximum number electron subshell 4l + 2 general chemistry chapter 2 periodic table general chemistry chapter 3 bonding chemical interactions organic chemistry chapter 3 physics math chapter 2 work energy physics math chapter 8 light optic physics math chapter 9 atomic nuclear phenomena periodic table pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question

correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read corresponding subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 lithium sodium similar chemical property example form ionic bond chloride following well explain a. lithium sodium ion positively charge b. lithium sodium group periodic table c. lithium sodium period periodic table d. lithium sodium low atomic weight 2 carbon silicon basis biological life synthetic computing respectively element share chemical property follow well describe difference element a. carbon small atomic radius silicon b. silicon small atomic radius carbon c.

carbon few valence electron silicon d. silicon few valence electron carbon 3 following element high electronegativity 4 ionization energy contribute atom chemical reactivity follow show accurate ranking ionization energy low a. ionization energy < second ionization energy < ionization energy li b. ionization energy < ionization energy li < second ionization energy c. ionization energy li < ionization energy < second ionization energy d. ionization energy li < second ionization energy < ionization energy 5 antimony antiparasitic medication specifically target leishmania donovani type element antimony 6 property atom predict extent location periodic table property property increase direction arrow show ii atomic radius iii ionization energy a. b. ii c. iii d. ii iii 7 metal make wire conduct electricity following property metal explain a. metal malleable b. metal low electronegativity c. metal valence electron freely d. metal high melting point 8 follow important property group element shade periodic table a. element good electrical conductor periodic table b. element form divalent cation c. second ionization energy element low d. atomic radius element decrease move 9 dissolve water following ion likely form complex ion h2o 10 valence electron present element period c. number decrease atomic number increase d. number increase atomic number increase 11

arsenic mediate toxic effect inhibition acetyl coa formation inhibition enzyme succinic dehydrogenase decrease atp production addition metabolic effect arsenic replace phosphorus reaction follow well explain similarity element a. similar atomic number b. similar number electron c. similar valence configuration d. similar atomic radius 12 atom depict high electron affinity 13 following atom ion large effective nuclear charge 14

halogen form ionic bond alkaline earth metal a. alkaline earth metal high electron affinity b. share electron equally alkaline earth metal halogen form octet c. row halogen small atomic radius alkaline earth metal d. halogen high electron affinity alkaline earth 15 high energy orbital element valence electron n = answer key follow page periodic table chapter 2.1 periodic table 2.2 type element 2.3 periodic property element atomic ionic radii 2.4 chemistry group alkali metals ia alkaline earth metals iia noble gases viiia transition metal b content chapter relevant 10 question general chemistry mcat chapter cover material following aamc content category 4e atom nuclear decay electronic structure atomic chemical behavior pharmacological history lithium interesting window scientific medical community attempt advantage chemical physical property element human benefit mid-1800 medical community show great interest theory link uric acid myriad malady discover solution lithium carbonate dissolve uric acid therapeutic preparation contain lithium carbonate salt popular nonmedical company try profit lithium reputation cure add soft drink eventually fascination theory uric acid wear lithium time spotlight come end 1940 doctor begin recommend salt restrict diet cardiac patient lithium chloride commercially available sodium chloride table salt substitute unfortunately lithium toxic fairly low concentration medical literature late 1940 report incident severe poisoning multiple death associate minor lithium overdosing u.s. company voluntarily withdraw lithium salt market right time

john cade psychiatrist australia propose use lithium salt treatment mania cade clinical trial successful fact use lithium salt control mania instance successful medical treatment mental

illness lithium carbonate commonly prescribe europe manic behavior 1970 u.s. food drug administration finally approve use lithium carbonate manic symptom lithium li element atomic number 3 soft alkali metal standard condition dense solid element specific gravity = 0.53 lithium reactive naturally occur earth elemental form find salt compound medical scientist pay attention particular element doctor believe lithium chloride good substitute sodium chloride patient salt- restrict diet answer lie periodic table 2.1 periodic table chapter 2.1 able explain modern periodic table organize differentiate representative nonrepresentative element 1869 russian chemist dmitri mendeleev publish version periodic table element show order know element accord atomic weight reveal pattern periodically recur physical chemical property periodic table revise work english physicist henry moseley organize element base increase atomic number number proton element atomic weight revise table property element discover predict periodic table create visual representation periodic law state chemical physical property element dependent periodic way atomic modern periodic table arrange element period row group family column base atomic number seven period represent principal quantum number n = 1 n = 7 s- p

block element period fill sequentially element give period proton electron element left neutral state group contain element electronic configuration valence shell share similar recall chapter 1 mcat general chemistry review period row graphically represent principal quantum number group column help determine valence electron configuration electron valence shell know valence electron farth nucleus great potential energy high potential energy fact hold tightly nucleus allow involve chemical bond valence electron atom valence shell electron largely determine chemical reactivity property element relate valence electron reactivity important element similar valence electron configuration generally behave similar way long type metal nonmetal metalloid roman numeral group represent number valence electron element group neutral state roman numeral combine letter b separate element large class element know representative element include group ia viiia element group valence electron orbital s p

subshell b element know nonrepresentative element include transition element valence electron s d subshell lanthanide actinide serie valence electron s f subshell representative element roman numeral letter designation determine electron configuration example element group va valence electron configuration s2p3 describe chapter 1 mcat general chemistry review nonrepresentative element unexpected electron configuration chromium 4s13d5 copper 4s13d10 modern iupac identification system group number 1 18 subdivide group group b element mcat concept check 2.1 assess understanding material 1 mendeleev table arrange atomic weight modern periodic table arrange 2 follow representative element element b element b element b element b 2.2 type element chapter 2.2 able classify element metal nonmetal metalloid predict trait element give location periodic table consider trend chemical reactivity physical property begin identify group element similar characteristic large collection divide category metal nonmetal metalloid call metal find left middle periodic table include active metal transition metal lanthanide actinide series element metal lustrous shiny solid mercury liquid standard condition generally high melting point density exception lithium density half water

generally high melting point density exception lithium density half water metal ability deform break ability metal hammer shape call malleability ability pull draw wire call ductility atomic level metal define low effective nuclear charge low electronegativity high electropositivity large atomic radius small ionic radius low ionization energy low electron affinity characteristic manifestation ability metal easily electron transition metal group b element oxidation state charge form bond atom valence electron metal loosely hold atom free make metal good conductor heat electricity valence electron active metal find s subshell transition metal find s d subshell lanthanide actinide series element s f subshell transition metal copper nickel silver gold palladium platinum relatively nonreactive property make ideal production coin jewelry alkali alkaline earth metal metallic nature easily lose electron s

subshell valence shell example metal show figure 2.1 copper wire wire exhibit luster malleability ductility wire exhibit good heat electrical conductivity figure 2.1 copper cu metal wire nonmetal find predominantly upper right periodic table nonmetal generally brittle solid state little metallic luster high ionization energy electron affinity electronegativity small atomic radius large ionic radius usually poor conductor heat electricity characteristic manifestation inability nonmetal easily electron nonmetal unified chemical physical property metal carbon show figure 2.2 stereotypical nonmetal retain solid structure brittle nonlustrous generally poor conductor heat electricity figure 2.2 charcoal compose nonmetal carbon c separate metal nonmetal stair step group element call metalloid metalloid call semimetal share characteristic metal nonmetal electronegativity ionization energy metalloid lie metal nonmetal physical property density melting point boiling point vary widely combination metallic nonmetallic characteristic example silicon si metallic luster brittle poor conductor reactivity metalloid dependent element react boron b example behave like nonmetal react sodium na like metal react fluorine f element classify metalloid form staircase periodic table include boron silicon germanium ge arsenic antimony sb tellurium te polonium po astatine debate polonium astatine status metalloid source label figure 2.3 color code major classification element periodic figure 2.3 periodic table code element type metalloid share property metal nonmetal instance metalloid good semiconductor partial conductivity electricity mcat concept check 2.2 assess understanding material 1 base location periodic table identify element likely possess following property poor conductivity heat electricity good conductivity brittle 2 classify following element metal m nonmetal nm 2.3 periodic property chapter 2.3 able compare atomic radius neutral atom ion rank element ionization energy electron affinity electronegativity mcat expect memorize entire periodic table fortunately periodic table guide unto self reference localization system element remember modern table organize way represent visually periodicity chemical physical property element periodic table provide tremendous information memorize note need memorize

element periodic table provide tremendous information memorize note need memorize periodic table mcat need understand trend periodic table help predict chemical physical behavior element try memorize periodic table access test day test interface understand configuration trend use efficiently high score explore periodic trend let stock key rule control valence electron work atom mention move left right period electron proton add time positivity nucleus increase electron surround nucleus include valence shell experience strong electrostatic pull center atom cause electron cloud outer boundary define valence shell electron close bind tightly nucleus electrostatic attraction valence shell electron nucleus know effective nuclear charge zeff measure net positive charge experience outermost electron pull somewhat mitigate nonvalence electron reside close nucleus element period zeff increase left right part atom responsible zeff illustrate figure 2.4 figure 2.4 factor determine effective nuclear charge zeff zeff rely principle electrostatic force define chapter 5 mcat physics math review value q1 q2 represent net charge nucleus valence electron shell respectively large charge get go right periodic table high value zeff second move element give group principal quantum number increase time mean valence electron increasingly separate nucleus great number fill principal energy level call inner shell result increase separation reduction electrostatic attraction valence electron positively charge nucleus outermost electron hold tightly principal quantum number increase go group increase shielding create inner shell electron cancel increase positivity nucleus zeff constant element give group despite fact valence electron hold tightly nucleus move group increase separation valence electron nucleus element gain lose electron order achieve stable octet formation representative noble inert gas group viiia group 18 chapter 3 mcat general chemistry review discuss octet rule hardly rule exception mind element especially one biological role tend stable electron valence shell fact guide principle work understanding trend demonstrate periodic table fact trend effective nuclear charge period impact

demonstrate periodic table fact trend effective nuclear charge period impact increase number

inner shell group help derive trend discuss atomic ionic radii think atom cloud electron surround dense core proton neutron atomic radius element equal half distance center atom element briefly contact distance center circle contact akin diameter make radius calculation simple atomic radius measure examine single atom electron constantly move make impossible mark outer boundary electron cloud atomic radius refer size neutral element ionic radius dependent element ionize base element type group number period left right proton electron add time atom electron add outermost shell number inner- shell

electron remain constant increase positive charge nucleus pull outer electron closely inward hold tightly zeff increase left right period result atomic radius decrease left right atomic radius essentially opposite periodic trend increase go right atomic radius increase go left group increase principal quantum number imply valence electron find far away nucleus number inner shell increase separate valence shell nucleus zeff remain essentially constant atomic radius increase group group large atom period large atom group ia group 1 reference large atomic radius periodic table belong cesium cs 260 pm small belong helium 25 pm francium typically consider exceptionally rare nature figure 2.5 display graph atomic radius vs. atomic number group ia element possess large atomic radius row figure 2.5 atomic radius pm vs. atomic number unlike atomic radius ionic radius

require critical thinking periodic table geography determine order understand ionic radius generalization metal lose electron positive nonmetal gain electron negative metalloid direction tend follow trend base metalloid line fall silicon si behave like nonmetal germanium ge tend act like metal mcat generalization infer information find passage question oxidation state compound nonmetal close metalloid line group number dictate require electron nonmetal achieve electronic configuration see group viiia group 18 nonmetal gain electron nucleus maintain charge nonmetal close metalloid line possess large ionic radius counterpart close group metal trend similar opposite metal close metalloid line electron lose achieve

electronic configuration see group viiia ionic radius metal near metalloid line dramatically small metal metal close group ia few electron lose experience drastic reduction radius ionization change illustrate figure 2.6 note tellurium te behave nonmetal boron b behave metal vary condition metalloid opposite figure 2.6 ionic radii pm metals nonmetals neutral atom show purple cation black anion green ionization energy ie know ionization potential energy require remove electron gaseous species remove electron atom require input heat make endothermic process great atom zeff close valence electron nucleus tightly bound make difficult remove electron increase ionization energy ionization energy increase left right period group subsequent removal second electron require increase amount energy removal electron mean electron remove increasingly cationic positive species energy necessary remove electron call ionization energy energy necessary remove second electron univalent cation x+ form divalent cation x2 + call second ionization energy elements groups ia iia groups 1 2 lithium beryllium low ionization energy call active metal active metal exist naturally neutral form find ionic compound mineral ore loss electron alkali metal group ia loss electron alkaline earth metal group iia result formation stable fill valence shell contrast group viia group 17 element halogen typically electron fact ionic form generally anion ionization energy

halogen typically electron fact ionic form generally anion ionization energy element show figure 2.7 ionization energies ev elements ionization energy ie small second ie small ie degree ie increase provide clue identity atom lose certain number electron give element noble gas like electron configuration remove subsequent electron cost energy example mg2 + g mg3 + g + e value second ionization energy disproportionally large group ia monovalent cation like na+ generally large group iia subsequent monovalent cation like mg+ remove electron group ia metal result noble gas like electron configuration group viiia group 18 element noble inert gas likely electron stable electron configuration unwilling disrupt stability give electron noble gas element high ionization energy halogen greedy group element periodic table come electron acquire additional electron halogen able complete octet achieve noble gas

configuration exothermic process expel energy form heat electron affinity refer energy dissipate gaseous species gain electron note electron affinity essentially opposite concept ionization energy exothermic process δhrxn negative sign electron affinity report positive number electron affinity refer energy dissipate electron affinity strong electrostatic pull high zeff nucleus valence shell electron great energy release atom gain electron electron affinity increase period left right valence shell far away nucleus principal quantum number increase electron affinity decrease group group ia iia group 1 2 low electron affinity prefer electron achieve octet configuration noble gas previous period conversely group viia group 17 element high electron affinity need gain electron achieve octet configuration noble gas group viiia group 18 period noble gas predict high electron affinity accord trend actually electron affinity order zero possess stable octet readily accept electron metal low electron affinity value see figure 2.8 figure 2.8 electron affinity ev elements electronegativity measure attractive force atom exert electron chemical bond great electronegativity atom attract electron bond electronegativity value relate ionization

great electronegativity atom attract electron bond electronegativity value relate ionization energy low ionization energy low electronegativity high ionization energy high electronegativity noble gas exception despite high ionization energy element negligible electronegativity form bond electronegativity value relative measure different scale express common scale pauling electronegativity scale range 0.7 cesium electronegative electropositive element 4.0 fluorine electronegative element electronegativity increase period left right decrease group figure 2.9 show electronegativity value figure 2.9

pauling electronegativity values element c = large electronegative f = small electronegative periodic trend summarize figure 2.10 figure 2.10 periodic trend left right atomic radius ionization energy electron affinity atomic radius ionization energy electron affinity
note atomic radius opposite trend ionic radius variable mcat concept check 2.3 assess

understanding material 1 following pair large radius f f k k+ 2 rank following element decrease ionization energy calcium carbon c germanium ge potassium k 3 rank follow element increase electron affinity barium ba copper cu sulfur s yttrium y 4 rank follow element decrease electronegativity antimony sb neon ne oxygen o thallium tl 5 rank following element increase atomic radius niobium nb praseodymium pr tantalum ta xenon xe 2.4 chemistry groups chapter 2.4 able identify group periodic table property exhibit connect periodic table group 1 2 16 17 18 3–12 common follow discussion major group likely encounter mcat rare test group important understand overarching trend discuss relate different group alkali metals ia alkali metal group ia group 1 possess classic physical property metal density low metal describe lithium early chapter alkali metal loosely bind electron outermost shell zeff value low give large atomic radius element respective period low zeff value explain trend low ionization energy low electron affinity low electronegativity alkali metal easily lose electron form univalent cation react readily nonmetal especially halogen nacl figure 2.11

illustrate reaction alkali metal water stereotypically violent reaction figure 2.11 reaction sodium water group ia metal react violently water form strong basis high reactivity water air alkali metal store mineral oil alkaline earth metals iia alkaline earth metal group iia group 2 possess property characteristic metal share characteristic alkali metal slightly high effective nuclear charge slightly small atomic radius electron valence shell easily remove form divalent cation alkali alkaline earth metal call active metal reactive naturally find elemental chalcogen group group 16 eclectic group nonmetal metalloid reactive halogen crucial normal biological function electron valence electron shell proximity metalloid generally small atomic radius large ionic radius oxygen important element group reason primary constituent water carbohydrate biological molecule sulfur important component certain amino acid vitamin selenium important nutrient microorganism role protection oxidative stress remainder group primarily metallic generally toxic live organism important note high concentration element matter biologically useful toxic damaging molecule discuss metabolism cover chapter 9 12

mcat biochemistry review utilize light nontoxic element chalcogen group oxygen sulfur heavy chalcogen toxic metal halogen group viia group 17 highly reactive nonmetal seven valence electron element desperate complete octet gain additional electron physical property group variable standard condition halogen range gaseous f2 cl2 liquid br2 solid i2 form chemical reactivity uniform high electronegativity electron affinity especially reactive alkali alkaline earth metal fluorine f high electronegativity element halogen reactive naturally find elemental state ion call halide diatomic molecule diatomic iodine standard condition see figure 2.12 figure 2.12 iodine standard state diatomic iodine halogen frequently test mcat remember need electron noble gas like electron configuration valence shell noble gases viiia noble gas group viiia group 18 know inert gas minimal chemical reactivity fill valence shell high ionization energy little tendency gain lose electron ne ar measurable electronegativity noble gas extremely low boiling point exist gas

measurable electronegativity noble gas extremely low boiling point exist gas room temperature noble gas find commercial niche lighting source see figure 2.13 lack reactivity figure 2.13 noble gas neon sign transition metal b transition element groups ib viiib groups 3 12 consider metal low electron affinity low ionization energy low electronegativity metal hard high melting boiling point tend malleable good conductor loosely hold electron progressively fill d orbital valence shell unique property transition metal different possible charge form oxidation state capable lose different number electron s- d orbital valence shell instance copper cu exist +1 +2 oxidation state manganese mn exist +2 +3 +4 +6 +7 oxidation state ability attain different positive oxidation state transition metal form different ionic compound different oxidation state correspond different color solution transition metal contain complex vibrant show figure 2.14 figure 2.14 solution transition metal contain compound left right cobalt(ii nitrate co(no3)2 red potassium dichromate k2cr2o7 orange potassium chromate k2cro4 yellow nickel(ii chloride nicl2 green copper(ii sulfate cuso4 blue potassium permanganate kmno4 violet complex ion tend associate solution molecule water hydration

complex cuso4 5 h2o nonmetal co(nh3)6]cl3 ability form complex contribute variable solubility certain transition metal contain compound example agcl insoluble water soluble aqueous ammonia formation complex ion ag(nh3)2]+ formation complex cause d orbital split energy sublevel enable complex absorb certain frequency light contain precise energy require raise electron lower- high energy d orbital frequency absorb know subtraction frequency complex transition metal act cofactor enzyme include vanadium chromium manganese iron cobalt nickel copper zinc cofactor coenzyme discuss chapter 2 mcat biochemistry review bring important point perception color perceive object particular color color absorb reflect object object absorb give color light reflect brain mix subtraction frequency perceive complementary color frequency absorb well illustrate example carotene photosynthetic pigment strongly absorb blue light reflect color brain interpret color

pigment strongly absorb blue light reflect color brain interpret color carotene result white light minus blue light yellow light complementary color show figure 2.15 mcat unlikely ask complement give color relationship complementary color explain fair game note manner color mix scheme distinctly different mix paint color difference scheme term additive subtractive color mixing respectively outside scope figure 2.15 red green blue additive color wheel color directly circle complementary color commonly reference complementary pair include red cyan green magenta blue yellow mcat concept check 2.4 assess understanding material 1 property list write group periodic table exhibit property high reactivity water valence electron contain metal multiple oxidation state negative oxidation state possess octet neutral state complete review periodic table elements commit understand memorize trend physical chemical property element help quickly answer question mcat progress chapter book foundational understanding element help develop rich nuanced understanding general particular behavior topic general chemistry give trouble past understandable perspective behavior characteristic review broadly diverse array element group discuss critical detrimental biological function addition begin human body utilize certain element specific purpose take advantage periodic

trend discuss review content test knowledge critical thinking skill complete test like passage set online resource periodic table

periodic table elements organize element accord atomic number reveal pattern similar chemical physical property element row call period base principal energy level n. column call group element group valence shell electron configuration type elements element periodic table belong type metal shiny lustrous conduct electricity malleable ductile metal find left middle periodic table nonmetal dull poor conductor electricity brittle nonmetal find right periodic table metalloid possess characteristic metal nonmetal find stair step pattern start boron b periodic property element effective nuclear charge zeff net positive charge experience electron valence shell form foundation periodic trend zeff increase left right period little change value group valence electron increasingly separated nucleus principal energy level n increase group atomic radius decrease left right period increase group ionic radius size charge species large nonmetallic ionic radius small metallic ionic radius exist metalloid boundary cation generally small correspond neutral atom anion generally large correspond neutral atom ionization energy energy necessary remove electron valence shell gaseous species increase left right period decrease group electron affinity energy release

gaseous species gain electron valence shell increase left right period decrease group electronegativity measure attractive force nucleus electron bond increase left right period decrease group chemistry groups alkali metal typically oxidation state +1 prefer lose electron achieve noble gas like configuration alkaline earth metal reactive metal alkaline earth metal oxidation state +2 lose electron achieve noble gas like configuration chalcogen oxidation state 2 +6 depend nonmetal metal respectively order achieve noble gas configuration biologically important halogen typically oxidation state 1 prefer gain electron achieve noble gas like configuration nonmetal noble gas fully fill valence shell standard state prefer additional electron high ionization energy ne ar virtually nonexistent electronegativity transition metal

unique multiple oxidation state explain ability form colorful complex nonmetal solution utility certain biological system answer concept check 1 modern periodic table arrange order atomic number b b b b 1 metal luster nonmetal poor conductivity metalloid exhibit brittleness good conductivity answer category 1 f > f k > k+ ionic radius anion large associate atomic radius ionic radius cation small 2 ionization energy carbon > germanium > calcium > potassium 3 electron affinity barium < yttrium < copper < sulfur 4 electronegativity oxygen > antimony > thallium > neon 5 atomic radius xenon < niobium < tantalum < praseodymium high reactivity water group 1 2 valence electron group 6 16 contain metal group 1 15 multiple oxidation state group notably group 3 12 negative oxidation state group notably group 14 possess octet neutral state group 18 science mastery assessment periodic table organize period row group column group column particularly significant represent set element valence electron configuration turn dictate chemical property element true fact ion positively charge explain similarity chemical property metal produce positively charge ion c true lithium sodium group period finally lithium sodium relatively low atomic weight element

group period finally lithium sodium relatively low atomic weight element share property eliminate d move group column extra electron shell accumulate despite fact valence configuration remain identical extra electron shell provide shielding positive nucleus outermost electron decrease electrostatic attraction increase atomic radius carbon silicon group silicon far group silicon large atomic radius extra electron shell question require knowledge trend electronegativity periodic table electronegativity increase move left right reason effective nuclear charge increase electronegativity decrease move periodic table electron shell separate nucleus outermost electron question chlorine furth right corner periodic table make b correct answer ionization energy increase left right ionization energy lithium low beryllium second ionization energy large ionization energy beryllium second ionization energy high value remove additional electron be+ require overcome significantly large electrostatic force antimony sb

right periodic table far right nonmetal d certainly lie far right fall group viia group 17

classify halogen c source rarely classify antimony metal usually classify electronegativity describe strong attraction element electron bond nucleus large effective nuclear charge high electronegativity zeff increase right period strong nuclear pull lead increase ionization energy force difficult remove electron vertical arrow explain size atom size decrease positive charge effective attract electron chemical bond high electronegativity energy require remove electron ionization description metal true significant property contribute ability metal conduct electricity fact valence electron freely malleability ability shape material hammer play role conduct electricity low electronegativity high melting point metal b d play major role conduction electricity block represent alkaline earth metal form divalent cation ion +2 charge element group iia electron outermost s subshell loss electron leave octet outermost shell divalent cation stable configuration alkaline earth metal element great conductor effective alkali metal eliminate c incorrect form divalent cation stable configuration alkaline earth metal second ionization energy high finally d incorrect atomic radius increase move group element number electron shell increase iron transition metal transition metal form ion iron example fe2 + fe3 + transition metal oxidation state form hydration complex water significance complex transition metal form complex solubility relate solvent increase ion give dissolve readily water transition metal likely form complex question simple recall period refer row periodic table group family refer column period additional valence electron add step right phosphorous arsenic find group 5a indicate similar number valence electron valence electron configuration main determinant bonding element similar valence state react similarly support c correct answer question surprising question illustrate important exception trend electron affinity generally increase move right periodic table base trend expect atom fluorine depict b correct correct answer chlorine d despite fact chlorine fluorine periodic table diagram answer choice help sense apparent exception fluorine chlorine valence electron configuration similar

effective nuclear charge electron add fluorine valence

electron configuration similar effective nuclear charge electron add fluorine valence shell negative charge add second energy shell small physical size mean new electron crowd small energy shell seven electron result energy release electron add fluorine energy predict general trend contrast additional electron add chlorine atom new electron add energy shell repulsion valence electron lead slightly great electron affinity chlorine chlorine d high electron affinity right answer effective nuclear charge refer strength proton nucleus pull electron phenomenon help explain electron affinity electronegativity ionization energy effective nuclear charge calculate subtract number non valence electron number proton b chlorine 17 proton 10 non valence electron give zeff 7 elemental potassium c low effective nuclear charge contain additional inner shell shield valence electron nucleus 19 proton 18 non valence electron zeff 1 d ionic potassium high effective nuclear charge option electron configuration cl 10 non valence electron contain extra proton nucleus zeff 9 ionic bond form unequal sharing electron bond typically occur electron affinity bond atom differ greatly example halogen high electron affinity add single electron valence shell create valence shell contrast alkaline earth metal low electron affinity likely electron donor loss electron leave valence shell state opposite incorrect halogen high electron affinity alkaline earth metal low electron affinity b incorrect equal sharing electron classic description covalent bonding ionic c true statement relevant ionic bond form n = 3 l = 0 1 2 high value l case 2 correspond d subshell 3d block appear fourth period

principal quantum number n = 3 general subshell energy shell increase energy follow s < p < d < f 3f subshell consult online resource additional practice general chemistry chapter 1 general chemistry chapter 3 bonding chemical interactions general chemistry chapter 4 compound stoichiometry organic chemistry chapter 3 physics math chapter 5 electrostatic magnetism physics math chapter 9 atomic nuclear phenomena bonding chemical pre med know feeling

content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 character bond carbon dioxide b. polar covalent c. nonpolar covalent d. coordinate covalent 2 following molecule contain oxygen atom negative average formal charge 3 following element break octet rule 4 follow correctly rank compound ascend iv isopropyl alcohol a. < ii < iv < iii b. iii < iv < < ii c. ii < iv < < iii d. iii < < iv < ii 5 co32 clf3 atom bond central atom good explanation co32 trigonal planar electronic geometry clf3 trigonal bipyramidal electronic geometry a. co32 multiple resonance structure clf3 b. co32 charge 2 clf3 charge c. clf3

lone pair central atom co32 d. co32 lone pair central atom clf3 6 following element pair form ionic bond a. ii iv b. ii c. ii iii d. iii iv 7 despite fact c2h2 hcn contain triple bond length triple bond equal follow good explanation finding a. c2h2 bond short atom b. molecule different resonance structure c. carbon electronegative hydrogen d. nitrogen electronegative carbon 8 follow good explanation phenomenon hydrogen a. hydrogen strong affinity hold valence electron b. hydrogen hold valence electron c. electronegative atom disproportionately carry share electron pair bond hydrogen d. hydrogen bond ionic character 9 following well describe number character bond ammonium cation a. polar covalent bond b. polar covalent bond coordinate covalent bond c. polar covalent bond coordinate covalent bond d. polar covalent

bond coordinate covalent bond 10 octet rule dictate molecular structure atom violate octet rule surround electron follow good explanation

atom exceed a. atom exceed octet electron outermost b. atom exceed octet bond transition metal c. atom exceed octet d orbital extra electron reside d. atom exceed octet highly electronegative 11 following type intermolecular force provide accurate explanation noble gas liquefy a. hydrogen bonding b. ion dipole interaction c. dispersion force d. dipole dipole interaction 12 structure show atom(positive charge a. phosphorus atom positive charge b. atom share charge equally c. oxygen atom share high charge d. oxygen atom peak trigonal pyramidal geometry positive charge 13 follow good new bond form reaction a. nonpolar covalent bond b. ionic bond c. coordinate covalent bond d. hydrogen bond 14 bf3 nh3 atom bond central atom follow good explanation geometry molecule a. bf3 bond atom lone pair make geometry b. nh3 nonpolar bf3 polar c. nh3 bond atom lone pair make geometry d. bf3 nonpolar nh3 polar 15 following compound high melting point bonding chemical chapter octet rule type bond 3.2 ionic bond 3.3 covalent bond property covalent compound coordinate covalent bond covalent bond notation geometry polarity atomic molecular orbital 3.4 intermolecular force london dispersion force content chapter relevant 12 question general chemistry mcat chapter cover material following aamc content category 4c electrochemistry electrical circuit element 5b nature molecule intermolecular interaction maillard reaction important chemical process occur cook reaction mechanism closely familiar study organic chemistry nucleophilic reaction amino terminus peptide chain protein carbonyl functionality sugar form n substitute glycosylamine compound undergo complex series rearrangement reaction produce set compound give cooked food pleasing color delectable flavor reaction especially important brown meat surface meat come contact hot surface pan grill protein sugar meat exterior begin interact maillard reaction pan sufficiently hot bring exterior meat temperature 155 ° c 310 ° f optimal temperature reaction occur grill master achieve impossible generate high heat exterior overcook

occur grill master achieve impossible generate high heat exterior overcook interior answer lie dry meat meat lot water exterior surface hit hot pan process take place boiling water boiling phase change liquid gas occur constant temperature water boiling point 100 ° c 212 ° f temperature considerably low necessary maillard reaction browning occur flavor compound form lesson want tasty steak dry surface meat course real lesson topic discussion chapter bonding chemical interaction address complex chemical bonding take place maillard reaction chapter chapter address basic chemical bonding interaction investigate nature behavior covalent ionic bond review system lewis structure bond electron account address main principle valence shell electron pair repulsion vsepr theory finally recount mode interaction molecule intermolecular chapter 3.1 able compare contrast ionic covalent compound identify element obey octet rule apply periodic trend determine covalent bond polar atom element noble gas combine form molecule atom molecule hold strong attractive force call chemical bond form interaction valence electron combine atom chemical physical property result compound usually different constituent element example elemental sodium alkali metal reactive actually produce fire react water reaction highly exothermic diatomic chlorine gas toxic chemical warfare world war i. sodium chlorine react biologically important compound nacl table salt produce octet rule atom join form compound example sodium chlorine atom form sodium chloride molecule constituent atom bond accord octet rule state atom tend bond atom electron outermost shell form stable electron configuration similar noble gas example octet configuration show noble gas argon ar figure 3.1 figure 3.1 electron configuration argon noble gas argon complete octet valence shell rule thumb element exception rule follow rule exceptional element include hydrogen valence electron achieve configuration helium lithium beryllium bond attain valence electron respectively boron bond attain valence electron element period 3 great expand valence shell include electron incorporate d orbital example certain compound

valence shell include electron incorporate d orbital example certain compound chlorine form seven covalent bond hold 14 electron octet rule desire atom achieve noble gas configuration mind exception rule simple way remember exception follow incomplete octet element stable few 8 electron valence shell include hydrogen stable 2 electron helium 2 lithium 2 beryllium 4 boron 6 expanded octet element period 3 great hold 8 electron include phosphorus 10 sulfur 12 chlorine 14 odd number electron molecule odd number valence electron distribute electron atom example nitric oxide way remember exception remember common element abide octet rule carbon nitrogen oxygen fluorine sodium magnesium note nonmetal gain electron metal lose electron achieve respective complete octet type bond classify chemical bond distinct type ionic ionic bonding electron atom low ionization energy typically metal transfer atom high electron affinity typically nonmetal illustration process show initial example sodium chloride figure figure 3.2 formation ionic bond sodium na low ionization energy easily release electron chlorine cl high electron affinity easily absorb electron valence shell example atom achieve octet formation result electrostatic attraction opposite charge hold ion nature bond sodium chloride positively charge sodium cation electrostatically attract negatively charge chloride anion important note type electrostatic attraction create lattice structure consist repeat row cation anion individual molecular bond show figure 3.3 figure 3.3 crystal lattice structure sodium chloride sodium = purple chloride covalent bonding electron pair share atom typically nonmetal relatively similar value electronegativity degree pair electron share equally unequally atom determine degree polarity covalent bond example electron pair share equally covalent bond nonpolar pair share unequally bond polar share electron contribute atom bond call electronegativity discuss chapter 2 mcat general chemistry review property address individual atom act bond help understand formation molecule atom different electronegativity example nonpolar covalent bonding show diatomic fluorine figure 3.4 atom seven electron valence

bonding show diatomic fluorine figure 3.4 atom seven electron valence shell share electron

atom form octet unlike ionic crystal lattice covalent compound consist individually bond molecule figure 3.4 formation covalent bond fluorine f seven valence electron share electron atom fluorine atom achieve mcat concept check 3.1 assess understanding material 1 describe atomic difference ionic covalent compound 2 list element follow octet rule explain violate octet rule 3 periodic trend determine covalent bond polar 3.2 ionic bond chapter 3.2 able explain ionic bond commonly form metal recall major characteristic ionic compound ionic bond form atom significantly different electronegativity atom lose electron cation atom gain electron anion ionic bond result electrostatic force attraction opposite charge ion electron share ionic bond electron transfer occur difference electronegativity great 1.7 pauling scale metal lose electron cation = positive + ion nonmetal gain electron anion = negative ion

mcat will expect memorize pauling scale recognize ionic bond generally form metal nonmetal example alkali alkaline earth metal groups ia iia group 1 2 respectively readily form ionic bond halogen group viia group 17 atom active metal loosely hold electron halogen likely gain electron complete valence shell difference bonding behavior class element difference electronegativity value δen explain formation ionic compound cesium chloride δen = 2.3 potassium iodide δen = 1.7 sodium fluoride δen = 3.1

ionic compound characteristic physical property recognize test day strength electrostatic force ionic constituent compound ionic compound high melting boiling point example melting point sodium chloride 801 ° c ionic compound dissolve readily water polar solvent molten aqueous state good conductor electricity solid state ionic constituent compound form crystalline lattice consist repeat positive negative ion show early figure 3.3 arrangement attractive force oppositely charge ion maximize repulsive force ion like charge minimize mcat concept check 3.2 assess understanding material 1 ionic bond tend form metal nonmetal 2 describe characteristic ionic compound 3.3 covalent bond chapter 3.3 able explain relationship bond strength bond length bond identify value δen polar covalent nonpolar covalent ionic bond

form predict molecular geometry molecule give formula draw lewis dot structure simple molecule include resonance structure atom similar electronegativity interact energy require form ion complete transfer electron great energy release formation ionic bond atom similar tendency attract electron form compound energetically unfavorable create ion transfer electron form octet atom share electron bonding force atom ionic instead attraction electron share pair positive nucleus bond atom think bond tug war atom difference electronegativity great 1.7 strong atom win electron anion electronegativity value relatively similar stalemate covalent bond equal sharing electron covalent compound contain discrete molecular unit relatively weak intermolecular interaction result compound like carbon dioxide co2 tend low melting boiling point addition break constituent ion poor conductor electricity liquid state aqueous property covalent compound formation covalent bond sufficient fill valence shell give atom atom form bond atom atom form multiple bond atom atom share pair electron say join single double triple covalent bond respectively number share electron pair atom call bond order single bond bond order double bond bond order triple bond bond order important characteristic covalent bond explain bond length bond energy polarity bond length average distance nucleus atom

length bond energy polarity bond length average distance nucleus atom bond number share electron pair increase atom pull close result decrease bond length give pair atom triple bond short double bond short single bond inverse relationship bond length strength organic know relationship test day earn quick point bond energy energy require break bond separate component isolate gaseous atomic state great number pair electron share atomic nucleus energy require break bond hold atom triple bond great bond energy single bond low bond energy discuss bond energy calculation involve bond enthalpy chapter 7 mcat general chemistry review convention great bond energy strong bond polarity occur atom relative difference electronegativity atom come covalent bond negotiate degree electron pair share atom high electronegativity get large share electron density polar bond create dipole positive

end dipole electronegative atom negative end electronegative atom show figure 3.5 polar covalent bond amine borane nitrogen take partial negative charge δ boron take partial positive charge δ+ atom identical nearly identical electronegativity share electron pair equal distribution electron call nonpolar covalent bond separation charge bond note bond atom element exactly electronegativity exhibit purely equal distribution electron seven common diatomic molecule h2 n2 o2 f2 cl2 br2 i2 time bond close

nonpolar bond atom difference electronegativity 0.5 generally consider nonpolar quick way remember naturally occur diatomic element periodic table form number 7 periodic table h 7 group viia h2 n2 o2 f2 cl2 br2 i2 polar covalent bond atom differ moderately electronegativity share electron unevenly result polar covalent bond difference electronegativity 0.5 1.7 result formation ionic bond sufficient cause separation charge bond result electronegative element acquire great portion electron density take partial negative charge δ electronegative element acquire small portion electron density take partial positive charge δ+ instance covalent bond hcl polar atom moderate difference electronegativity δen = 0.9 bond chlorine atom gain partial negative charge hydrogen atom gain partial positive charge difference charge atom indicate arrow cross tail end give appearance plus sign point negative end show figure 3.6 figure 3.6 dipole moment

hcl range electronegativity nonpolar bond roughly 0 0.5 polar bond find 0.5 1.7 ionic bond 1.7 chemistry course allude grey area 1.7 2.0 mcat molecule range metal nonmetal effectively ionic polar covalent molecule separation positive negative charge call polar molecule dipole moment polar bond polar molecule vector quantity give equation p = qd p dipole moment q magnitude charge d displacement vector separate partial charge dipole moment vector represent arrow point positive negative charge measure debye unit coordinate covalent bonds coordinate covalent bond share electron originate atom generally mean lone pair atom attack atom unhybridized p orbital form bond show figure 3.7 bond form indistinguishable

covalent bond distinction helpful keep track valence electron formal charge coordinate covalent bond typically find lewis acid base reaction describe chapter 10 mcat general chemistry review lewis acid compound accept lone pair electron lewis base compound donate pair electron form covalent bond figure 3.7 coordinate covalent bond chemistry create coordinate covalent bond appear form reaction call nucleophile electrophile reaction describe chapter 4 mcat organic chemistry review lewis acid base reaction describe chapter 10 mcat general chemistry review complexation reaction describe chapter 9 mcat general chemistry review nh3 donate pair electron form coordinate covalent bond act lewis base time bf3 accept pair electron form coordinate covalent bond act lewis acid covalent bond notation electron involve covalent bond valence shell bond electron electron valence shell involve covalent bond nonbonding electron unshared electron pair know lone pair associate atomic nucleus atom bond atom different combination lewis structure system notation develop track bond nonbonded electron pair think lewis structure bookkeeping method electron number valence electron attribute particular atom lewis structure molecule necessarily number valence electron neutral atom difference account formal charge atom lewis structure lewis structure draw molecule possible lewis structure differ bond connectivity arrangement lewis structure represent different

lewis structure differ bond connectivity arrangement lewis structure represent different possible compound lewis structure bond connectivity differ arrangement electron pair structure represent different resonance form single compound note lewis structure represent actual theoretical geometry real compound usefulness lie show different possible way atom combine form different compound resonance form arrangement assess likelihood arrangement check formal charge atom arrangement arrangement minimize number magnitude formal charge usually stable arrangement compound lewis structure lewis dot diagram chemical symbol element surround dot represent s p valence electron atom lewis symbol element second period periodic table show table 3.1 table 3.1 lewis symbol period 2

elements draw lewis dot structure remember atom expand octet utilize d orbital outer shell place atom period 3 number dot lewis structure notation come group number lithium group ia electron dot carbon group iva dot lewis symbol represent distribution valence electron atom represent distribution valence electron molecule example lewis symbol fluoride ion f lewis structure diatomic molecule f2 certain rule follow assign lewis structure molecule step draw lewis structure outline hcn example draw backbone compound arrangement atom general electronegative atom central atom hydrogen halogen f cl br usually occupy terminal position hcn h occupy end position remain atom c electronegative occupy central position skeletal structure follow h c n count valence electron atom number valence electron molecule sum valence electron atom present h 1 valence electron c 4 valence electron n 5 valence electron hcn total 10 valence electron draw single bond central atom atom surround single bond correspond pair h c n complete octet atom bond central atom remain valence electron leave assign recall h exception octet rule valence electron example h valence electron bond c.

place extra electron central atom central atom octet try write double triple bond central surrounding atom lone pair hcn structure satisfy octet rule c c

valence electron lone electron pair n atom move form bond c create triple bond c n. easy visualize bonding electron pair represent line familiar dot line notation bond h c n octet rule satisfied atom c n valence electron h valence electron determine lewis structure representative actual arrangement atom compound calculate formal bond electron pair regardless actual difference electronegativity word assume electron pair split evenly nucleus bond difference number electron assign atom lewis structure number electron normally find atom valence shell formal charge simple equation use calculate formal charge v normal number electron atom valence shell nnonbonding number nonbonding electron nbonding number bond electron double number bond bond electron charge ion compound equal sum formal charge individual atom comprise ion compound formal way calculate formal charge

formula formal charge = valence electron dot stick dot refer lone electron stick refer bond example calculate formal charge central n atom nh4]+ solution lewis structure nh4]+ nitrogen group va valence electron nh4]+ n bond bond electron zero nonbonding electron v = 5 nbonding = 8 nnonbonding = 0 formal charge n atom nh4]+ +1 use logic determine formal charge draw n bond assume equal sharing electron bond mean n valence electron normal state n valence electron nitrogen few electron normal state +1 charge let offer brief note explanation difference formal charge oxidation number formal charge underestimate effect electronegativity difference oxidation number overestimate effect electronegativity difference assume electronegative atom 100 percent share bond electron pair example molecule co2 carbon dioxide formal charge atom 0 oxidation number oxygen atom 2 carbon +4 reality distribution electron density carbon oxygen atom lie extreme predict formal charge oxidation state suggest early possible draw lewis structure demonstrate arrangement atom differ specific placement electron call resonance structure represent double headed arrow actual electronic distribution compound hybrid composite

represent double headed arrow actual electronic distribution compound hybrid composite possible resonance structure example so2 resonance structure show figure 3.8 figure 3.8 resonance structure so2 double headed

arrow indicate molecule involve resonance hybrid resonance important topic general organic chemistry allow great stability delocalize electron charge know π pi system resonance organic molecule discuss chapter 3 mcat organic chemistry nature bond actual compound hybrid structure evaluate spectral datum indicate s o bond identical equivalent phenomenon know resonance actual structure compound call resonance hybrid resonance structure figure 3.8 significantly stable structure consequently major contributor resonance hybrid general stable structure contribute character resonance hybrid figure 3.8 minor contributor contain formal charge indicate decrease stability use formal charge assess stability resonance structure

accord follow lewis structure small formal charge prefer lewis structure large formal charge lewis structure separation opposite charge prefer lewis structure large separation lewis structure negative formal charge place electronegative atom stable negative formal charge place electronegative example write resonance structure nco]–. 1 c electronegative give atom c atom occupy central position skeletal structure nco n c o 2 n 5 valence electron c 4 valence electron o 6 valence electron species negative charge total valence electron = 5 + 4 + 6 + 1 = 16 3 draw single bond central c atom surround atom n o.

draw pair electron represent bond n c o 4 complete octet n o remain 12 electron 5 c octet incomplete way double triple bond form complete c octet lone pair o atom form triple bond c o atom lone electron pair take o n form double bond n c o c lone electron pair take n atom form triple bond c n atom resonance structure nco 6 assign formal charge atom resonance structure stable structure charge minimize negative formal charge electronegative atom o. exception octet rule state previously octet rule exception addition hydrogen helium lithium beryllium boron exception usually reach octet element period exception electron valence shell electron place orbital d subshell result atom element form bond test day automatically discount lewis structure central atom bond testmaker test ability recognize atom expand valence shell octet consider sulfate ion so42. lewis structure sulfate ion give sulfur 12 valence electron permit atom assign formal charge zero sulfate ion draw resonance form double bond attach different combination oxygen atom figure 3.9 show possible form figure 3.9 different resonance form sulfate ion surprised draw resonance structure molecule ion proficient drawing importantly recognize resonance structure save time test day geometry polarity lewis dot structure suggest reflect actual geometric arrangement atom compound need system provide information system know valence shell electron pair repulsion vsepr theory valence shell electron pair repulsion vsepr theory use lewis dot structure predict molecular geometry covalently bond molecule state three- dimensional arrangement atom surround central atom determine repulsion bond nonbonding electron pair valence shell central atom electron pair

arrange far apart possible minimize repulsive force following step predict geometrical structure molecule vsepr theory draw lewis dot structure molecule count total number bond nonbonding electron pair valence shell central atom arrange electron pair central atom far apart possible example compound ax2 lewis structure

central atom far apart possible example compound ax2 lewis structure x x. atom bond electron pair valence shell position electron pair far apart possible geometric structure x x summary electronic geometry predict vsepr theory show table 3.2 table 3.2 vsepr theory table list common electronic configuration molecule geometric arrangement electron pair x x geometric arrangement electron pair accord aamc official content list need prepare draw identify structural formula molecule involve h c n o f s p si cl memorize element familiar process create lewis diagram element predict dimensional shape vsepr theory example predict molecular geometry nh3 1 lewis structure nh3 2 central atom n bond electron pair nonbonding electron pair total electron pair 3 electron pair farthest apart occupy corner tetrahedron electron pair lone pair observed molecular geometry trigonal pyramidal show describe shape molecule arrangement atom electron consider electron pair arrange tetrahedrally shape nh3 pyramidal trigonal planar lone pair repel bond electron pair cause far apart possible shape table 3.2 refer electronic geometry different molecular geometry work example notice ammonia molecule tetrahedral electronic structure consider molecular structure trigonal example predict geometry co2 solution lewis structure co2 double bond behave like single bond purpose predict molecular shape compound group electron carbon accord vsepr theory set electron orient 180 ° apart opposite side carbon atom minimize electron repulsion molecular structure co2 linear subtlety mcat love test difference electronic geometry molecular geometry electronic geometry describe spatial arrangement pair electron central atom include bond lone pair contrast molecular geometry describe spatial arrangement bonding pair electron coordination number number atom surround bond central atom relevant factor determine molecular geometry example consider ch4 methane

nh3 ammonia h2o electronic geometry compound pair electron surround central atom tetrahedral electronic geometry molecule different coordination number different molecular geometry molecular geometry methane tetrahedral geometry ammonia trigonal pyramidal geometry water

molecular geometry methane tetrahedral geometry ammonia trigonal pyramidal geometry water identify angular bent ch4 nh3 h2o tetrahedral electronic geometry differ molecular ch4 tetrahedral nh3 pyramidal h2o bent angular distinction important mcat primarily focus molecular geometry important implication electronic geometry determination ideal bond angle tetrahedral electronic geometry example associate ideal bond angle 109.5 ° nonbonding pair able exert repulsion bond pair electron reside close nucleus angle ammonia close 107 ° angle water 104.5 ° polarity molecule atom different electronegativity bond covalently share pair electron result bond polar electronegative atom possess great share electron density presence bond dipole necessarily result molecular dipole overall separation charge molecule consider molecular geometry vector addition bond dipole base molecular geometry compound nonpolar bond nonpolar compound polar bond polar nonpolar depend spatial orientation polar bond molecule compound molecular geometry bond dipole moment cancel vector sum zero result nonpolar compound example ccl4 carbon tetrachloride polar c cl bond molecular geometry carbon tetrachloride tetrahedral bond dipole point vertex tetrahedron cancel result nonpolar compound show figure 3.10 figure 3.10 ccl4 nonpolar compound polar bond molecular geometry arrange bond dipole cancel molecule net dipole moment polar instance o h bond h2o polar hydrogen atom assume partial positive charge oxygen assume partial negative charge recall molecular geometry water angular bent vector summation bond dipole result molecular dipole moment partially positive hydrogen end partially negative oxygen end

illustrate figure 3.11 figure 3.11 h2o polar molecule polar bond careful spot polar bond

molecule molecule polar nonpolar contrary nonpolar bond molecule structure nonpolar doubt draw relevant structure scratch paper test day atomic molecular orbital finish discussion covalent bond need address concept atomic molecular orbital recall model atom dense positively charged nucleus surround cloud electron organize orbital region space surround nucleus certain probability find electron quantum number describe energy position electron atom principal quantum number n indicate average energy level shell azimuthal quantum number l describe subshell principal energy level l = 0 indicate s subshell orbital spherical shape 1s orbital n = 1 l = 0 ml = 0 plot figure 3.12 figure 3.12 1s orbital quantum numbers chapter 1 mcat general chemistry review revisit value n n value l 0 n 1 l = 0 s l = 1 p l = 2 d l = 3 f value l 2l + 1 value ml number orbital value range l l = 1

indicate p subshell orbital shape like barbell x- y- z axis right angle 2p orbital n = 2 l = 1 ml = 1 0 +1 plot figure 3.13 figure 3.13 p orbital x- y- z axis scope mcat mathematical analysis wave function orbital determine assign plus minus sign lobe p orbital shape d orbital seven f orbital complex need memorize mcat atom bond form compound atomic orbital interact form molecular orbital describe probability find bond electron give space molecular orbital obtain combine wave function atomic orbital qualitatively overlap atomic orbital describe molecular orbital sign atomic orbital bond orbital form sign different antibonding different pattern overlap observe formation molecular bond orbital overlap head head result bond sigma σ bond σ bond allow free rotation axis electron density bond orbital single linear accumulation atomic nucleus orbital overlap way parallel electron cloud density pi π bond form π bond allow free rotation electron density orbital parallel twist way allow continuous overlapping cloud electron density mcat concept check 3.3 assess understanding material 1 describe relationship bond strength bond length bond 2 value δen nonpolar covalent bond form polar 3 draw lewis dot structure carbonate ion co32 4 predict molecular geometry follow molecule 3.4 intermolecular force chapter 3.4 able order intermolecular force strong weak describe occur dipole dipole hydrogen bonding london dispersion force interaction predict intermolecular

force possible give interact atom compound participate weak electrostatic interaction strength intermolecular force impact certain physical property melting boiling point weak intermolecular interaction dispersion force know london force dipole dipole interaction intermediate strength finally strong type interaction hydrogen bond misnomer actual sharing transfer electron mind hydrogen bond strong interaction 10 percent strength covalent bond electrostatic interaction overcome small moderate amount energy intermolecular force bonding force substance solid liquid state determine substance miscible immiscible solution solution solubility discuss chapter

state determine substance miscible immiscible solution solution solubility discuss chapter 9 mcat general chemistry london dispersion forces bond electron nonpolar covalent bond appear share equally atom point time locate randomly orbital give moment electron density unequally distribute atom result rapid polarization counterpolarization electron cloud formation short live dipole moment subsequently dipole interact electron cloud neighbor compound induce formation dipole momentarily negative end molecule cause close region neighbor molecule temporarily positive cause end neighbor molecule temporarily negative turn induce molecule temporarily polarized cycle begin attractive repulsive interaction short live rapidly shift dipole know london dispersion force type van der waals force dispersion force weak intermolecular interaction result induce dipole change shift moment moment extend long distance significant molecule close proximity strength london force depend degree ease molecule polarize easily electron shift large molecule easily polarizable comparable small molecule possess great dispersion force dispersion force type van der waals force weak intermolecular attraction million interaction amazing power adhesion demonstrate gecko foot animal ability climb smooth vertical inverted surface dispersion force despite weak nature underestimate importance dispersion force noble gas liquefy temperature intermolecular force exist noble gas atom low temperature noble gas liquefy indicative small magnitude dispersion force atom polar molecule tend orient way oppositely charge end respective

molecular dipole close positive region molecule close negative region molecule arrangement energetically favorable attractive electrostatic force form molecule attractive force denote dash line molecular notation indicate temporary bonding interaction show figure 3.14 figure 3.14 dipole dipole interaction hcl dipole dipole interaction present solid liquid phase negligible gas phase significantly increase distance gas particle polar specie tend high melting boiling point nonpolar specie comparable molecular weight interaction realize london force dipole dipole interaction different kind duration electrostatic force opposite partial charge difference transience permanence molecular dipole organic chemistry carbonyl group possess distinct dipole facilitate nucleophilic attack

organic chemistry carbonyl group possess distinct dipole facilitate nucleophilic attack focus reaction chapter 6 9 mcat organic hydrogen bond favorite topic mcat hydrogen bond specific unusually strong form dipole dipole interaction intra- intermolecular hydrogen bond actually bond sharing transferring electron atom hydrogen bond highly electronegative atom nitrogen oxygen fluorine hydrogen atom carry small electron density hydrogen bond pick fon phone hydrogen bond exist molecule contain hydrogen bond fluorine oxygen hydrogen atom essentially act naked proton positively charge hydrogen atom interact partial negative charge fluorine oxygen nitrogen nearby molecule substance display hydrogen bonding tend unusually high boiling point compare compound similar molecular weight exhibit hydrogen bonding difference derive energy require break hydrogen bond hydrogen bonding show figure 3.15 particularly important behavior water alcohol amine carboxylic acid figure 3.15 hydrogen bonding water biochemical molecule nucleotide different region stabilize hydrogen bonding show figure 3.16 overstatement water ability form hydrogen bond exist liquid state room temperature exist form recognize human figure 3.16 hydrogen bonding guanine cytosine mcat concept check 3.4 assess understanding material 1 rank major intermolecular force strong weak 2 describe occur dipole dipole interaction 3 order exhibit hydrogen bonding true give chapter build knowledge atom trend demonstrate element periodic table explain

different way atom partner form compound exchange electron form ion hold electrostatic attraction opposite charge share electron form covalent bond discuss nature characteristic covalent bond note relative length energy polarity review lewis dot structure vsepr theory prepare predict likely bond arrangement resonance structure molecular geometry finally compare relative strength important intermolecular electrostatic interaction note strong hydrogen bonding weak actual covalent bond time brown food pan oven moment consider happen atomic molecular level cooking review content test knowledge critical thinking skill complete test like passage set online resource chemical bond ionic covalent element form bond attain noble gas like electron configuration octet

element form bond attain noble gas like electron configuration octet rule state element stable valence electron exception rule element incomplete octet stable few electron include h li b. element expand octet stable electron include element period 3 great compound odd number electron electron ionic bond form transfer electron element relatively low ionization energy element relatively high electron affinity ionic bond occur element large difference electronegativity δen >

1.7 usually metal nonmetal positively charge ion call cation negatively charge ion call result electrostatic attraction ion cause remain close proximity form bond ionic compound form crystalline lattice large organize array ion ionic compound unique physical chemical property ionic compound tend dissociate water polar solvent ionic solid tend high melting point covalent bond form sharing electron element similar electronegativity bond order refer covalent bond single bond double bond triple bond bond order increase bond strength increase bond energy increase bond length decrease covalent bond categorize nonpolar polar base nature element involve nonpolar bond result molecule atom exactly electronegativity bond consider nonpolar small difference electronegativity atom δen < 0.5 technically slightly polar polar bond form significant difference electronegativity δen = 0.5 1.7

transfer electron form ionic bond polar bond electronegative element take partial negative charge electronegative element take partial coordinate covalent bond result single atom provide bond electron atom contribute coordinate covalent bond find lewis acid base chemistry lewis dot symbol chemical representation atom valence draw complete lewis dot structure require balance valence bonding nonbonding electron molecule ion formal charge exist atom surround few valence electron neutral state assume equal sharing electron molecule π pi system electron resonance structure exist represent possible configuration electron stable unstable contribute overall structure valence shell electron pair repulsion vsepr theory predict three- dimensional molecular geometry covalently bond molecule theory electron bond nonbonding arrange far apart possible dimensional space lead nonbonde electron exert repulsion bond electron reside close nucleus electronic geometry refer position electron molecule bond nonbonding molecular geometry refer position bonding pair electron molecule polarity molecule dependent dipole moment bond sum dipole moment molecular structure polar molecule contain polar bond nonpolar molecule contain nonpolar bond polar bond dipole moment cancel σ π bond describe pattern overlap observe molecular bond sigma σ bond result head head overlap pi π bond result overlap parallel electron cloud intermolecular force electrostatic attraction molecule significantly weak covalent bond weak ionic london dispersion force weak interaction present atom molecule size atom structure increase correspond london dispersion force dipole dipole interaction occur oppositely charged end polar molecule strong london force interaction evident solid liquid phase negligible gas phase distance particle hydrogen bond specialized subset dipole dipole interaction involve intra- intermolecular attraction hydrogen bonding occur hydrogen bond electronegative atom fluorine oxygen nitrogen answer concept check 1 ionic bond form ion involve gain loss electron covalent bond occur electron share atom 2 example form incomplete octet h li b expand octet period 3 great acceptable 3 polarity covalent bond determine difference electronegativity atom involve 1

3 polarity covalent bond determine difference electronegativity atom involve 1 metal lose electron low ionization energy nonmetal gain electron high electron affinity process complementary lead formation ionic bond 2 characteristic ionic compound include high melting boiling point electrostatic attraction solubility ion water interaction polar solvent good conductor heat electricity crystal lattice arrangement minimize repulsive force large electronegativity difference ion possible answer 1 bond strength define electrostatic attraction nucleus electron multiple bond high bond order increase strength bond length consequence attraction strong bond short bond energy minimum energy need break bond strong bond high bond energy 2 nonpolar covalent bond form δen = 0 0.5 polar covalent bond form δen = 0.5 1.7 ionic bond form δen = 1.7 high 4 pcl5 trigonal bipyramidal mgf2 linear alf3 trigonal planar ubr6 octahedral 1 hydrogen bonding >

dipole dipole interaction > dispersion london force 2 dipole consist segment molecule partial positive partial negative region positive end molecule attract negative end molecule vice versa 3 experience hydrogen bonding molecule contain hydrogen bond electronegative atom nitrogen oxygen fluorine science mastery assessment carbon dioxide co2 double bond carbon oxygen atom polar covalent bond difference electronegativity bond atom great cause electron disproportionately electronegative atom bond polar electronegativity difference great completely transfer electron electronegative atom bond covalent oxygen somewhat great electronegativity compare carbon bond carbon dioxide polar covalent answer question understand contribution resonance structure average formal charge b possible resonance structure oxygen atom carry formal charge 1 structure average approximately charge oxygen atom negative answer choice water formaldehyde d formal charge oxygen ozone c oxygen +1 charge question ask element reliably follow octet rule element break octet rule include carbon nitrogen oxygen fluorine sodium magnesium c correct eliminate b d observe remain element valence stable valence electron s p expand octet key answer question

understand type intermolecular force exist molecule large intermolecular force correspond high boiling point kr noble gas octet intermolecular force present london dispersion force weak type intermolecular force acetone isopropyl alcohol polar dipole dipole interaction strong dispersion force isopropyl alcohol form hydrogen bond increase boiling point finally strong interaction ionic bond exist central carbon carbonate lone pair resonance structure involve double bond carbon oxygen having bond carbon orbital bond carry lone pair make carbonate geometry trigonal planar alternatively clf3 bond chloride maintain extra lone pair lone pair inhabit orbital mean central chloride organize item bond fluoride lone pair good configuration maximize distance group trigonal bipyramidal b true statement account difference geometry ionic bond form element large difference electronegativity i.e. metal nonmetal mg metal cl o h nonmetal b contain metal nonmetal correct c d describe covalent bond hcl ionize

metal nonmetal correct c d describe covalent bond hcl ionize aqueous solution exist polar covalent compound gaseous state bond length decrease bond order increase decrease large difference electronegativity case c2h2 hcn triple bond compare bond length base bond order rely periodic trend bond length decrease move right periodic table row electronegative atom short atomic radius nitrogen hcn likely hold electron close short radius carbon c2h2 electronegative atom bond hydrogen disproportionately pull covalently bond electron leave hydrogen partial positive character partial positive charge attract nearby negative partial negative charge electronegative atom recall ammonium nh4 + ammonia nh3 ammonium form association nh3 uncharged molecule lone pair nitrogen positively charge hydrogen cation word nh3 lewis base h+ lewis acid type bonding lewis acid base coordinate covalent bond atom period great d orbital hold additional 10 electron typical octet electron reside s- p orbital element period 3 high place electron d orbital list type force describe interaction different type molecule noble gas entirely uncharged polar covalent bond ionic bond dipole moment intermolecular force experience noble gas london dispersion force interaction small

magnitude necessary condensation liquid lewis diagram phosphate molecule overall formal charge 3 oxygen atom assign formal charge 1 give overall charge 3 1 charge oxygen phosphorus formal charge +1 reaction question show water molecule lone pair electron central oxygen combine free hydrogen cation result molecule h3o+ form new bond h+ h2o.

bond create sharing oxygen lone pair free h+ ion represent donation share pair electron lewis base h2o lewis acid h+ electron acceptor type bond call coordinate covalent bond nh3 hydrogen atom bond central nitrogen lone pair group atom lone pair lead nh3 assume tetrahedral electronic geometry trigonal pyramidal molecular geometry nitrogen ammonia sp3 hybridize hybridize p orbital s orbital group arrange central atom maximize distance group minimize energy molecule tetrahedral configuration contrast bf3 atom lone pair result sp2 hybridization shape call trigonal planar compound melt interaction molecule break sufficient extent enable movement nacl interaction ionic hand solid molecule sucrose glycerol water hold hydrogen bond great electrostatic attraction charge ionic bond ionic bond nacl significantly strong hydrogen bond molecule nacl high melting point consistent b consult online resource additional practice equation remember 3.1 dipole moment p = qd 3.2 formal charge general chemistry chapter 1 general chemistry chapter 2 periodic table general chemistry chapter 4 compound stoichiometry organic chemistry chapter 3 organic chemistry chapter 4 analyze organic reaction physics math chapter 5 electrostatic magnetism compound stoichiometry pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match

explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review

include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 following well describe ionic compound a. ionic compound form molecule contain atom b.

ionic compound form charge particle measure c. ionic compound form charge particle share electron d. ionic compound dimensional array charge particle 2 following compound formula weight 74 75 gram mole 3 follow gram equivalent weight h2so4 respect a. 49.1 g b. 98.1 g c. 147.1 g d. 196.2 g 4 following molecule express empirical 5 following compound percent composition carbon mass close 62 percent 6 specific characterization reaction show ca(oh)2 aq + h2so4 aq caso4 aq + h2o l 7 reaction show 39.05 g na2s react 85.5 g agno3 excess reagent leave reaction go na2s + 2 agno3 ag2s + 2 nano3 a. 19.5 g na2s b. 26.0 g na2s c. 41.4 g agno3 d. 74.3 g agno3 8 give mass kclo3 calculate mass oxygen produce follow reaction assume go completion 2 kclo3 2 kcl + 3 o2 9 aluminum metal remove tarnish silver solid metal place water accord follow reaction 3 ago + 2 al 3 ag + al2o3 reaction i. double displacement reaction ii single displacement reaction iii oxidation reduction reaction iv combination reaction a. ii b. iv c. iii d. ii iii 10 follow type reaction generally number reactant product i. double displacement reaction ii single displacement reaction iii combination reaction a. b. ii c. ii d. ii iii 11

diethyl zinc unstable compound expose air react oxygen produce zinc oxide carbon dioxide water unbalanced reaction show coefficient carbon dioxide balanced reaction 12 process photosynthesis carbon dioxide water combine energy form glucose oxygen accord follow equation theoretical yield glucose 30 gram water react excess carbon dioxide energy accord

equation a. 30.0 g b. 50.0 g c. 300.1 g d. 1801 g 13 following reaction au2s3 s + h2 g au s + h2s g 2 mole au2s3 s react 5 mole hydrogen gas a. au2s3 s b. h2 g c. au s d. h2s g 14 following strong electrolytic solution a. nonpolar covalent compound significant solubility b. ionic compound compose cation +3 charge anion 1 charge c. polar covalent compound small dissociation constant d. ionic compound compose cation +1 charge anion 2 charge 15 carbon disulfide nitrous oxide ignite react exothermically produce elemental sulfur nitrogen carbon dioxide reaction produce woof sound refer barking dog reaction follow represent balanced chemical reaction a. 8 n2o + 4 cs2 s8 + 4 co2 + 8 n2 b. 6 n2o + 4 cs2 s8 + 4 co2 + 6 n2 c.

8 n2o + 2 cs2 s8 + 2 co2 + 8 n2 d. 7 n2o + 5 cs2 s8 + 4 co2 + 7 n2 compound stoichiometry chapter 4.1 molecule mole 4.2 representation compound law constant composition empirical molecular formula 4.3 type chemical reaction 4.4 balance chemical equation 4.5 application stoichiometry cation anion content chapter relevant 7 question general chemistry mcat chapter cover material following aamc content category 4c electrochemistry electrical circuit element 4e atom nuclear decay electronic structure atomic chemical behavior 5a unique nature water solution oh smell smell like rancid almond notice green bug back impression shield stink bug stink bug stink produce highly concentrated solution volatile compound perceive malodorous noxious irritating interestingly primary compound stink bug stink bomb hydrogen cyanide highly toxic compound inhibit cytochrome c oxidase block aerobic respiration benzaldehyde like aromatic compound benzaldehyde vaporize room temperature reach olfactory system gas particle benzaldehyde key ingredient artificial almond extract low concentration produce pleasant aroma toast almond high concentration odor rotten almond noxious irritant skin eye respiratory tract benzaldehyde compound compose seven carbon atom hydrogen atom oxygen atom mole benzaldehyde mass approximately 106 gram react atom compound form new compound pure substance compose element fix proportion compound break chemical mean produce constituent element compound characterize describe physical chemical property chapter focus compound reaction review way compound

represent empirical molecular formula percent composition brief overview major class chemical reaction examine closely subsequent chapter finally recap step involve balance chemical equation particular focus identify limit reagent calculate 4.1 molecule mole chapter 4.1 able calculate molar mass give substance agcn calculate number mole molecule give mass gram compare number molecule different compound give gram weight molecular formula determine normality solution molecule combination atom hold covalent bond molecule small unit compound display identify property molecule compose atom element n2 o2

compound display identify property molecule compose atom element n2 o2 compose atom different element co2 carbon dioxide socl2 thionyl chloride c6h5cho benzaldehyde reaction usually involve large number molecule far count individually usually measure amount compound term mole gram molar mass interconvert unit ionic compound form true molecule way oppositely charge ion arrange solid state solid consider nearly infinite three- dimensional array charge particle comprise compound describe chapter 3 mcat general chemistry review solid nacl coordinated lattice na+ ion surround cl ion cl ion surround na+ ion make difficult clearly define sodium chloride molecule term formula unit represent empirical formula compound instead molecule actually exist molecular weight meaningless term formula weight instead ionic compound form combination element large electronegativity difference sodium chlorine molecular compound form element similar electronegativity carbon oxygen difference ionic covalent bond discuss chapter 3 mcat general chemistry review remember term atomic weight misnomer actually weight average masse naturally occur isotope element weight apply discussion molecular weight molecular weight simply sum atomic weight atom molecule unit atomic mass unit amu molecule similarly formula weight ionic compound find add atomic weight constituent ion accord empirical formula unit amu molecule example molecular weight socl2 solution find molecular weight socl2 add atomic weight atom 1 s 1 × 32.1 amu 1 o 1 × 16.0 amu 2 cl 2 × 35.5 amu total molecular weight 119.1 amu molecule mole quantity substance atom molecule dollar bill kitten equal number particle find 12 gram

carbon-12 number particle define avogadro number na 6.022 × 1023 mol–1 mole compound mass gram equal molecular formula weight compound amu example molecule h2co3 carbonic acid mass 62 amu mole compound mass 62 gram mass mole compound call molar mass usually express term molecular weight incorrectly imply molar mass remember molecular weight measure formula determine number mole sample remember avogadro

molecular weight measure formula determine number mole sample remember avogadro number mole unit convenience like dozen convenient unit egg equation stoichiometry titration problem example mole 9.53 g mgcl2 solution find molar mass mgcl2 solve number mole equivalent weight relate concept equivalent source confusion student problem context equivalent equivalent weight usually discuss acid base reaction oxidation reduction reaction precipitation reaction source confusion anxiety let start basic discussion equivalent certain element compound act potently perform certain reaction example mole hcl ability donate mole hydrogen ion h+ solution mole h2so4 ability donate mole hydrogen ion mole h3po4 ability donate mole hydrogen ion gather mole hydrogen ion particular acid base reaction use mole hcl half mole h2so4 mole h3po4 consider difference na mg mole sodium ability donate mole electron mole magnesium ability donate mole electron provide context concept equivalent mole thing interested proton hydroxide ion electron ion mole give compound produce sodium donate mole electron equivalent magnesium donate mole electron equivalent idea equivalent relate concept normality explain discussion acid basis chapter 10 mcat general chemistry review far discussion focus mole mole relationship acid compound hydrogen ion donate need work unit mass mole mole hcl donate mole hydrogen ion certain mass hcl 36.5 g donate equivalent hydrogen ion compound measure gram produce equivalent particle interest call gram equivalent weight calculate n number particle interest produce consume molecule compound reaction example need 31 gram h2co3 equivalent hydrogen ion molecule h2co3 donate hydrogen ion n = 2 simply equivalent weight compound mass provide mole particle interest confront stoichiometry problem look normality identify equivalent unit

proton hydroxide ion electron ion multiply number mole molar concentration find normal concentration compound reaction know need determine equivalent present use equation finally introduce measurement normality normality n measure concentration give unit mcat commonly hydrogen ion concentration 1 n solution acid contain concentration

commonly hydrogen ion concentration 1 n solution acid contain concentration hydrogen ion equal 1 mole liter 2 n solution acid contain concentration hydrogen ion equal 2 mole liter actual concentration acidic compound different normality different compound able donate different number hydrogen ion 1 n hcl solution molarity hcl 1 m hcl monoprotic acid 1 n h2co3 solution molarity h2co3 0.5 m h2co3 diprotic acid note normality calculation assume reaction proceed completion carbonic acid fully dissociate solution react base molecule proton conversion normality molarity give solute n number proton hydroxide ion electron ion produce consume solute figure 4.1 show titration diprotic acid h2co3 base x axis indicate equivalent base need neutralize proton acid figure 4.1 titration carbonic acid base carbonic acid diprotic equivalent base require neutralize proton acid real benefit work equivalent normality allow direct comparison quantity entity interested acid base reaction care hydrogen hydroxide ion ion come primary concern convenient able equivalent acid hydrogen ion neutralize equivalent base hydroxide ion necessarily say deal mole acidic compound mole basic compound example mole hcl completely neutralize mole ca(oh)2 mole hcl donate equivalent acid ca(oh)2 donate equivalent example gram equivalent weight gew sulfuric acid solution find molar mass h2so4 identify equivalent proton h+ transfer acid base reaction number proton sulfuric acid n 2 calculate gram equivalent weight acid base chemistry gram equivalent weight represent mass acid yield mole proton mass base yield mole hydroxide ion example normality 2 m mg(oh)2 solution solution identify number equivalent n hydroxide ion oh molecule mg(oh)2 equivalent interest magnesium hydroxide base calculate normality mcat concept check 4.1 assess understanding material 1 calculate molar masse following substance 2 calculate number mole 100 g following substance 3 number molecule 18 g h2o compare

number formula unit 58.5 g nacl 4 determine normality following solution note species interest h+ 0.25 m

determine normality following solution note species interest h+ 0.25 m h3po4 100 ml solution 4.2 representation chapter 4.2 able recall similarity difference molecular empirical calculate percent composition mass compound c6h12o6 determine empirical formula compound give percent composition different way represent compound constituent atom review couple system chapter 3 mcat general chemistry review lewis dot structure vsepr theory organic chemistry common encounter skeletal representation compound call structural formula bond constituent atom compound inorganic general chemistry typically represent compound show constituent atom represent actual bond connectivity atomic arrangement example formula c6h12o6 glucose tell particular compound consist atom carbon atom hydrogen atom oxygen indication different atom arrange bond exist atom representation discuss detail chapter 2 mcat organic chemistry review understand theory representation help convert different projection representation ease law constant composition law constant composition state pure sample give compound contain element identical mass ratio example sample water contain hydrogen atom oxygen atom term mass gram hydrogen gram oxygen biologically important molecule water amino acid earth composition universe density physical property differ empirical molecular formula way express formula compound empirical formula give simple number ratio element compound molecular formula give exact number atom element compound multiple empirical formula example empirical formula benzene ch molecular formula c6h6 compound empirical molecular formula identical case h2o.

previously discuss ionic compound nacl caco3 empirical formula empirical formula ch2o indicative monosaccharide common monosaccharide include glucose fructose galactose structure monosaccharide carbohydrate general discuss chapter 4 mcat percent composition element mass percent specific compound give element determine percent composition

element compound following formula calculate percent composition element empirical molecular formula possible determine molecular formula give percent composition molar mass compound follow example demonstrate calculation percent composition common way stoichiometry test mcat practice problem build speed efficiency test day example percent composition chromium k2cr2o7 solution molar mass k2cr2o7 calculate percent composition cr example empirical molecular formula carbohydrate contain 40.9 carbon 4.58 hydrogen 54.52 oxygen molar mass method determine number mole element compound assume 100 gram sample convert percentage element present directly gram element convert gram find simple number ratio element divide number mole compound small number obtain previous step finally empirical formula obtain convert number obtain number multiply integer value empirical formula = c1h1.33o1 × 3 = c3h4o3 determine molecular formula divide molar mass 264 g mol give question stem empirical formula weight result value give number empirical formula unit molecular formula formula weight empirical formula c3h4o3 finally find molecular formula multiply ratio c3h4o3 × 3 = c9h12o9 molecular formula c9h12o9 method molar mass give generally easy find molecular formula accomplish multiply molar mass give percentage find mass element present mole compound divide respective atomic weight find mole ratio element glance give molecular formula c9h13o9 familiarity carbohydrate indicate molecular formula c9h12o9 fit ratio ch2o take rounding error account empirical formula find reduce subscript ratio simple integer value c3h4o3 method approach problem verse know multiple way solve problem help tackle question efficiently molecular formula empirical formula multiple calculate molecular formula need know mole ratio empirical formula molar mass molar mass divide empirical formula weight multiplier empirical formula to- molecular formula conversion mcat

formula weight multiplier empirical formula to- molecular formula conversion mcat concept check 4.2 assess understanding material 1 similarity difference molecular 2 find percent composition mass sodium carbon oxygen sodium carbonate na2co3 3 experimental data

combustion unknown compound indicate 28.5 iron 24.0 sulfur 49.7 oxygen mass 4.3 type chemical chapter 4.3 able describe series event single displacement double displacement neutralization combustion reaction classify reaction predict product give reactant reaction discuss analog mcat organic chemistry review mcat biochemistry review sure understand relationship product reactant help simplify advanced reaction section review major class chemical reaction begin classification major type reaction see mcat discuss method recognize product important understand convention reaction mechanism follow section discuss properly balance combination reaction reactant form product formation water burn hydrogen gas air example combination reaction reaction highlight 2 h2 g + o2 g 2 h2o g figure 4.2 formation water hydrogen oxygen combination reaction reactant product + b c decomposition reaction opposite combination reaction single reactant break product usually result heating high frequency radiation electrolysis example decomposition breakdown mercury(ii oxide δ delta sign reaction arrow represent addition decomposition reaction generally product reactant b + c example reaction utilize high frequency light decomposition silver chloride crystal show figure 4.3 presence sunlight ultraviolet component sunlight sufficient energy catalyze certain chemical reaction silver chloride exposure sunlight result decomposition reaction yield rust color product consist separate silver figure 4.3 silver chloride agcl crystal silver chloride decompose rust- color product exposure sunlight combustion reaction special type reaction involve fuel usually hydrocarbon oxidant normally oxygen common form reactant form product carbon dioxide water example balanced equation express combustion methane show figure 4.4 figure 4.4 combustion methane combustion involve oxidation o2 similar fuel typically hydrocarbon combustion reaction usually conduct hydrocarbon fuel use element sulfur compound sugar product differ carbon dioxide water present

element sulfur compound sugar product differ carbon dioxide water present important recognize reactant product reaction type context single displacement reaction occur atom ion compound replace atom ion element example solid copper metal displace silver ion clear

solution silver nitrate form blue copper nitrate solution solid silver metal cu s + agno3 aq ag s + cuno3 aq single displacement reaction classify oxidation reduction reaction discuss great detail chapter 11 mcat general chemistry review example ag agno3 oxidation state +1 leave compound gain electron ag+ reduce ag hand copper lose electron oxidation join nitrate ion double displacement reaction call metathesis reaction element different compound swap place form new compound type reaction occur product remove solution precipitate gas original specie combine form weak electrolyte remain undissociated solution example solution calcium chloride silver nitrate combine insoluble silver chloride form solution calcium cacl2 aq + 2 agno3 aq ca(no3)2 aq + 2 agcl s series double displacement reaction depict figure 4.5 show illustration test tube zn(no3)2 dissolve solution precipitate solid zinc salt left right solution nh4)2s naoh na2co3 figure 4.5 illustration

double displacement reaction form zinc salt left nh4)2s solution produce zns s middle naoh solution produce zn(oh)2 s right na2co3 solution produce znco3 s neutralization reaction specific type double displacement reaction acid react base produce salt usually water example hydrochloric acid sodium hydroxide react form sodium chloride water hcl aq + naoh aq nacl aq + h2o l acid basis combine neutralization reaction produce salt usually water acid base chemistry discuss chapter 10 mcat general chemistry review reaction acid basis visible addition indicator use indicator strip show figure 4.6 determine reaction occur figure 4.6 indicator strip test solution vary ph indicator strip place solution indicator strip right read indicator key mcat concept check 4.3 assess understanding material 1 describe word occur zn(no3)2 dissolve nh4)2s 2 complete classify likely reaction table 2 h2 + o2 al(oh)3 + h3po4 nano3 + cuoh zn + agcl 4.4 balance chemical chapter 4.4 able balance chemical equation chemical equation express type reactant obtain give quantity product utmost importance reaction balance reflect law conservation mass charge mass reactant consume equal mass product generate specifically ensure number atom element reactant equal number atom element product stoichiometric coefficient number place compound indicate relative number

mole give species involve reaction example balanced equation express combustion nonane c9h20 g + 14 o2 g 9 co2 g + 10 h2o l coefficient indicate mole c9h20 gas react fourteen mole o2 gas produce mole carbon dioxide mole water general stoichiometric coefficient give number step take balance chemical reaction necessary ensure calculation reaction perform correctly let review step involve balance chemical equation example unlikely come question explicitly ask balance equation need recognize unbalanced reaction quickly add necessary coefficient balance reaction look number atom element charge side especially oxidation reduction reaction example balance following reaction c4h10 l + o2 g co2

balance following reaction c4h10 l + o2 g co2 g + h2o l method balance carbon 4 reactant product carbon good choice start appear side reaction c4h10 l + o2 g 4 co2 g + h2o l balance hydrogen 10 reactant product hydrogen appear make good choice work c4h10 l + o2 g 4 co2 g + 5 h2o l balance oxygen 13 product reactant note oxygen appear multiple reactant product make complex atom balance good leave end produce number ratio case double coefficient 2 c4h10 l + 13 o2 g 8 co2 g + 10 h2o l finally check element total charge balance correctly difference total charge reactant product charge balance instruction balance charge oxidation reduction reaction find chapter 11 mcat general chemistry review method doubt guess assume 4 reactant balance carbon appropriately 4 c4h10 l + o2 g 16 co2 g + h2o l second balance hydrogen 40 reactant product 4 c4h10 l + o2 g 16 co2 g + 20 h2o l balance oxygen 52 product reactant 4 c4h10 l + 26 o2 g 16 co2 g + 20 h2o l fourth produce simple number ratio great common factor case divide 2 2 c4h10 l + 13 o2 g 8 co2 g + 10 h2o l finally check element total charge balance correctly notice method produce multiple final answer ratio correct term stoichiometry perform mcat simple number easy calculation balance equation focus represent element work way represented element reaction usually oxygen hydrogen stuck guess coefficient reactant balance remainder mcat concept check 4.4 assess understanding material 1 balance following reaction fe + cl2 fecl3 zn + hcl zncl2 + h2 c5h12 + o2 co2 + h2o pb(no3)2 + alcl3 pbcl2 + al(no3)3 4.5 application chapter 4.5

+ alcl3 pbcl2 + al(no3)3 4.5 application chapter 4.5 able calculate gram product produce give quantity reactant identify limit reagent reaction calculate mass excess reagent reaction limit reagent calculate percent yield reaction useful information glean balanced reaction mole ratio reactant consume product generate generate mole ratio reactant product ratio generate stoichiometric coefficient formation water 2 h2 + o2 2 h2o example determine mole hydrogen gas consume mole water produce mole oxygen gas consume mole water produce furthermore mole mole hydrogen gas consume rate twice oxygen gas stoichiometry application dimensional analysis simplify series fraction fraction demonstrate underlie step process convert give unit mole use mole ratio convert mole desire unit stoichiometry problem usually involve unit conversion care work type problem ensure unit cancel appropriately lead desire unit answer choice pay close attention follow problem demonstrate clear easy follow method keep track number calculation unit example gram calcium chloride need prepare 71.7 g silver chloride accord follow equation cacl2 aq + 2 agno3 aq ca(no3)2 aq + 2 agcl s solution note equation balance 1 mole cacl2 react 2 mole agno3 yield 2 mole agcl molar mass cacl2 111.1 g molar mass agcl 143.4 g.

give quantity 71.7 g 27.8 g cacl2 need produce 71.7 g agcl common conversion stoichiometry include 1 mole ideal gas stp = 22.4 l 1 mole substance = 6.022 × 1023 particle avogadro number 1 mole substance = molar mass gram periodic table rarely reactant add exact stoichiometric proportion show balanced equation reaction result reaction reactant consume reactant know limit reagent reactant limit product form reaction reactant remain limit reagent call excess reagent reactant quantity reactant give mcat expect figure limit reagent figure 4.7 show reaction vessel significant amount reactant b react equal amount produce product c. left reaction reactant b. reaction product c reactant leave reactant consider excess reactant b consider limit figure 4.7 reaction limit reagent consider excess reagent b limit reagent problem involve determination limit reagent mind principle 1 comparison reactant unit mole

gram gram comparison useless 2 absolute mole quantity reactant determine reactant limit reagent rate reactant consume stoichiometric ratio reactant combine absolute mole quantity determine reactant limit reagent example 27.9 g fe react 24.1 g s produce fes limit reagent gram excess reagent present vessel end reaction balanced equation fe + s fes. solution

determine number mole reactant 1 mole fe need react 1 mole s 0.5 mole fe give 0.75 mole s limit reagent fe 0.5 mole fe react 0.5 mole s leave excess 0.25 mole s vessel mass excess reagent yield reaction refer product predict theoretical yield actually obtain raw actual yield reaction carry theoretical yield maximum product generate predict balanced equation assume limit reactant consume reaction occur entire product collect theoretical yield rarely attain actual chemical reaction actual yield product actually obtain reaction ratio actual yield theoretical yield multiply 100 percent give percent experimentally base passage involve chemical reaction include pseudo- discrete question involve find percent yield example percent yield reaction 28 g cu produce react 32.7 g zn excess cuso4 solution solution balanced equation follow zn s + cuso4 aq cu s + znso4 aq calculate theoretical yield cu 31.8 g represent theoretical yield finally determine percent yield mcat concept check 4.5 assess understanding material question 1–3 refer following unbalanced equation na s + o2 g na2o s 1 balance chemical equation na s + o2 g na2o s 2 46 g na 32 g o2 provide find maximum number mole sodium oxide produce 3 identify limit reagent find mass excess reagent leave reaction run completion 4 be(oh)2 produce water react beo.

start 2.5 kg beo excess water produce 1.1 kg be(oh)2 percent yield chapter 4.6 able determine molecule act electrolyte solution recall common polyatomic ion include name charge ionic compound particular interest chemist certain important type chemical reaction acid base oxidation reduction reaction instance commonly place ionic solution stoichiometry problem goal ion identify oxidation state allow determine electron equivalent balance equation deduce chemical formula cations anions chapter 3 mcat general chemistry review discuss ionic

compound positively charge cation usually metal negatively charge anion usually nonmetal rule hold true element like hydrogen act like anion cation classify nonmetal show figure 4.8 ionic compound hold ionic bond rely force electrostatic attraction oppositely figure 4.8 oxidation state hydrogen magnitude electrostatic force ionic bond follow convention describe coulomb law chapter 5 mcat physics math review distance nucleus ionic bond inversely proportional force ionic compound long bond distance weakly hold nomenclature ionic compound base name 1 element usually metal form positive ion charge indicate roman numeral parenthesis follow element 2 old commonly method add ending ous ic root latin element represent ion less great charge respectively 3 monatomic anion name drop ending element add ide 4 polyatomic anion contain oxygen call oxyanion element form oxyanion oxygen end ite oxygen end ate 5 extended series oxyanion prefix hypo hyper write indicate oxygen oxygen respectively 6 polyatomic anion gain h+ ion form anion low charge result ion name add word hydrogen dihydrogen anion old method use prefix bi indicate addition single hydrogen carbonate bicarbonate hydrogen sulfate bisulfate 7 common polyatomic ion useful know table 4.1 common polyatomic ion unlikely ous ic ending require problem solving passage tend provide reaction scheme allow deduce unfamiliar compound formula important understand nomenclature discrete lit anion few oxygen heavy anion eat oxygen ionic specie definition charge cation positive charge anion negative charge element

specie definition charge cation positive charge anion negative charge element find naturally charged form exist naturally charged uncharged state element different charge oxidation state depend atom compound charge atom molecule mcat include active metal alkali metal group ia group 1 alkaline earth metal group iia group 2 charge +1 +2 respectively natural state remember alkali metal typically find nature uncharged state highly reactive moisture instead find cation salt nonmetal find right periodic table generally form anion example halogen group viia group 17 form monatomic anion charge 1 7 electron aim fill octet

summary element give group

tend form monatomic ion charge example group ia element charge +1 ionic state note anionic specie contain metallic element example chromate metal positive oxidation state note oxyanion halogen clo halogen assign positive oxidation state oxyanion transition metal like mno4 cro4 2 ion inordinately high oxidation number metal tend gain electron order reduce oxidation number good oxidize agent good oxidize reduce agent discuss chapter 4 mcat organic chemistry review nonrepresentative element like transition metal copper iron chromium numerous positively charge state state need memorize qualitatively color solution indicative oxidation state give element solution element different oxidation state undergo different electron transition absorb different frequency light figure 4.9 phenomenon show plutonium salt different oxidation state plutonium indicate roman numeral figure 4.9 solution plutonium oxidation state trend ionicity describe helpful complicate fact element intermediate electronegativity consequently likely form ionic compound left right transition metallic nonmetallic character periodic table spite fact ionic compound compose ion solid ionic compound tend poor conductor electricity charge particle rigidly set place lattice arrangement crystalline solid aqueous solution lattice arrangement disrupt ion dipole interaction ionic component water molecule cation anion free result solution ion able conduct electricity solute enable solution carry current call electrolyte electrical conductivity aqueous solution govern presence concentration ion solution subsequently number electron equivalent transfer system electrochemical cell vary pure water ion hydrogen ion hydroxide ion result water low level autodissociation poor conductor ionic compound good electrolyte dissolve readily nonpolar covalent compound weak form current carry ion tendency ionic solute dissolve solvate constituent ion water high low solute consider strong electrolyte dissociate completely constituent ion example strong electrolyte include certain ionic compound nacl ki molecular compound highly polar covalent bond dissociate ion dissolve hcl water example solvation compound show figure 4.10 solvation polar covalent compound s indicate solvent weak

electrolyte hand ionize hydrolyze incompletely aqueous

s indicate solvent weak electrolyte hand ionize hydrolyze incompletely aqueous solution solute dissolve ionic constituent example include hg2i2 ksp = 4.5 × 10–29 acetic acid weak acid ammonia weak basis compound ionize water retain molecular structure solution limit solubility compound call nonelectrolyte include nonpolar gas organic compound o2 g co2 g glucose electrolyte ionize solution produce large effect colligative property describe chapter 9 mcat general chemistry review expect give concentration mcat concept check 4.6 assess understanding material 1 label following solution electrolyte nonelectrolyte note assume compound aqueous solution 2 identify follow ion cation anion provide formula chemical symbol cation anion begin consideration compound benzaldehyde compound constituent atom different element set ratio define empirical molecular formula molecule compound define mass measure molecular weight mass mole compound determine molar mass unit gram mole review basic classification reaction commonly test mcat combination decomposition combustion single- displacement double displacement neutralization reaction furthermore confident understanding step necessary balance chemical reaction ready tackle stoichiometric problem preparation test day move chapter discuss chemical kinetic thermodynamic let offer congratulation complete chapter introduce fundamental concept chemistry structure atom trend element bonding formation compound understanding gain far foundation comprehension difficult general chemistry concept test mcat move forward review general chemistry stuck detail detail learn well application basic principle mcat practice passage question review content test knowledge critical thinking skill complete test like passage set online resource molecule mole compound substance compose element fixed molecular weight mass amu constituent atom compound indicate molecular formula molar mass mass mole avogadro number 6.022 × 1023 particle compound usually measure gram mole gram equivalent weight measure mass substance donate equivalent species interest normality ratio equivalent liter relate molarity multiply molarity number equivalent present

mole equivalent mole species interest equivalent see acid base chemistry hydrogen ion hydroxide ion oxidation reduction reaction mole electron ion representation

ion hydroxide ion oxidation reduction reaction mole electron ion representation compound law constant composition state pure sample compound contain element mass ratio empirical formula small number ratio element molecular formula multiple empirical formula give exact number atom element compound calculate percent composition mass determine mass individual element divide molar mass compound type chemical reaction combination reaction occur reactant combine form decomposition reaction occur reactant chemically break product combustion reaction occur fuel oxidant typically oxygen react form product water carbon dioxide fuel displacement reaction occur atom ion compound replace atom ion compound single displacement reaction occur ion compound replace element double displacement reaction occur element different compound trade place form new compound neutralization reaction acid react base form salt usually water balance chemical equation chemical equation balance perform stoichiometric calculation balanced equation determine follow step order balance common atom balance common atom usually hydrogen oxygen balance charge necessary application stoichiometry balanced equation determine limit reagent reactant consume chemical reaction reactant present term excess reagent theoretical yield product generate limit reactant consume reaction actual yield typically low theoretical yield percent yield calculate divide actual yield theoretical yield convert percentage like organic chemistry ion general chemistry system roman numeral nonrepresentative element denote ionic ous ending indicate less charge ic ending indicate great charge monatomic anion end ide oxyanion give suffix indicate oxidized central atom contain less oxygen give suffix ite great give suffix ate oxyanion serie member give additional level nomenclature species few oxygen give prefix hypo species oxygen give prefix per–.

polyatomic ion contain hydrogen denote number hydrogen hydrogen bi denote dihydrogen

denote ionic charge predictable group number type element metal nonmetal representative element generally unpredictable metal form positively charge cation base group number nonmetal form negatively charge anion base number electron need achieve octet electrolyte contain equivalent ion molecule dissociate solution strength electrolyte depend degree dissociation answer concept check note denominator great numerator approximately 3 percent actual value 1 approximately 3 percent approximation quickly estimate answer close note answer fraction base eighth commonly mcat know value 1/8 7/8 useful note final fraction ninth divide follow standard pattern useful know mcat 1/9 = 0.111 2/9 = 0.222 3/9 = 3 value equal mole give substance number entity mole avogadro number 6.022 × 1023 mol–1 4 normality calculate gram convert mole normality molecular mass 95 give 1 molecular empirical formula contain element ratio differ molecular formula actual number atom element compound empirical formula ratio actual number atom 2 molar mass sodium carbonate give percent composition note case estimation reduce value denominator make calculate value large actual value 3 start assume 100 g sample represent 28.5 g fe 24.0 g s 49.7 g o.

divide number gram atomic weight determine number mole find multiplier give compound integer value mole sulfur multiply 0.75 mole × 4 = 3 mole 4 multiplier compound give ratio 2 fe 3 s 12 o. give empirical formula fe2s3o12 1 ammonium cation swap place displace zinc cation yield ammonium nitrate zinc(ii sulfide zinc(ii sulfide precipitate solution solid salt 2 h2 + o2 3 h2o + neutralization type double- 2 h2 + o2 zn + agcl zncl + ag 2 fe + 3 cl2 2 fecl3 zn + 2 hcl zncl2 + h2 c5h12 + 8 o2 5 co2 + 6 h2o 3 pb(no3)2 + 2 alcl3 3 pbcl2 + 2 al(no3)3 1 4 na s + o2 g 2 na2o s 4 sodium atom need oxygen molecule sodium run determine na2o form 3 limit reagent na 4 sodium atom need 1.0 0.5 mol o2 = 0.5 mol o2 remain gram 4 reaction beo + h2o be(oh)2 1 electrolyte hcl mgbr2 nonelectrolyte sucrose ch4 cation anion cation anion science mastery assessment ionic compound compose atom hold ionic bond ionic bond associate charge particle large difference electronegativity form molecule measure molecular weight b ionic compound form large array ion crystalline solid measure formula weight ionic bond

electron share donate electronegative atom electronegative atom eliminate c compound list b d covalent compound measure molecular weight formula weight formula weight mgcl2 high 24.3 amu + 2 × 35.5 amu = 95.3 amu formula unit eliminate c kcl fit criterion 39.1 amu + 35.5 amu = 74.6 amu helpful know molar mass mole h2so4 find add atomic weight atom constitute molecule gram equivalent weight mass gram release mole proton sulfuric acid hydrogen molecule gram equivalent weight 98.1 g divide 2 49.1 g.

definition empirical formula formula represent molecule simple ratio number element comprise compound case give empirical formula ch molecule carbon hydrogen atom 1:1 ratio accurately represent empirical formula c carbon atom hydrogen atom molecular empirical formula c3h4 formula represent small number ratio constituent element percent composition mass give element molecule equal mass element molecule divide molar mass compound times 100 case acetone c3h6o overestimation actual value low close 62 choice available b ethanol underestimation actual value high near 62 c propane c3h8 calculate underestimation actual value 62 finally d note compound commonly encounter mcat familiar structure composition include common name reaction classic example neutralization reaction acid base react form salt usually water reaction fit criterion double displacement reaction c molecule essentially exchange ion neutralization specific description process question give masse reactant start reaction figure leave determine species limit reagent formula weight na2s formula weight agno3 determine give need mole agno3 mole na2s agno3 limit reagent correct answer choice gram na2s. 0.5 mol agno3 na2s consume half rate agno3 base mole ratio 0.25 mol na2s 0.25 mol excess na2s mass question well answer dimensional analysis

keep mind molar mass measure gram substance mole substance come unit gram oxygen b unit gram mole oxygen gram oxygen c unit mole gram oxygen d unit mol2 gram oxygen reaction single displacement silver silver oxide replace aluminum form aluminum oxide single-displacement reaction necessitate transfer electron oxidation reduction reaction silver

example change +2 oxidation state neutral aluminum change neutral +3 oxidation state typically single displacement double displacement reaction reactant swap component specie combination reaction hand reactant product reactant combine form product unbalanced reaction give question stem zinc balance check carbon 4 carbon atom reactant 1 product add coefficient 4 carbon dioxide product check hydrogen 10 hydrogen atom reactant 2 product add coefficient 5 water product finally check oxygen 2 oxygen atom reactant 14 product add coefficient 7 molecular oxygen reactant alteration yield balanced reaction coefficient 4 co2 molecule product answer equation give unbalanced step balance theoretical yield product synthesize limit reagent completely question ask glucose produce limit reagent 30 gram water fraction method discuss chapter solve mass glucose produce 50 gram glucose produce limit reagent definition reactant au h2s product act limit reagent eliminate c d note give equation unbalanced step balance au2s3 s + 3 h2 g 2 au s + 3 h2s g problem state 2 mole gold(iii sulfide 5 mole hydrogen gas available use mole gold(iii sulfide 6 mole hydrogen gas need 1:3 ratio reactant 5 mole hydrogen gas present limit reagent good electrolyte dissociate readily high dissociation constant ionic compound large amount cation anion rule c d few

total ion small total magnitude charge strong electrolyte b approach answer question write unbalanced equation description question stem balance equation fast method elimination give chemical equation properly balance check element time observe question oxygen atom equation balance oxygen balance b c d correct consult online resource additional practice equation remember 4.1 mole mass 4.2 gram equivalent weight 4.3 equivalent mass 4.4 molarity normality 4.5 percent composition 4.6 percent yield general chemistry chapter 2 periodic table general chemistry chapter 3 bonding chemical interactions general chemistry chapter 9 general chemistry chapter 10 acid basis general chemistry chapter 11 physics math chapter 5 electrostatic magnetism pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal

strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note corresponding subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 order reaction involve reactant product double concentration reactant cause rate increase factor 2 happen rate reaction concentration second reactant cut half a. increase factor 2 b. increase factor 4 c. decrease factor 2 d. decrease factor 4 2

certain equilibrium process activation energy forward reaction f great activation energy reverse reaction δg‡ 3 reactant second order reaction certain temperature increase factor 4 rate reaction alter a. unchanged b. increase factor 4 c. increase factor 16 d. determine information give 4 concentration reactant zero order reaction increase two- fold new rate reaction a. unchanged b. decrease factor 2 c. increase factor 2 d. determine information give 5 following experimental method affect rate a. place exothermic reaction ice bath b. increase pressure reactant closed container c. put reactant aqueous solution d. remove product irreversible reaction 6 increase concentration reactant accomplish solution contain saturate catalyst a. increase rate constant reaction rate b. decrease rate constant increase reaction rate c. increase rate constant increase reaction rate d. reaction rate unaffected 7 certain chemical reaction following rate law rate = k[no2][br2 following statement necessarily describe(kinetic i. reaction second order ii no2 consume equal br2 consume iii rate affect addition compound no2 a. b. ii c. ii iii d. ii iii 8

following datum show table collect combustion theoretical compound xh4 xh4 + 2 o2 xo2 + 2 h2o rate law reaction describe a. rate = k[xh4][o2 b. rate = k[xh4][o2]2 c. rate = k[xh4]2[o2 d. rate = k[xh4]2[o2]2 9 following well describe purpose catalyst a. catalyst reaction increase reaction efficiency b. catalyst increase rate reaction lower activation energy c. catalyst alter thermodynamic reaction facilitate formation product reactant d. catalyst stabilize transition state bring high energy 10 rate law reaction rate = k[a]0[b]2[c]1 overall order reaction question 11–13 consider follow energy diagram show 11 overall reaction depict energy diagram a. endergonic point b high point a. b. endergonic point c high point a. c. exergonic point d high point e. d. exergonic point high point e. 12 process high activation energy a. step forward reaction b. step reverse reaction c. second step forward reaction d. second step reverse reaction 13 point c reaction profile refer c. transition state 14 follow system obey second order kinetic 2 no2 no3 + no3 + co no2 + co2 rate law reaction a. rate = k[no2][co b. rate = k[no2]2[co c. rate = k[no2][no3 d. rate = k[no2]2 15

potential energy diagram show represent different reaction assume identical condition reaction display energy diagram proceed fast chapter 5.1 chemical kinetics molecular basi chemical reaction factor affect reaction rate 5.2 reaction rate definition rate determination rate law content chapter relevant 11 question general chemistry mcat chapter cover material following aamc content 1a structure function protein constituent amino 5e principle chemical thermodynamic kinetics follow chapter focus primary topic chemical kinetics chemical equilibrium term suggest chemical kinetics study reaction rate effect reaction condition rate mechanism imply observation start kinetic molecular basis reaction provide framework reaction chemistry follow explore equilibrium reaction related distinct kinetics reaction fairly good understanding equilibrium difference spontaneous nonspontaneous reaction instance utilization atp body spontaneous reaction provide thermochemical energy reaction equilibrium tell atp favor dissociation tell rate dissociation fact condition body alter rate atp synthesize utilize energy primarily temperature symptom hyper- hypothermia relate change

metabolism cause change temperature broadly multistep reaction see substrate level oxidative phosphorylation biochemistry intermediate step crucial kinetic 5.1 chemical kinetic chapter 5.1 able describe series event multistep mechanism explain meaning importance rate determine step describe activation energy compare contrast transition state theory collision theory reaction spontaneous nonspontaneous change gibbs free energy δg determine reaction occur outside assistance reaction spontaneous necessarily mean run quickly fact nearly biochemical reaction enable life exist spontaneous proceed slowly aid enzyme catalyst measurable reaction progress actually occur course average human lifetime enzyme like catalyze reaction saturate experience maximal turnover rate show figure 5.1 let review reaction mechanism rate rate law factor pertain simple chemical figure 5.1 enzyme biological catalyst saturate high substrate condition saturate active site enzyme lead maximal turnover enzyme selectively enhance rate certain reaction factor 102 1012 thermodynamically feasible reaction pathway enzyme function discuss chapter 2 mcat biochemistry review rarely balanced reaction equation determine limit reactant yield accurate representation actual step

reaction equation determine limit reactant yield accurate representation actual step involve chemical process reactant product reaction proceed step series know mechanism reaction sum give overall reaction know accept mechanism reaction help explain reaction rate position equilibrium thermodynamic characteristic consider generic reaction a2 + 2 b 2 ab mechanisms propose pathway reaction coincide rate datum information experimental observation reaction mechanism major topic organic chemistry metabolism chapter 5 10 mcat organic chemistry review chapter 9 11 mcat biochemistry review focus exclusively reaction mechanism specific context equation imply mechanism molecule b collide molecule a2 form molecule ab suppose instead reaction actually take place step step 1 a2 + b a2b step 2 a2b + b 2 ab note step take overall net reaction molecule a2b appear overall reaction call intermediate reaction intermediate difficult detect consume immediately form propose mechanism include intermediate support kinetic experiment important point remember slow

step propose mechanism call rate determine step act like kinetic bottleneck prevent overall reaction proceed fast slow step rate reaction fast rate determine step molecular basis chemical thing a2 react 2 b form 2 ab able describe precisely possible actual interaction occur a2 b produce ab rate theory propose explain event take place atomic level process collision theory chemical kinetics reaction occur molecule collide collision theory chemical kinetic state rate reaction proportional number collision second react molecule theory suggest collision result chemical reaction effective collision lead formation product occur molecule collide correct orientation sufficient energy break exist bond form new one minimum energy collision necessary reaction place call activation energy ea energy barrier fraction collide particle kinetic energy exceed activation energy mean fraction collision effective rate reaction express rate = z × f z total number collision occur second f fraction collision effective quantitatively rigorous analysis collision theory accomplish arrhenius equation normally

effective quantitatively rigorous analysis collision theory accomplish arrhenius equation normally k rate constant reaction frequency factor ea activation energy reaction r ideal gas constant t temperature kelvin frequency factor know attempt frequency reaction measure molecule certain reaction collide unit s–1 activation energy subject touch briefly follow subsection qualitatively future chapter overall important study arrhenius equation actual calculation involve euler number e natural log ln commonly find mcat relationship variable exponent rule govern equation example simple relationship k evident equation frequency factor reaction increase rate constant reaction increase direct relationship complex relationship see equation example temperature t chemical system increase infinity variable hold constant value exponent magnitude 1 assume rate constant go decrease result note presence negative sign magnitude exponent get small actually move negative value zero exponent negative positive mean rate constant actually increase sense conceptually rate reaction increase temperature low activation energy high temperature negative exponent arrhenius equation small magnitude increase rate constant k. frequency factor increase

increase number molecule vessel molecule opportunity collision increase show figure 5.2 figure 5.2 frequency factor increase increase concentration transition state theory molecule collide energy equal great activation energy form transition state old bond weaken new bond begin form transition state dissociate product fully form new bond reaction a2 + 2 b 2 ab progress reaction coordinate trace reaction reactant product represent show figure 5.3 figure 5.3 transition state transition state call activate complex great energy reactant product denote symbol energy require reach transition state activation energy activate complex form dissociate product revert reactant additional energy input transition state distinguish reaction intermediate transition state theoretical construct exist point maximum energy distinct identity finite lifetime relative reactant product transition state high energy theoretical structure isolate use propose structure well understand reaction involve free energy diagram illustrate relationship activation energy free energy reaction free

energy diagram illustrate relationship activation energy free energy reaction free energy system important feature recognize diagram relative energy product reactant free energy change reaction δgrxn difference free energy product free energy reactant negative free energy change indicate exergonic reaction energy give positive free energy change indicate endergonic reaction energy absorb transition state exist peak energy diagram difference free energy transition state reactant activation energy forward reaction difference free energy transition state product activation energy reverse reaction + δg = endergonic = energy absorb δg = exergonic = energy give example consider formation hcl h2 cl2 overall reaction h2 g + cl2 g 2 hcl g figure 5.4 show reaction exergonic free energy product free energy reactant energy release free energy change reaction negative figure 5.4 reaction diagram formation hcl left reactant h2 cl2 right product 2 hcl reaction exergonic forward reverse activation energy show kinetic thermodynamic consider separately note activation energy lower affect δg fact catalyst increase rate reaction factor affect reaction rate delve specific rate calculation helpful understand condition alter experimental rate great concentration reactant great number

effective collision unit time recall lead increase frequency factor arrhenius equation reaction rate increase zero order reaction discuss shortly reaction occur gaseous state partial pressure gas reactant serve measure concentration discuss chapter 8 mcat general chemistry review nearly reaction reaction rate increase temperature increase temperature substance measure particle average kinetic energy increase temperature increase average kinetic energy molecule consequently proportion reactant gain energy surpass ea capable undergo reaction increase high temperature reaction nuclear reaction show figure 5.5 temperature dependent experience optimal temperature activity figure 5.5 reaction temperature dependent example show nuclear fusion reaction extreme temperature nucleus begin hear raise temperature system 10 ° c result

approximate doubling reaction rate careful approximation generally true biological system system biological system temperature get high catalyst denature reaction rate plummet figure 5.6 show general curve enzymatic reaction optimal 35 ° c 40 ° c body temperature notice curve fall sharply 40 ° c point denaturation occur figure 5.6 activity vs. temperature curve generic human enzyme rate reaction take place affect medium take place molecule likely react aqueous environment likely react nonaqueous solvent dimethyl sulfoxide dmso ethanol furthermore physical state medium liquid solid gas significant effect generally polar solvent prefer molecular dipole tend polarize bond reactant lengthen weaken permit reaction occur catalyst substance increase reaction rate consume reaction catalyst interact reactant adsorption formation intermediate stabilize reduce activation energy necessary reaction proceed catalyst include enzyme chemically interact reactant return original chemical state formation product increase frequency collision reactant change relative orientation reactant make high percentage collision effective donate electron density reactant reduce intramolecular bonding reactant molecule homogeneous catalysis catalyst phase solid liquid gas reactant heterogeneous catalysis catalyst distinct phase figure 5.7 compare energy profile catalyze uncatalyzed reaction note depend context reaction profile use gibbs free energy

enthalpy y axis figure 5.7 reaction diagram catalyze uncatalyze reaction notice effect catalyst decrease energy activation ea forward reverse reaction presence catalyst impact free energy reactant product difference mean catalyst change rate reaction fact change forward rate reverse rate factor consequently impact whatsoever equilibrium position measurement keq remember useful catalyst biological nonbiological system catalyst

miracle worker transform nonspontaneous reaction spontaneous spontaneous reaction quickly equilibrium equilibrium like biological homeostasis dynamic process seek find balance system use concept advantage mcat seven basic science equilibrium dynamic mean undergo change net change zero mcat concept check 5.1 assess understanding material 1 describe word occur following step mechanism 2 mean step mechanism rate determine 3 activation energy 4 transition state theory compare collision theory transition state theory 5.2 reaction rate chapter 5.2 able predict impact change temperature concentration catalyst presence rate reaction zero second order reaction determine rate law rate order reaction give experimental reaction rate datum reaction unfortunately come handy build speedometer determine rate reaction proceed measurement concentration reactant product note change time definition rate consider generic reaction 2 + b c mole c produce mole mole b describe rate reaction term disappearance reactant time appearance product time reactant definition consume process formation product place negative sign rate expression reactant reaction rate reaction respect respect b respect c notice stoichiometric coefficient reaction equal mean rate change concentration equal mole consume mole b consume rate consumption twice rate consumption b. furthermore mole consume mole c produce rate consumption twice rate production c. base stoichiometry rate consumption b equal rate production c.

standard rate reaction rate respect reaction specie equal rate concentration change specie divide specie stoichiometric coefficient general reaction aa + bb cc + dd rate express unit mole liter second molarity second determination rate law chemical physical foundations

biological systems section mcat unlikely testmaker provide reaction equation merely look write correct rate law mcat question ask determine rate law reaction thing look remember stoichiometric coefficient overall reaction different rate law order reaction nearly forward irreversible reaction rate proportional concentration reactant concentration raise experimentally determine exponent general aa + bb cc + dd rate proportional a]x[b]y include proportionality constant k rate determine accord rate = k[a]x[b]y k reaction rate coefficient rate constant exponent x y order reaction expression call rate law remember rate measure unit concentration time molarity second exponent x y x y z reactant state order reaction respect reactant overall x order respect reactant y order respect reactant b. overall order reaction sum x y. exponent integer fraction determine experimentally mcat focus exclusively zero- first- second- order reaction case exponent integer consideration rate law offer warning common trap chemical kinetic common assumption order reaction stoichiometric coefficient balanced overall equation pay close attention

mcat value x y stoichiometric coefficient order reaction determine experimentally case stoichiometric coefficient match order reaction reaction mechanism single step balance overall reaction reflective entire chemical process second complete reaction mechanism give rate- determine step indicate stoichiometric coefficient reactant rate determine step equal order reaction occasionally little complicate rate determine step involve intermediate reactant case derive intermediate molecule concentration law mass action equilibrium constant expression step produce intermediate note exponent rate law equal stoichiometric coefficient reaction occur single step mechanism note product concentration appear rate law fall exceedingly common trap confuse rate law equilibrium expression second common trap mistake equilibrium constant expression law mass action rate law expression look similar alert test day mistake use expression equilibrium include concentration specie reaction reactant product expression chemical kinetic rate law expression include reactant keq indicate reaction equilibrium position lie rate indicate quickly reaction trap regard rate constant k. technically

speak k constant particular value specific chemical reaction depend activation energy reaction temperature reaction take place specific reaction specific temperature rate constant constant reversible reaction keq equal ratio rate constant forward reaction k divide rate constant reverse reaction k–1 fourth final trap notion principle equilibrium apply system end reaction system reach equilibrium hand reaction rate theoretically measure time usually measure near beginning reaction minimize effect reverse reaction experimental determination rate state time bear repeat value k x y rate law equation rate = k[a]x[b]y determine experimentally give reaction give temperature rate law complex order reaction difficult discern mcat limit coverage topic fairly straightforward reaction mechanism experimental datum rate law mcat experimental datum determine rate order usually provide chart include initial concentration reactant initial rate product formation function reactant concentration datum trial include chart use datum identify pair trial concentration reactant change concentration reactant remain constant condition change rate product formation trial change fully

remain constant condition change rate product formation trial change fully attributable change concentration reactant consider reaction reactant b form product c. imagine trial concentration constant concentration b double rate formation product c subsequently quadruple exponent b look generic rate law rate = k[a]x[b]y logic look like double b result

quadrupling rate determine order reaction y respect b need calculate exponent number 2 raise equal 4 2y = 4 y = 2 testmaker love rate problem solve question require real understanding proportionality variable relationship practice able quickly head minimal paper pencil calculation remember look pair reaction trial concentration species change remain constant step repeat process reactant datum different pair trial make sure concentration reactant try analyze change trial concentration reactant remain order reaction determine respect reactant write complete rate law replace exponent x y actual number determine value rate constant k plug actual value trial pick whichever trial arithmetically example give datum

find rate law following reaction + b c + d solution look trial concentration substance hold constant trial 1 2 concentration keep constant concentration b double rate increase factor approximately 4 k constant trial rate proportional b raise power symbol mean proportional specifically relationship change rate change concentration b write specific set datum proportionality word rate multiply 4 b multiply 2 y equal 2 base know far rate law trial 2 3 concentration b keep constant concentration double rate increase factor approximately 2 k b constant trial rate proportional raise power relationship change rate change concentration b write specific set datum word rate multiply 2 multiply 2 x equal 1 rate = k[a]1[b]2 typically write rate = k[a][b]2 raise value power equivalent value e.g. 21 = 2 order reaction 1 respect 2 respect b overall reaction order 1 + 2 = 3 calculate k substitute value trial rate law case trial 1 choose number straightforward final rate law rate = 2.0 m–2 s–1

a][b]2 classify chemical reaction zero order order second- order high order mixed order basis kinetic continue consider generic reaction aa + bb cc + dd zero order reaction rate formation product c independent change concentration reactant b. reaction constant reaction rate equal rate constant rate coefficient k. rate law zero order reaction rate = k[a]0[b]0 = k k unit remember rate constant dependent temperature possible change rate zero order reaction change temperature way change rate zero order reaction addition catalyst lower activation energy increase value k. temperature addition catalyst factor change rate plot zero order reaction concentration vs. time curve result linear graph show figure 5.8 line show rate formation product independent concentration reactant slope line opposite rate figure 5.8 kinetic zero order reaction note rate reaction k opposite slope order reaction rate directly proportional reactant double concentration reactant result doubling rate formation product rate law order reaction rate = k[a]1 rate = k[b]1 k unit s–1 classic example order reaction process radioactive decay rate law rate decrease radioactive isotope proportional concentration radioactive substance time t express mathematically a]t = a]0e kt a]t concentration time t a]0 initial concentration k rate constant t time important recognize order

rate law single reactant suggest reactiogn begin molecule undergo chemical change chemical interaction usually physical interaction molecule plot order reaction concentration vs. time curve result nonlinear graph show figure 5.9 curve show rate formation product dependent concentration reactant plot ln vs. time reveal straight line slope line opposite rate constant k. figure 5.9 kinetic order reaction left note rate reaction dependent reactant concentration right note rate constant opposite slope graph ln vs. time second order reaction rate proportional concentration reactant square concentration single reactant follow rate law reflect second order rate = k[a]1[b]1 rate = k[a]2 rate = k[b]2 k unit m–1

k[a]1[b]1 rate = k[a]2 rate = k[b]2 k unit m–1 s–1

important recognize second order rate law suggest physical collision reactant molecule especially rate law order respect reactant plot reaction second order respect single reactant concentration vs. time curve result nonlinear graph show figure 5.10 curve show rate formation product dependent concentration reactant vs. time reveal linear curve slope curve equal rate constant k. figure 5.10 kinetic second order reaction left note rate reaction dependent reactant concentration right note rate constant equal slope graph fortunately noteworthy reaction single reaction step involve termolecular process word process order rate far rare particle collide simultaneously correct orientation sufficient energy undergo reaction mix order reaction refer non integer order fraction case reaction rate order vary course reaction fraction specifically describe break order recent time term mixed order come refer solely reaction change order time know definition sufficient test day example mix order rate law give represent single reactant c catalyst overall reaction mechanism relevance scope mcat derivation rate law unnecessary test day understand imply equation important result large value beginning reaction k3[a k2 reaction appear order respect a. note symbol

mean great imply context contribution k2 denominator k2 + a]k3 negligible end reaction low

k2 k3[a make reaction appear second order respect a. mcat ask derive rate expression mix order reaction responsible able recognize rate order change reactant concentration change mcat concept check 5.2 assess understanding material 1 describe effect following condition initial rate reaction give reaction order example rate increase rate divide 2 rate unaffected reactant concentration 2 determine rate law rate order following reaction + b + c d begin consideration chemical reaction mechanism illustrate individual step necessary transform reactant product demonstrate way derive reaction rate law analysis experimental datum look factor affect rate overview begin appreciate chemical principle human body rely principle chemical kinetic body maintain certain temperature primarily stabilize enzyme catalyze metabolic reaction necessary life body maintain ph buffer alter concentration proton affect ability enzyme maintain secondary tertiary quaternary structure directly affect collision reactant begin appreciate question clinical perspective medical career chapter investigate chemical equilibrium relate kinetics distinct commonly review content test knowledge critical thinking skill complete test like passage set online resource change gibbs free energy δg determine reaction chemical mechanism propose series step overall intermediate molecule exist course reaction reactant product overall slow step know rate determine step limit maximum rate reaction proceed collision theory state reaction rate proportional number effective collision react molecule collision effective molecule proper orientation sufficient kinetic energy exceed activation energy arrhenius equation mathematical way represent collision transition state theory state molecule form transition state activate complex reaction old bond partially dissociate new bond partially form transition state reaction proceed product revert reactant transition state high point free energy reaction diagram reaction rate affect number factor increase concentration reactant increase reaction rate zero order reaction effective collision time increase temperature increase reaction rate particle

kinetic energy increase change medium increase decrease reaction rate depend reactant interact medium add catalyst increase reaction rate lower activation energy homogeneous

catalyst phase reactant heterogeneous catalyst different phase reaction rate measure term rate disappearance reactant appearance product rate law form rate = k[a]x[b]y rate order usually match stoichiometric coefficient rate law determine experimental datum rate order reaction sum individual rate order rate zero order reaction constant rate depend concentration reactant rate zero order reaction affect change temperature add catalyst concentration vs. time curve zero order reaction straight line slope line equal k. order reaction nonconstant rate depend concentration reactant concentration vs. time curve order reaction nonlinear slope ln vs. time plot k order reaction second order reaction nonconstant rate depend concentration reactant concentration vs. time curve second order reaction nonlinear slope vs. time plot k second order reaction break order reaction noninteger order mix order reaction rate order change time answer concept check 1 molecule a2b come combination reaction form intermediate a4b2 subsequently decompose produce final product molecule a2 molecule b2 2 rate determine step slow step reaction determine overall rate reaction reaction proceed fast rate step occur 3 activation energy minimum energy need chemical reaction 4 theory require certain activation energy overcome order reaction occur reaction occur transition state theory focus form high energy activate complex proceed forward backward form product revert reactant respectively collision theory focus energy orientation reactant consider potential reaction energy form product reactant concentration 2 question ask rate law rate order following reaction + b + c d start write

generic rate law reaction rate = complex rate law problem check possibility reagent impact rate law look trial 1 2 concentration b double change rate reagent b impact rate law exponent zero rate law update rate = k[a]x[b]0[c]z compare trial 1 3 concentration double concentration b c remain constant rate increase factor approximately 8 result proportionality rate law update rate = finally compare trial 3 4 concentration c double concentration b

remain constant rate approximately double result proportionality rate law update rate = final

rate law rate = k[a]3[b]0[c]1 = k[a]3[c rate order 3 + 0 + 1 = 4 science mastery assessment base information give question rate order respect concentration reactant concentration reactant double rate double reaction order sum exponent rate law equal 3 reaction order respect reactant 3 1 = 2 concentration second reactant multiply try answer question draw free energy diagram system activation energy forward reaction great activation energy reverse reaction product high free energy reactant overall energy system high end beginning net free energy change positive indicate endergonic nonspontaneous reaction term endothermic exothermic b associate enthalpy free energy depend enthalpy depend entropy information question stem reliably determine sign entropy change reaction second order reaction second order respect reactant order respect different reactant case reactant increase factor 4 reaction second order respect reactant rate law rate = k[a]2[b]0 rate increase factor 16 order respect reactant order respect reactant rate law rate = k[a]1[b]1 rate increase factor 4 know correct rate law determine effect rate definition zero order reaction unaffected concentration reactant reaction change concentration reactant affect rate question ask alteration affect rate reaction temperature directly affect rate constant k make incorrect change partial pressure gas affect number effective collision time make b incorrect note concentration change affect rate zero-order reaction solvent affect rate reaction depend reactant interact solvent make c incorrect remove product irreversible reaction d affect rate reaction rate law depend concentration product increase concentration reactant alter reaction rate first- high order reaction saturate solution contain catalyst maximum turnover rate increase rate constant reaction rate high add reactant sum exponent order concentration specie rate law equal 2 reaction second- order exponent rate law unrelated stoichiometric coefficient no2 br2 stoichiometric coefficient original reaction second order reaction invalidate

no2 br2 stoichiometric coefficient original reaction second order reaction invalidate statement ii statement iii incorrect rate affect wide variety compound catalyst example increase rate start generic rate law rate = k[xh4]x[o2]y trial concentration xh4 hold constant concentration o2

multiply 4 rate reaction increase factor approximately 4 give proportion δrate = o2 y 4 = 4y mean y = 1 rate law update rate =

k[xh4]x[o2]1 trial concentration o2 hold constant concentration xh4 double rate reaction increase factor approximately 4 give δrate = xh4 x 4 = 2x x = 2 rate law update rate = k[xh4]2[o2]1 final version rate law rate = k[xh4]2[o2 definition catalyst increase rate reaction lower activation energy make easier forward reverse reaction overcome energy barrier catalyst reaction alter equilibrium reaction eliminate c finally catalyst stabilize transition state lower energy raise eliminate d overall order reaction sum individual order reaction rate order 0 + 2 + 1 = 3 system exergonic energy release reaction exergonic reaction net energy change negative free energy final product low free energy initial reactant point e represent energy final product low energy diagram point represent energy initial reactant energy give reaction exergonic activation energy reaction represent distance y axis energy reactant peak energy prior formation product activation energy step forward reaction example equal distance y-axis point point b. large energy increase graph occur progress point e point d represent step reverse reaction intermediate exist valley reaction diagram reactant represent point a. product b represent point e. transition state c represent point b d.

answer question recall slow step reaction rate determine step rate relate concentration reactant rate determine step overall reaction no2 compound include correct answer concentration no2 square rate law question stem tell system obey second order kinetic fast reaction reach activation energy fast proceed completion question state condition equal reaction low activation energy fast rate diagram d low equation remember 5.1 collision theory rate = z × f 5.2 arrhenius equation 5.3 definition rate 5.4 rate law rate = k[a]x[b]y 5.5 radioactive decay a]t = a]0e kt biochemistry chapter 2 general chemistry chapter 3 bonding chemical interaction general chemistry chapter 6 general chemistry chapter 7 organic chemistry chapter 4 analyze organic reaction physics math chapter 3 pre med know feeling

content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read corresponding subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 reaction find stop reactant convert product follow true reaction a. reaction irreversible forward rate great reverse b. reaction irreversible reverse rate large product c. reaction reversible forward rate equal reverse rate d. reaction reversible reverse rate great forward 2 equilibrium expression reaction cu2so4 s 2 cu+ aq

2 equilibrium expression reaction cu2so4 s 2 cu+ aq + 3 carbonated beverage produce dissolve carbon dioxide water produce carbonic acid co2 g + h2o l h2co3 aq bottle contain carbonated water open taste beverage gradually change carbonation lose following statement well explain phenomenon a. change pressure volume cause reaction shift left decrease aqueous carbonic acid b. change pressure volume cause reaction shift right decrease gaseous carbon dioxide c.

carbonic acid react environmental oxygen nitrogen d. carbon dioxide react environmental oxygen nitrogen 4 follow well describe favor production kinetic product thermodynamic product a. high temperature short reaction time b. low temperature short reaction time c. high temperature long reaction time d. low temperature long reaction time 5 kc 1 a.

equilibrium mixture favor product reactant b. equilibrium mixture favor reactant product c. equilibrium concentration reactant product equal d. reaction essentially irreversible 6 acetic acid dissociate solution accord following equation ch3cooh ch3coo + h+ sodium acetate add solution acetic acid excess water following effect observe solution a. decrease ph b. increase ph c. decrease pkeq pka d. increase pkeq pka question 7 8

refer reaction fei aq + i2 g fei3 aq 7 follow increase formation product a. decrease volume container b. decrease pressure container c. increase volume container d. decrease volume container maintain constant 8 reaction exothermic effect decrease temperature equilibrium a. forward reaction rate reverse reaction rate increase b. forward reaction rate decrease reverse reaction rate c. forward reaction rate increase reverse reaction rate d. forward reaction rate reverse reaction rate decrease 9 follow action affect equilibrium position a. add remove heat b. add remove catalyst c. increase decrease concentration reactant d. increase decrease volume reactant 10 seal 1 l container 1 mole nitrogen gas react 3 mole hydrogen gas form 0.05 mole nh3 equilibrium follow close kc reaction 11 increase temperature alter keq reaction increase temperature indefinitely unfavorable change reaction condition a. equilibrium constant definite limit surpass b. product reactant decompose high temperature c. increase temperature decrease pressure alter reaction condition d. reaction irreversible keq resist change temperature 12 change free energy compare kinetic a. free energy change kinetic product great b. free energy change kinetic product great c. free energy change thermodynamic product great d. free energy change thermodynamic product great 13 compound ka equilibrium constant acid dissociation approximately 10–4 following compound likely react solution compound 14 consider following reaction 3 + 2 b 3 c + 4 d reaction 1 4 d + 3 c 3 + 2 b reaction 2 keq reaction 1 equal 0.1 keq reaction 2 15 following statement well describe effect lower temperature follow reaction a. c d increase b. b increase c. δh increase d. δh decrease chapter dynamic equilibria reversibility law mass action property law mass action 6.2 le châtelier principle change concentration change pressure volume change temperature

6.3 kinetic thermodynamic control content chapter relevant 4 question general chemistry

kinetic thermodynamic control content chapter relevant 4 question general chemistry mcat chapter cover material following aamc content category 1d principle bioenergetic fuel molecule metabolism 5a unique nature water solution 5e principle chemical thermodynamic kinetic aamc show rarely directly test detail equilibrium chapter need excellent conceptual understanding equilibrium master high yield topic acid base chemistry chapter 10 mcat general chemistry review enzyme chapter 2 mcat biochemistry review pediatric rotation page come emergency room resident say bring kid dka dka know stand diabetic ketoacidosis fairly common way undiagnosed type diabetes mellitus present remember second year class endocrine pathophysiology ketoacidosis arise result body metabolism fatty acid insulin production shut fatty acid metabolize ketone body alternative energy source glucose ketone produce ketoacid diabetic crisis continue worsen concentration ketoacid increase term metabolic acidosis result plasma ph 7.35

enter child room examination way child young year old conscious agitated obvious sign notice immediately rapid shallow breathing ask child hyperventilate resident take piece paper write follow co2 g + h2o l h2co3 aq h+ aq + hco3 aq child breathing begin slow realization dawn
le châtelier principle respiratory system try compensate metabolic acidosis increase breathing rate allow child blow co2 cause equilibrium shift left hydrogen ion combine bicarbonate ion produce carbonic acid decompose co2 gas expel lung result decrease plasma hydrogen ion concentration stabilize ph keep get low wow chemistry essential medical chemical equilibrium dynamic state chemical reaction concentration reactant product stabilize time low energy configuration pay particular attention concept chemical equilibrium return topic review solution acid base chemistry chapter 6.1 able determine sign δg direction reaction give keq calculate keq reaction write equilibrium constant expression reaction 3 h2 g + n2 g 2 nh3 g previous chapter dance term equilibrium warn confuse chemical equilibrium expression rate

expression stress catalyst reaction fast equilibrium position actually change equilibrium position alter value keq principle concept focus chapter direct discussion upcoming chapter important general chemistry topic mcat solution acid basis oxidation reduction reaction dynamic equilibrium reversibility far reaction cover irreversible reaction proceed direction reaction go completion maximum product form determine limit reagent initially present reversible reaction reaction proceed way forward product right reverse reactant left reversible reaction usually proceed completion product react reform reactant reaction system close reactant product add remove system eventually settle state rate forward reaction equal rate reverse reaction concentration product reactant remain constant dynamic equilibrium forward reverse reaction occur stop static equilibrium go rate net change concentration product reactant show figure 6.1 biochemical reaction classify reversible activation energy lower enzyme irreversible biochemical step term commit reverse pathway step tend rate- limit step metabolic pathway discuss

reverse pathway step tend rate- limit step metabolic pathway discuss chapter 9 11 mcat biochemistry review figure 6.1 dynamic equilibrium occur forward reverse rate consider generic reversible reaction illustrate figure 6.1 b equilibrium concentration b constant necessarily equal reaction b b continue occur equal rate equilibrium think balance forward reverse reaction well equilibrium understand basis entropy measure distribution energy system system environment reversible reaction give temperature reaction reach equilibrium system entropy energy distribution maximum gibbs free energy system minimum chapter 7 mcat general chemistry review explore classic mcat definition entropy measure disorder system important realize unit entropy imply distribution energy system law mass action generic reversible reaction aa + bb cc + dd law mass action state system equilibrium constant temperature following ratio constant law mass action actually relate expression rate forward reverse reaction consider following step reversible reaction 2 b + c reaction occur step rate forward reverse reaction give ratef = kf[a]2 rater = kr[b][c ratef = rater system

equilibrium rate equal set rate expression forward reverse reaction equal equilibrium rate forward reaction equal rate reverse reaction entropy maximum gibbs free energy minimum link concept thermodynamic kinetic kf kr constant define new constant kc kc call equilibrium constant subscript c indicate term concentration deal gas equilibrium constant refer kp subscript p indicate term pressure dilute solution kc keq interchangeably new equation write purpose need distinguish different k value dilute solution keq = kc calculate unit concentration forward reverse reaction rate equal equilibrium concentration reactant product usually equal mean forward reverse reaction rate constant kf kr respectively usually equal ratio kf kr kc reaction occur step equilibrium constant overall reaction find multiply equilibrium constant step reaction equilibrium constant overall reaction equal concentration product divide concentration reactant overall reaction concentration term raise stoichiometric coefficient respective

concentration reactant overall reaction concentration term raise stoichiometric coefficient respective specie forward reverse rate constant nth step designate kn k n respectively example reaction aa + bb cc + dd occur step forward reverse rate example expression equilibrium constant follow 3 h2 g + n2 g 2 nh3 g kp reaction remember warning chapter 5 mcat general chemistry review confuse equilibrium expression rate law equilibrium expression exponent equal coefficient balanced equation rate law exponent determine experimentally equal stoichiometric coefficient law mass action define position equilibrium equilibrium state achieve time depend actual rate forward reverse reaction equilibrium achieve microsecond millennium serve timer indicate far reaction proceed equilibrium role serve reaction quotient q. point time reaction measure concentration reactant product calculate reaction quotient accord follow equation equation look identical equation keq form information provide different concentration law mass action equilibrium constant concentration concentration reactant product constant calculate value q reaction utility q value comparison q give moment reaction know keq reaction particular temperature le

châtelier principle elaborate shortly guide reaction reaction q < keq forward reaction reach equilibrium great concentration reactant small concentration product equilibrium forward rate reaction increase restore equilibrium q = keq reaction dynamic equilibrium reactant product present equilibrium proportion forward reverse rate reaction equal q > keq forward reaction exceed equilibrium great concentration product small concentration reactant equilibrium reverse rate reaction increase restore equilibrium q < keq δg < 0

reaction proceed forward direction q = keq δg = 0 reaction dynamic equilibrium q > keq δg > 0 reaction proceed reverse direction reaction reach equilibrium state indicate q < keq continue spontaneously forward direction consume reactant form product equilibrium ratio reactant product reach reaction equilibrium state continue react forward reverse direction reaction rate forward reverse reaction equal concentration reactant product constant q = keq reaction equilibrium state indicate q > keq proceed reverse direction consume product form reactant equilibrium ratio reactant product reach reaction equilibrium movement forward direction result increase product reverse direction result reformation reactant nonspontaneous trend illustrate figure 6.2 figure 6.2 gibbs free energy vs. reaction quotient chapter 7

mcat general chemistry review discuss spontaneity system relate enthalpy properties law mass action sure remember following characteristic law mass action equilibrium constant expression concentration pure solid pure liquid appear equilibrium constant expression equilibrium expression technically base activity compound concentration activity pure solid liquid define 1 purpose mcat negligible difference concentration activity keq characteristic particular reaction give temperature equilibrium constant temperature dependent large value keq far right equilibrium position equilibrium constant reaction write direction keq equilibrium constant reverse reaction calculation involve equilibrium constant form highly repetitive discuss keq chapter equilibrium constant related calculation appear solution ksp acid basis kw ka kb enzyme kinetic kd kb ka learn in out equilibrium calculation large payoff mcat concept

grasp scale equilibrium constant ideal situation concentration product reactant regardless actual concentration reduce 1:1 ratio case keq equal 1 real world situation exist unlikely reaction exactly equal concentration product reactant equilibrium keq 1 valuable reference point give concentration product great concentration reactant keq heavy fraction great 1 hand concentration reactant great product keq heavy fraction 1 mind keq express single value exponent sign scale exponent give information relative quantity reactant product reaction strongly favor product large positive exponent large exponent reactant present equilibrium word large positive exponent indicate reaction go completion hand large negative exponent indicate reaction strongly favor reactant equilibrium case small reactant convert product perform equilibrium calculation keq large negative exponent allow convenient necessary shortcut react consider negligible compare reactant remain consider reaction keq = 10 12 start concentration = 1 m. keq expression write previously teach solve type equilibrium problem technique refer icebox test day generate entire icebox table take valuable time effort technique shortcut logic practice solve equilibrium problem icebox technique method describe chapter fast solution x react x c x b produce equilibrium equilibrium concentration 1 x m.

substitute value keq expression unfortunately perform calculation require equation polynomial function extremely burdensome solve value keq large negative exponent allow use x negligible shortcut relative 1 m start concentration react small base keq = 10 12 assume x negligible round denominator start concentration problem readily solve value x find 10 6 confirm estimate x negligible compare 1 x = 0.000001 1 0.00001 1 value keq order magnitude concentration reactant go product order magnitude initial concentration reactant estimation valid likewise value keq significantly large estimation case react significant compare start concentration reactant situation unlikely test mcat equilibrium constant calculate type reaction different name solubility problem mcat general chemistry review chapter 9 keq know ksp acid basis mcat general chemistry review chapter 10 keq know ka kb

kw enzyme kinetic mcat biochemistry review chapter 2 keq know kd kb ka example 3 mole n2o4 place 0.5 l container allow reach equilibrium accord following reaction equilibrium concentration no2 give keq reaction 6 × solution start write expression keq note concentration no2 square coefficient 2 balanced reaction determine start concentration n2o4 take account initial volume 500 ml = 0.5 l starting concentration n2o4 = 6 m. x represent n2o4 react 2x represent no2 produce 10 6 value keq plug expression note small negative exponent value keq indicate x negligible comparison 6 m allow keq expression simplify x determine follow careful note value x represent n2o4 react final answer represent no2 produce twice n2o4 react 2x final answer concentration no2 6 × 10–3 m. mcat concept check 6.1 assess understanding material 1 give product = 0.075 m reactant = 1.5 m determine direction reaction sign free energy change reaction following keq value note assume reaction product reactant stoichiometric coefficient direction reaction 5.0 × 102 5.0 × 103 5.0 × 101 2

write equilibrium constant expression following reaction co g + 2 h2 g ch3oh g h3po4 aq + h2o l h2po4 aq + h3o+ aq 3 consider hypothetical reaction follow determine reactant convert product equilibrium negligible compare start concentration a. initial concentration react initial concentration react 1.0 × 102 1.0 × 103 4 follow reaction keq 2.1 × 10–7 give initial concentration equal 0.1 m initial concentration b equal 0.2 m equilibrium concentration c approximation x negligible valid calculation 6.2 le châtelier principle chapter 6.2 able use le châtelier principle determine change condition include ph temperature pressure concentration change affect reaction previously equilibrium le châtelier principle state stress apply system system shift relieve apply stress regardless form stress take reaction temporarily move equilibrium state concentration partial pressure system long equilibrium ratio equilibrium ratio change result change temperature system reaction respond react whichever direction forward reverse result reestablishment equilibrium state le châtelier principle apply wide variety system appear fundamental concept mcat science section change concentration reactant product add remove reaction equilibrium reaction move minimum energy state

change concentration chemical specie system ratio product reactant equal equilibrium ratio word change concentration reactant product result

qc keq reactant add product remove qc < keq reaction spontaneously react forward direction increase value qc qc = keq reactant remove product add qc > keq reaction spontaneously react reverse direction decrease value qc qc = keq simply system react direction away add species remove bicarbonate buffer system classic example le châtelier principle apply co2 g + h2o l h2co3 aq h+ aq + hco3 aq tissue relatively high concentration co2 reaction shift right lung co2 lose reaction shift left note blow co2 hyperventilation mechanism deal acidemia excess h+ blood buffer system play key role respiratory circulatory excretory system discuss chapter 6 7 10 mcat biology review respectively advantage le châtelier principle improve yield chemical reaction example industrial production chemical product reversible reaction remove form prevent reaction reach equilibrium state reaction continue react forward direction produce product assume reactant continually replace consume drive reaction forward start high concentration reactant lead increase absolute quantity product form reaction eventually reach equilibrium state product remove form change pressure volume liquid solid essentially incompressible chemical reaction involve gaseous species affect change system pressure volume system compress volume decrease total pressure increase increase total pressure associate increase partial pressure gas system result system long equilibrium state qp equal keq system forward reverse whichever low total number mole gas consequence ideal gas law tell direct relationship number mole gas pressure gas increase pressure system respond decrease total number gas mole decrease pressure note scenario assume volume system decrease hold constant system return equilibrium state expand volume system total pressure partial pressure decrease system long equilibrium state react direction great number mole gas order restore pressure consider following reaction n2 g + 3 h2 g 2 nh3 g left reaction total mole gas molecule right mole pressure system increase system react direction

gas molecule right mole pressure system increase system react direction produce few mole gas case direction right ammonia form pressure decrease system react direction produce mole gas reverse reaction favor nitrogen hydrogen gas reform change temperature le châtelier principle tell change temperature system cause system react particular way return equilibrium state unlike effect change concentration pressure result change temperature change reaction quotient qc qp change keq change temperature cause concentration partial pressure reactant product change immediately q immediately temperature change temperature change keq different value q long equal keq system whichever direction allow reach new equilibrium state new temperature direction determine enthalpy reaction reaction endothermic δh > 0 heat function reactant reaction exothermic δh < 0

heat function product think heat reactant product allow apply principle concentration change example consider follow endothermic reaction show equilibrium position shift change temperature heat add temperature increase reaction shift right flask turn reddish brown increase no2 heat remove temperature decrease reaction shift left flask turn transparent increase n2o4 demonstrate le châtelier principle equilibrium shift direction consume energy figure 6.3 example reversible endothermic reaction n2o4 g 2 no2 g left temperature decrease equilibrium favor n2o4 production turn reaction vessel transparent right temperature increase equilibrium favor no2 production turn reaction vessel reddish brown aq + 2 b g c g + heat shift right shift left b add c add c remove b remove shift right shift left pressure increase volume reduce pressure reduce volume temperature reduce temperature increase mcat concept check 6.2 assess understanding material 1

describe happen following situation reaction h2so4 aq h+ aq + hso4 aq ph reaction 2 c s + o2 g 2 co g pressure reaction vessel decrease reaction ch4 g + 2 o2 g co2 g + 2 h2o l + heat reaction vessel warm reaction h3po4 aq + h2o l h3o+ aq + h2po4 aq water remove change

temperature 6.3 kinetic thermodynamic chapter 6.3 able identify condition cause reaction favor kinetic distinguish kinetic thermodynamic pathway reaction having cover fundamental kinetics thermodynamic come topic bridge chemical system control reaction particular biochemical reaction require regulation precise manner useful organism application kinetic thermodynamic control common mcat range metabolic reaction require high energy phosphate molecule atp effect temperature solvent enzyme activity example consider unimolecular system lens transition state theory figure 6.4 show start material reactant certain energy level reactant undergo different set reaction low temperature small heat transfer kinetic product form high temperature large heat transfer thermodynamic product form figure 6.4 kinetic thermodynamic control reaction kinetic pathway require free energy reach transition state result higher- energy stable product note free energy add kinetic pathway low thermodynamic pathway kinetic product form fast thermodynamic product call fast product hand free energy thermodynamic product significantly low kinetic product thermodynamic product associate great stability negative δg stability organic molecule cover chapter 2 mcat organic chemistry review dependent torsional strain angle strain nonbonded strain example consider conversion 2 methylcyclohexanone thermodynamic product kinetic product show figure 6.5 reaction require base b order catalyze conversion different product produce figure 6.5 conversion 2 methylcyclohexanone 1 thermodynamic product 2 kinetic product thermodynamic pathway 1 double bond locate c-1 methyl group require energy form transition state reaction base overcome steric hindrance create methyl group base squeeze reach carbon methyl group attach abstract proton double bond substituted pathway product reaction

group attach abstract proton double bond substituted pathway product reaction stable likely react kinetic pathway 2 double bond locate c-1 c-6 pathway prefer little heat available energy need reach transition state base easily reach c-6 remove proton result enolate form product substitute double bond reduce stability lack stability leave ring susceptible attack mcat

concept check 6.3 assess understanding material 1 condition favor formation kinetic product thermodynamic 2 reaction coordinate diagram kinetic pathway appear compare thermodynamic pathway discuss important concept principle past chapter relate study reaction rate chemical equilibrium chapter begin law mass action significance equilibrium state chemical reaction understanding significance keq q able predict direction reaction response stress concentration pressure temperature change apply system concept homeostasis biology direct result energy associate disturb equilibrium body reaction hold slightly equilibrium state generate energy pathology encounter future career medicine fundamental basis disturb chemical equilibrium wait start order metabolic panel patient review content test knowledge critical thinking skill complete test like passage set online resource reversible reaction eventually reach state energy minimize entropy maximize chemical equilibrium dynamic reaction occur concentration reactant product remain constant rate forward reaction equal rate reverse reaction law mass action give expression equilibrium constant keq reaction quotient q form calculate concentration reactant product q calculate value relate reactant product concentration give time reaction keq ratio product reactant equilibrium species raise stoichiometric coefficient keq reaction constant pure solid liquid appear law mass action gas aqueous specie comparison q keq provide information reaction respect equilibrium state q < keq δg < 0

reaction proceed forward direction q = keq δg = 0 reaction dynamic equilibrium q > keq δg > 0 reaction proceed reverse direction equilibrium calculation broadly applicable area chemistry formulaic application magnitude keq determine balance reaction react treat negligible compare concentration keq > 1 product present great concentration equilibrium keq 1 product reactant present equilibrium reasonably similar level keq < 1 reactant present great concentration equilibrium keq < < < 1 reactant convert product consider negligible comparison initial concentration le châtelier principle le châtelier principle state chemical system experience stress react restore equilibrium main type stress apply system change

concentration pressure volume temperature increase concentration reactant decrease concentration product shift reaction right increase concentration product decrease concentration reactant shift reaction increase pressure gaseous system decrease volume shift reaction few mole gas decrease pressure gaseous system increase volume shift reaction mole gas increase temperature endothermic reaction decrease temperature exothermic reaction shift reaction right decrease temperature endothermic reaction increase temperature exothermic reaction shift reaction left kinetic thermodynamic control reactions kinetic thermodynamic product regulate temperature presence catalyst kinetic product high free energy thermodynamic product form low temperature term fast product form quickly condition thermodynamic product low free energy kinetic product stable despite proceed slowly kinetic pathway thermodynamic pathway spontaneous negative answer concept check 1 calculate value q give concentration q compare value keq

predict direction direction reaction 5.0 × 102 equilibrium net reaction 5.0 × 103 qc > keq proceed reactant left 5.0 × 101 qc > keq proceed product right 3 concentration reactant convert product consider negligible order magnitude initial concentration reactant initial concentration react 1 × 102 1 × 103 4 step solve write equation keq reaction note equation keq include product d d solid initial concentration b x react plug equation keq give keq = 2.1 x 10–7 concentration b sufficiently large x consider negligible comparison allow equation keq simplify solve value x = 4.2 × 10–9 equal equilibrium concentration c b react approximation x negligible compare initial concentration b valid increase ph h2so4 aq h+ aq + hso4 aq h+ decrease shift reaction right decrease pressure 2 c s + o2 g 2 co g reaction shift right favor mole gas warm ch4 g + 2o2 g co2 g + 2 h2o l + heat reaction shift left additional heat energy produce reactant remove water h3po4 aq + h2o l h3o+ aq + h2po4 aq reaction shift leave concentration increase proportionately product reactant stoichiometric coefficient 1 reactant product value q increase 1 kinetic product favor low temperature low heat transfer thermodynamic product favor high temperature high heat 2 kinetic pathway require small

gain free energy reach transition state high free energy product small difference free energy transition state product science mastery assessment scenario likely describe situation reaction reach equilibrium far right high product concentration low reactant concentration reaction reversible reaction proceed way right reaction equilibrium equal forward reverse rate reaction recall pure solid liquid appear equilibrium expression keq denominator reactant solid cuprous sulfate call ksp solid dissociate ion solution correct keq cu+ square stoichiometric coefficient 2 carbon dioxide gas evolve leave bottle decrease total pressure

2 carbon dioxide gas evolve leave bottle decrease total pressure reactant le châtelier principle explain decrease pressure shift equilibrium increase number mole gas present particular reaction shift left turn decrease carbonic acid increase carbon dioxide water oxygen nitrogen highly reactive unlikely combine spontaneously carbon dioxide carbonic acid c d recall multiple product possible equilibrium exist multiple product product call kinetic product thermodynamic product transition state lead kinetic product low energy kinetic product form rapidly solution kinetic product stable thermodynamic product end result equilibrium product initially favor kinetic product eventually favor stable thermodynamic product take factor favor kinetic product conduct reaction short duration thermodynamic product chance form reaction conduct low temperature help stabilize stable kinetic product factor low temperature short reaction time justify choice b large value keq kc kp large ratio product reactant kc 1 significantly large concentration product reactant equilibrium large keq reaction ultimately reach equilibrium far product reversible eliminate d add sodium acetate increase number acetate ion present accord le châtelier principle change push reaction left result decrease number free h+ ion ph determine hydrogen ion concentration decrease number free proton increase ph. acid ka simply keq acid dissociation remain constant give temperature pressure eliminate c increase pressure container decrease volume favor few mole gas product make b c incorrect d disturb equilibrium significance decrease volume container equilibrium increase pressure case pressure remain constant despite change volume exothermic reaction produce

heat decrease temperature favor product formation result increase forward reaction rate concomitant decrease reverse reaction rate equilibrium reaction change factor add subtract heat shift equilibrium base enthalpy change reaction increase reactant concentration shift equilibrium direction product opposite occur reactant concentration decrease eliminate c change volume reactant affect reaction gaseous reactant product eliminate d add remove catalyst change reaction rate change equilibrium lie start balanced equation reaction h2

reaction rate change equilibrium lie start balanced equation reaction h2 n2 produce nh3 n2 + 3 h2 2 nh3 write kc = keq = volume 1 l gas mole equal value concentration gas mole liter m relatively small nh3 produce indicate possible consider n2 h2 react negligible compare start concentration put amount reactant product keq expression give extremely high temperature reactant product decompose affect equilibrium potentially destroy desire product imply reaction limit true increase temperature unfavorable c false increase temperature increase pressure assume constant volume d incorrect refer property irreversible reaction involve equilibrium product reactant thermodynamic product stable kinetic product make thermodynamic product low energy energy product low change free energy great thermodynamic product compare kinetic product d correct ka equal ratio product reactant species raise stoichiometric coefficient compound ka great 10–7 contain h+ cation ha anion equilibrium make acid mean compound question likely react compound basic answer choice nh3 base reaction 2 reverse reaction 1 mean keq reaction 2 inverse keq reaction 1 answer negative δh value indicate exothermic reaction mean forward reaction produce heat visualize follow + b c + d + heat mean remove heat decrease temperature similar remove product reaction compensate loss reaction shift right cause increase concentration c d decrease concentration b.

consult online resource additional practice equation remember 6.1 equilibrium constant 6.2 reaction quotient biochemistry chapter 2 general chemistry chapter 5 general chemistry

chapter 7 general chemistry chapter 9 general chemistry chapter 10 acid bases organic chemistry chapter 2 pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 consider cooling ideal gas close system process illustrate pressure volume graph show follow figure base information process 2 pot water 100 ° c sit heating element boil following well characterize phase change process a. isothermal expansion b. adiabatic expansion c. isovolumetric heating d. adiabatic compression 3 pure sodium metal spontaneously combust contact room temperature water true equilibrium constant combustion reaction 25 ° c a. keq < 0 b. 0 < keq < 1 c. keq = 1 d. keq > 1 4 following process exothermic standard heat a. combustion ethane b. combustion propane c. combustion n butane d. combustion n pentane 5 methanol react acetic acid form methyl acetate water type bond bond dissociation energy c = o o h c o

base value table heat reaction 6 following refer temperature pressure phase exist equilibrium a. critical point b. triple point d. state function 7 10 g sample water bring 40oc boiling completely boil gas phase follow expression represent total energy require final temperature vapor 100oc heat vaporization water 2,260 j g. a. 10 g)(40oc)(4.2 j goc + 2,260 j g)(10 g b. 10 g)(40oc)(4.2 j goc + 2,260 j oc)(60oc c. 10 g)(60oc)(4.2 j goc + 2,260 j g)(10 g d. 10 g)(60oc)(4.2 j

goc + 2,260 j oc)(60oc 8 consider chemical reaction vessel depict follow diagram a. reaction spontaneous b. reaction nonspontaneous c. information determine reaction spontaneous d. information determine reaction spontaneous chemical reaction 300 k change gibbs free energy a. δg = 2000 + 300 k)(8.314)(ln q b. δg = 2000 300 k)(8.314)(ln q c. δg = 2000 + 300 k)(8.314)(log q d. δg = 2000 300 k)(8.314)(log q 10 chemical reaction negative enthalpy negative entropy following term necessarily describe reaction 11 following statement true process spontaneous a. δg > 0 keq > q b. δg > 0 keq < q c. δg < 0 keq > q d. δg < 0 keq < q 12 following reaction great decrease entropy a. 2 nh3 g 3 h2 g + n2 g b. 2 na s + cl2 g 2 nacl s c. 2 h2o2 l 2 h2o l + o2 g d. zn s + cuso4 aq znso4 aq + cu s 13 reaction coordinate chemical reaction display graph follow term describe energy reaction 14 process melt nacl require large energy strong attraction ion researcher find 58 g salt melt 1060 k require heat input 30,000 j. change entropy a. 28 j k b. 1,580 j k c. 61,000 j k d. information

provide 15 explosion necessarily characterize a. δg < 0 b. δh > 0 c. δs < 0 d. t < 0 answer key

follow page chapter 7.1 system process 7.2 state state function constant pressure constant volume calorimetry standard heat formation standard heat reaction bond dissociation energy standard heat combustion 7.6 gibb free energy standard gibbs free energy free energy keq q content chapter relevant 7 question general chemistry mcat chapter cover material following aamc content category 1d principle bioenergetics fuel molecule metabolism 5e principle chemical thermodynamic kinetic styrofoam cup good insulator holding container certain calorimetry experiment coffee cup calorimetry use styrofoam cup measure heat solution specific heat metal material low tech produce remarkably accurate result long care take calibrate calorimeter minimize heat loss container time favorite coffee chain think occur cold cream add hot coffee take time measure masse temperature hot coffee cold cream mix measure drink temperature stir look specific heat water cream information calculate heat exchange hot coffee cold cream chapter review basic principle thermochemistry study energy

change accompany chemical physical process start law thermodynamic state energy create destroy simply change form quantify exchange energy system move initial state final state define mean system surrounding state function heat enthalpy entropy gibbs free energy 7.1 system process chapter 7.1 able identify system surrounding give situation involve transfer recall feature isothermal adiabatic isobaric isovolumetric student anxiety constitute system exclusion system constitute surrounding environment problem definition way boundary shift suit need experimenter observer simply system matter observe total reactant product chemical reaction solute solvent create solution gas inside balloon surrounding environment outside system boundary system surrounding permanently fix move example consider mass coffee coffee cup system cup contain environment setup likely interested determine heat transfer hot coffee cool coffee cup alternatively define system hot coffee cup environment air surround coffee cup setup likely interested calculate heat exchange hot coffee cup system cool surround air boundary extend far far entire mass universe ultimately include

air boundary extend far far entire mass universe ultimately include system point surrounding boundary place decision base phenomenon interested study system characterize exchange heat matter surrounding system characterize isolated system exchange energy heat work matter surrounding example insulated bomb calorimeter close system exchange energy heat work matter surrounding example steam radiator open system exchange energy heat work matter surrounding example pot boiling water system experience change property concentration reactant product temperature pressure undergo process process definition associate change state system process uniquely identify property constant process process create special condition allow simplify law thermodynamic $\delta u = q w$ δu change internal energy system q heat add system w work system example isothermal process occur system temperature constant constant temperature imply total internal energy system u constant process temperature internal energy directly proportional u constant $\delta u = 0$ law simplify $q = w$ heat add system equal work system isothermal process appear hyperbolic curve pressure

volume graph p v graph work represent area curve show figure 7.1 figure 7.1 graph isothermal expansion temperature constant isothermal process area curve represent work perform gas heat enter system adiabatic process occur heat exchange system environment thermal energy system constant process q = 0

law simplify δu = w change

internal energy system equal work system opposite work system adiabatic process appear hyperbolic p v graph show figure 7.2 figure 7.2 graph adiabatic expansion heat exchange zero adiabatic process temperature constant show dotted line isobaric process occur pressure system constant isothermal isobaric process common usually easy control temperature pressure isobaric process alter law note isobaric process appear flat line p v graph show figure 7.3 figure 7.3 graph isobaric expansion pressure constant isobaric process slope line zero finally isovolumetric isochoric process experience change volume gas expand compress work perform process law simplify δu = q change internal energy equal heat add system isovolumetric process vertical line p v graph area curve represent work gas zero term isothermal adiabatic isobaric isovolumetric isochoric familiar discuss chapter 3 mcat physics math review process classify spontaneous nonspontaneous spontaneous process occur have drive energy outside source calculate change gibbs free energy δg process chemical reaction allow predict process spontaneous nonspontaneous discuss later chapter quantity calculate change gibbs free energy δh δs tell process temperature dependent spontaneous temperature nonspontaneous spontaneous reaction mention chapter 5 6 mcat general chemistry review necessarily happen quickly completion spontaneous reaction high activation energy rarely place example time see match ignite provide quantity thermal energy generate friction associate strike match equal exceed activation energy allow match light burn spontaneously point combustion chemical component match molecular oxygen air need additional external energy activation energy spontaneous reaction proceed slowly role

enzyme biological catalyst selectively enhance rate certain spontaneous slow chemical reaction biologically necessary product form rate sufficient sustain life discuss chapter 6 mcat general chemistry review reaction completion settle low energy state call equilibrium spontaneous reaction completion simply reach equilibrium dynamically stable concentration reactant product common method supply energy nonspontaneous reaction couple nonspontaneous reaction spontaneous one show figure 7.4 figure 7.4 coupling reaction combustion

spontaneous one show figure 7.4 figure 7.4 coupling reaction combustion glucose exergonic formation peptide bond endergonic energy combustion glucose store bond gtp lyse provide energy form peptide bond mcat concept check 7.1 assess understanding material 1 person snap ice pack place leg term energy transfer consider system surrounding scenario 2 unique following type process 7.2 state state function chapter 7.2 able recall standard condition calculation distinguish state function process function list common state function identify triple point critical point phase diagram state system describe certain macroscopic property property state function describe system equilibrium state describe process system system get current equilibrium useful compare equilibrium state pathway take equilibrium state describe quantitatively process function important work w heat q state function include pressure p density ρ temperature t volume v enthalpy h internal energy u gibbs free energy g entropy s state system change equilibrium state function change addition state function independent path process take necessarily independent example gibbs free energy relate enthalpy temperature entropy state function pressure feel dense want watch tv hug pressure p density ρ temperature t volume v enthalpy h internal energy u gibbs free energy g entropy s system different equilibrium state different temperature pressure set standard condition define measure enthalpy entropy gibbs free energy change reaction standard condition define 25 ° c 298 k 1 atm pressure 1 m concentration confuse standard condition standard temperature pressure stp temperature 0 ° c 273 k pressure 1 atm standard condition kinetics equilibrium

thermodynamic problem stp ideal mcat sure confuse standard condition thermodynamic standard temperature pressure stp gas law calculation standard condition 25 ° c 298 k 1 atm pressure 1 m concentration stp 0 ° c 273 k 1 atm pressure standard condition stable form substance call standard state substance recognize standard state element compound commonly encounter

standard state substance recognize standard state element compound commonly encounter mcat example h2 g h2o l nacl s o2 g c s graphite stable form substance standard condition recognize substance standard state important thermochemical calculation heat reaction particular heat formation change enthalpy entropy free energy occur reaction take place standard condition call standard enthalpy standard entropy standard free energy change respectively symbolize δh ° δs ° δg ° degree sign variable represent zero standard state zero point phase diagram graph standard nonstandard state matter give substance isolate system determine temperature pressure phase change solid liquid gas reversible equilibrium phase eventually reach give combination temperature pressure example 0 ° c 1 atm isolate system ice water exist equilibrium word ice absorb heat liquid water melt heat remove liquid water equal liquid water freeze form ice relative amount ice water remain constant equilibrium liquid gas state water establish close container room temperature atmospheric pressure plastic water bottle cap screw tightly water bottle liquid phase small number molecule surface gain kinetic energy escape gas phase likewise small number gas molecule lose sufficient kinetic energy reenter liquid phase equilibrium establish relative amount water liquid gas phase constant standard condition equilibrium occur air water 3 percent water vapor mass phase equilibrium analogous dynamic equilibrium reversible chemical reaction concentration reactant product constant rate forward reverse reaction equal equilibrium rate forward reverse process consider phase change temperature substance phase relate average kinetic energy molecule substance molecule exactly instantaneous speed molecule possess range instantaneous kinetic energy value liquid phase molecule relatively free molecule near

surface liquid kinetic energy leave liquid phase escape gaseous phase process know evaporation vaporization time liquid lose high energy particle temperature remain liquid decrease evaporation endothermic process heat source liquid water course liquid water receive thermal energy source case puddle water dry

liquid water receive thermal energy source case puddle water dry hot summer sun pot water stovetop give energy liquid completely evaporate boiling specific type vaporization occur certain condition liquid lose particle vapor phase time boiling rapid bubbling entire liquid rapid release liquid gas particle evaporation happen liquid temperature boiling occur boiling point liquid involve vaporization entire volume liquid covered close container escape molecule trap solution molecule exert counter pressure force gas liquid phase process call condensation condensation facilitate low temperature high pressure atmospheric pressure act liquid manner similar actual physical lid evaporation condensation proceed respective rate process equal equilibrium reach pressure gas exert liquid equilibrium vapor pressure liquid vapor pressure increase temperature increase molecule sufficient kinetic energy escape gas phase temperature vapor pressure liquid equal ambient know external applied incident pressure call illustrate equilibrium exist liquid solid phase water 0 ° c atom molecule solid confine specific location atom molecule undergo motion equilibrium position vibrational motion increase heat apply understanding entropy availability energy microstate increase temperature solid increase basic term mean molecule great freedom movement energy disperse atom molecule solid phase absorb energy dimensional structure solid break atom molecule escape liquid phase transition solid liquid call fusion melting reverse process liquid solid call solidification crystallization freezing temperature process occur call melting point freezing point depend direction transition pure crystalline solid distinct precise melting point amorphous solid glass plastic chocolate candle wax tend melt solidify large range temperature order molecular structure final phase equilibrium exist gaseous solid phase solid go directly gas phase process call sublimation dry ice solid co2 sublime room temperature

atmospheric pressure absence liquid phase make convenient dry refrigerant reverse transition gaseous solid phase call deposition organic chemistry laboratory device know cold finger purify product heat reduce pressure cause sublime desire product usually volatile impurity gas pure original

cause sublime desire product usually volatile impurity gas pure original product impurity leave solid state gas deposit cold finger cold water flow yield purified solid product collect phase diagram graph temperature pressure substance thermodynamically stable particular phase temperature pressure phase equilibrium line phase diagram call line equilibrium phase boundary indicate temperature pressure value equilibrium phase line equilibrium divide diagram region correspond phase solid liquid gas represent phase transformation phase diagram single compound show figure 7.5 figure 7.5 phase diagram single compound mcat able identify understand area line line represent solid liquid interface line b liquid gas interface line c solid gas interface general gas phase find high temperature low pressure solid phase find low temperature high pressure liquid phase find moderate temperature moderate pressure point phase boundary meet call triple point temperature pressure phase exist equilibrium phase boundary separate solid liquid phase extend indefinitely triple point phase boundary liquid gas phase terminate point call critical point temperature pressure distinction phase impossibility possible distinguish liquid solid phase supercritical fluid perfectly logical liquid heat close system density decrease density vapor sit increase critical point temperature pressure density equal distinction phase heat vaporization point temperature pressure critical point value zero water unique property ice float skate flow smoothly ice rink boil negative slope solid liquid equilibrium line phase diagram density ice liquid water increase pressure constant temperature actually melt ice opposite see substance figure 7.5 mcat concept check 7.2 assess understanding material 1 standard condition standard condition 2 definition state function process function 3 list common state function 4 identify triple point critical point diagram definition triple point critical point chapter 7.3 able differentiate temperature heat

compare specific heat heat capacity recall specific heat water describe process constant volume constant pressure examine state function focus chapter address topic heat source confusion student great

function focus chapter address topic heat source confusion student great barrier proper understanding heat semantic conflation term heat temperature people use term interchangeably everyday conversation obscure lexicon thermodynamic temperature t relate average kinetic energy particle substance temperature way scale hot cold familiar temperature scale fahrenheit celsius kelvin average kinetic energy particle substance relate thermal energy enthalpy substance include consideration substance present calculate total thermal energy content temperature substance thermal energy increase temperature increase hot necessarily great thermal energy absolute term substance cold example determine large lukewarm water great total heat content small hot remember heat temperature different heat specific form energy enter leave system temperature measure average kinetic energy particle system absolute temperature scale kelvin determine law thermodynamic elucidate finite limit temperature exist temperature 0 k definition system say unable lose heat energy quantum mechanic describe state molecular motion possible absolute zero scope mcat heat q transfer energy substance result difference temperature fact zeroth law thermodynamic imply object thermal equilibrium temperature equal heat process function state function quantify thermal energy transfer object result difference temperature measure heat transfer remember law thermodynamic state change total internal energy δu system equal heat q transfer system minus work w system δu = q w.

heat work measure independently assess transfer energy form heat process regardless work process system absorb heat call endothermic δq > 0 process system release heat call exothermic δq < 0 unit heat unit energy joule j calorie cal 1 cal = 4.184 j. enthalpy δh equivalent heat q constant pressure assumption mcat usually make thermodynamic problem

important way body work prevent overheating production sweat exocrine secretion water electrolyte urea production sweat cool mechanism evaporation sweat help cool body evaporation vaporization liquid gas phase endothermic process energy absorb body particle liquid gain kinetic energy escape gas phase hot arid desert air low partial pressure water vapor humid tropical air sweat vaporize readily dry air humid air accordingly people feel comfortable dry heat humid heat substance different temperature bring thermal contact physical arrangement allow heat transfer energy warm substance cool substance substance undergo endothermic exothermic reaction heat energy exchange system environment process measure transfer heat call calorimetry basic type calorimetry include constant pressure calorimetry constant volume calorimetry coffee cup calorimeter introduce beginning chapter low tech example constant pressure calorimeter bomb calorimeter example constant volume calorimeter equation heat transfer give specific heat test study q = mcδt look lot like q equal mcat heat q absorb release give process calculate equation q = mcδt m mass c specific heat substance δt change temperature kelvin degree celsius specific heat define energy require raise temperature gram substance degree celsius kelvin specific heat value generally provide test day constant remember specific heat walk barefoot blacktop feel hot wooden walkway temperature different specific heat require heat raise temperature glass water swim pool item specific heat c different heat capacity product mc mass time specific heat constant pressure constant- picture setup constant pressure calorimeter think coffee cup calorimeter insulated container cover lid fill solution reaction physical process dissolution

insulated container cover lid fill solution reaction physical process dissolution occur incident pressure atmospheric pressure remain constant process temperature measure reaction progress sufficient thermal insulation styrofoam ensure heat measure accurate representation reaction gain loss heat environment commercial application principle include home insulation padded clothing certain food container thermos test look plasma protein cancer diagnostic medicine utilize differential scanning calorimetry dsc constant pressure

device identify blood component result show thermal property major plasma protein alter early- late stage tumor term bomb calorimeter sound ominous accurate descriptive term decomposition vessel well reflect actually take place constant volume calorimetry show figure 7.6 sample matter typically hydrocarbon place steel decomposition vessel fill pure oxygen gas decomposition vessel place insulated container hold know mass water content decomposition vessel ignite electric ignition mechanism material combust burn presence oxygen heat evolve heat combustion reaction w = pδv work isovolumetric process δv = 0

wcalorimeter = 0 furthermore insulation calorimeter consider isolate rest universe identify system sample plus oxygen steel vessel surrounding water figure 7.6 diagram bomb calorimeter bomb calorimeter help elucidate thermodynamic property chemical compound include food additive determine nutritional value caloric content heat exchange calorimeter rest universe qcalorimeter 0 δusystem + δusurrounding = δucalorimeter = qcalorimeter wcalorimeter = 0 δusystem = δusurrounding work note layer insulation isolate entire calorimeter rest universe create adiabatic process mean heat exchange calorimeter rest universe exchange steel decomposition vessel surround water previous derivation show heat exchange system surrounding make possible calculate heat know heat transfer energy system surrounding key concept test calorimetry question ask equilibrium question final temperature liquid liquid solid system remember cold object gain thermal energy hot object lose instinctively realize metal bar 1000 k hot bath water 298 k water high specific heat set equation qcold = qhot form equation avoid pesky sign notation issue δt equation encounter general chemistry text example cup contain 100 gram water 300 k mix cup contain 200 g water 450 k.

equilibrium temperature system note assume pressure sufficiently high avoid boiling solution liquid undergo thermal exchange heat give liquid equal heat absorb plug value question solve final equilibrium temperature mixture use value c long consistent liquid case quantity water

compound heat temperature rise melting boiling point reach temperature remain constant compound convert phase liquid gas respectively entire sample convert temperature begin rise depict heating curve figure 7.7 figure 7.7 heating curve single compound heating curve phase change reaction undergo change temperature reason use q = mcδt interval δt = 0 know intuitively heat continue add order solid melt heat solid absorb energy allow particle overcome attractive force hold rigid dimensional arrangement melt ice cube heat add process overcome intermolecular force water molecule ice form liquid water ice turn liquid water temperature liquid water increase converse true remove heat liquid solid liquid phase transition temperature cause formation rigid lattice water molecule phase change use value base enthalpy transition solid liquid boundary enthalpy heat fusion δhfus determine heat transfer phase change transition solid liquid change enthalpy positive heat add transition liquid solid change enthalpy negative heat remove liquid gas boundary enthalpy heat vaporization δhvap sign convention follow similar pattern utilize equation q = ml m mass l latent heat general term enthalpy isothermal process give unit need different formula calculate q phase change δt = 0 q = mcδt erroneously think q = 0 total heat need cross multiple phase boundary simply summation heat change temperature respective phase heat associate phase example energy require change 90 gram ice cube 10 ° c vapor 110 ° c note solution constant give term mass g term mole convert mass 90 g mole begin ice phase heat ice cube solid liquid phase transition occur 0 ° c step involve change temperature use heat formula contain δt

c step involve change temperature use heat formula contain δt pertinent variable ice solid water important match result term j kj different step calculation step 2 convert ice liquid form phase change temperature change step 3 heat water liquid gas phase transition temperature step 4 vaporize water temperature change occur phase change step 5 finally heat water target temperature 110 ° c total heat require phase change beginning end question involve unlikely see mcat step calculate understand significance rationale calculation definitely scope test

good interest memorize possible value c δh test day mcat provide constant need especially system water say practice heat calculation water solution gain familiarity heat capacity water help test day mcat concept check 7.3 assess understanding material 1 contrast temperature heat 2 contrast specific heat heat capacity 3 contrast constant volume constant pressure calorimetry 4 specific heat liquid water calorie chapter 7.4 able distinguish endothermic exothermic reaction determine enthalpy molecule atom give reaction datum reaction laboratory occur constant pressure 1 atm closed thermodynamic system express heat change constant pressure chemist use term enthalpy h enthalpy state function calculate change enthalpy δh system undergo process example chemical reaction compare enthalpy final state enthalpy initial state irrespective path take change enthalpy equal heat transfer system constant pressure find enthalpy change reaction δhrxn subtract enthalpy reactant enthalpy δhrxn = hproduct hreactant positive δhrxn correspond endothermic process negative δhrxn correspond exothermic process possible measure enthalpy directly δh measure certain fast spontaneous process method develop calculate δh process standard heat formation standard enthalpy formation compound δh ° f enthalpy require produce mole compound element standard state remember standard state refer stable physical state element compound 298 k 1 atm note δh ° f element standard state definition zero δh ° f value know substance tabulate need memorize value provide standard heat reaction

know substance tabulate need memorize value provide standard heat reaction standard enthalpy reaction δh ° rxn enthalpy change accompany reaction carry standard condition calculate take difference sum standard heat formation product sum standard heat formation reactant δh ° rxn = σ δh ° f product σ δh ° f reactant enthalpy state function property equilibrium state pathway take process irrelevant change enthalpy equilibrium state consequence hess law state enthalpy change reaction additive thermochemical equation chemical equation energy change know add net equation reaction correspond heat reaction add net heat reaction show figure 7.8 figure 7.8 illustration hess law form product d reactant

enthalpy state function δh = δh1 + δh2 + δh3 state function path independent hess law embody enthalpy equation introduce example describe reaction result break reactant component element form product element enthalpy change reverse reaction magnitude opposite sign enthalpy change forward reaction δhreactant element = δhelement reactant δhrxn write δhrxn = δhreactant element + δhelement product way write δh ° rxn = σ δh ° f product σ δh ° f reactant consider follow phase change enthalpy change phase change call heat vaporization δh ° vap long initial final state exist standard condition δh ° rxn equal δh ° vap irrespective particular pathway process take example possible br2 l decompose br atom recombine form br2 g simply boil liquid gaseous state net reaction change enthalpy example give follow thermochemical equation calculate δh reaction d c s graphite + 2 h2 g ch4 g solution equation b c combine obtain equation d equation d contain c h2 ch4 eliminate o2 co2 h2o equation equation reverse ch4 product equation e equation b leave equation f consistency c multiply 2 equation g d calculate e + f + g important realize hess law apply

e + f + g important realize hess law apply state function include entropy gibbs free energy equation sure multiply correct stoichiometric coefficient perform calculation bond dissociation energy hess law express term bond enthalpy call bond dissociation energy bond dissociation energy average energy require break particular type bond atom gas phase remember bond dissociation endothermic process bond dissociation energy give give table mcat format similar table 7.1 table 7.1 sample bond enthalpy bond enthalpy average bond energy bond different compound example c h bond average measurement individual c h bond enthalpy thousand different organic compound note bond formation opposite bond breaking magnitude energy negative positive energy release bond form remember atom generally form bond stable complete octet make sense bond formation exothermic bond dissociation endothermic enthalpy change associate reaction give δh ° rxn = σ δhbond break σ δhbond form = total energy absorb total energy release take energy pull atom apart bond breakage generally endothermic reverse process bond formation generally exothermic example calculate

enthalpy change following reaction bond dissociation energy h h c h bond respectively δhf c g solution ch4 form free element standard state c solid state h2 gaseous state δhrxn = δhf reaction write step δhf = δh1 + 2 × δh2 + δh3 δh1 = δhf δh2 energy require break h h bond mole h2 δh2 = bond enthalpy note reaction b double order produce 4 atom h molecule h2 δh3 energy release 4 c h bond form energy release bond form δh3 negative entire reaction standard heat combustion imply standard heat combustion δh ° comb enthalpy change associate combustion fuel measurement enthalpy change require reaction spontaneous fast combustion reaction ideal process measurement combustion reaction present mcat occur presence atmospheric oxygen mind combustion reaction oxygen oxidant diatomic fluorine example oxidant addition hydrogen gas

reaction oxygen oxidant diatomic fluorine example oxidant addition hydrogen gas combust chlorine gas form gaseous hydrochloric acid process evolve large heat light characteristic combustion reaction reaction list ch4 g example show early combustion reaction o2 g oxidant enthalpy change list reaction δhcomb reaction glycolytic pathway describe chapter 9 mcat biochemistry review combustion reaction utilize fuel glucose mix oxidant oxygen produce carbon dioxide water c6h12o6 + 6 o2 6 co2 + 6 h2o heat combustion reaction find similar fashion hess law give numerous reaction pathway involve determine overall enthalpy reaction show figure 7.9 figure 7.9 determine enthalpy glycolysis large alkane reactant numerous combustion product mcat concept check 7.4 assess understanding material 1 define endothermic exothermic process 2 give follow reaction determine enthalpy 3 enthalpy reaction reaction 2 h2o g 2 h2 g + o2 g give follow bond enthalpy chapter 7.5 able order phase matter low high entropy define entropy term relation energy distribution disorder predict direction change entropy give reaction student perplex concept entropy enthalpy make intuitive sense especially energy change reactant product large fast dramatic combustion reaction involve explosion entropy intuitive consider example normal following hot tea cool frozen drink melt iron rust building crumble balloon deflate live thing die decay

example common denominator energy form go localize concentrate spread disperse thermal energy hot tea spread cool air surround thermal energy warm air spread cool frozen drink chemical energy bond elemental iron oxygen release disperse result formation stable low energy bond iron oxide rust potential energy building release disperse form light sound heat building crumble fall energy pressurize air release surround atmosphere balloon deflate chemical energy molecule atom living flesh release environment process death decay second law thermodynamic state energy spontaneously disperse localize spread way think entropy disorder take literally trap student fall careful think entropy disorder

disorder take literally trap student fall careful think entropy disorder old analogy messy disordered room entropy deficient hinder understanding actually increase confusion entropy measure spontaneous dispersal energy specific temperature energy spread widely spread energy process equation calculate change entropy δs change entropy qrev heat gain lose reversible process t temperature kelvin unit entropy usually energy distribute system give temperature entropy increase energy distribute system give temperature entropy entropy change accompany phase change easily estimate qualitatively example freezing accompany decrease entropy relatively disordered liquid order solid boiling accompany large increase entropy liquid disordered gas substance sublimation phase transition great increase notice second law state energy spontaneously disperse energy localize concentrate concentration energy rarely happen spontaneously close system work usually concentrate energy example refrigerator work direction spontaneous heat flow counteract flow heat warm exterior refrigerator cool interior concentrate energy outside system surrounding result refrigerator consume lot energy accomplish movement energy temperature entropy kitchen raw egg exemplify asymmetry time fresh break easily break spontaneously simple reason way break physics jargon break egg high entropy figure 7.10 entropy kitchen second law describe time arrow unidirectional limitation movement energy recognize new old show figure 7.10 example instantly recognize video recording explosion run forward backward way understand energy

close system spontaneously spread entropy increase define include entire universe fact second law ultimately claim entropy universe increase δsuniverse = δssystem + δssurrounding > 0

entropy state function change entropy equilibrium state pathway independent depend difference entropy final initial state standard entropy change reaction δs ° rxn calculate standard entropy reactant product like enthalpy δs ° rxn = σ δs ° f product σ δs ° f reactant mcat concept check 7.5 assess understanding material 1 rank phase matter low high entropy 2 describe entropy term energy dispersal disorder 3 follow situation result increase decrease entropy h2o l h2o s dry ice sublimate carbon dioxide nacl s nacl aq nacl s nacl aq n2 g + 3 h2 g 2 nh3 g ice pack place wound 7.6 gibbs free energy chapter 7.6 able determine gibbs free energy reaction vary temperature predict temperature necessary temperature dependent reaction equilibrium identify change concentration reactant product alter progress reaction final state function examine chapter gibbs free energy g. state function combination examine temperature enthalpy entropy change gibbs free energy δg measure change enthalpy change entropy system undergo process indicate reaction spontaneous nonspontaneous change free energy maximum energy release process occur constant temperature pressure available perform useful work change gibbs free energy define follow δg = δh tδs t temperature kelvin tδs represent total energy absorb system entropy gibbs free energy δg = δh tδs goldfish equal sign horrible minus sign tartar sauce helpful visual aid conceptualize gibbs free energy think valley hill ball tend roll hill valley eventually come rest low point valley system include chemical reaction whichever direction result reduction free energy system valley represent equilibrium side hill represent point pathway away equilibrium show graphically figure 7.11 discuss previous chapter figure 7.11 gibbs free energy spontaneity decrease gibbs free energy indicate reaction spontaneous equilibrated system disturb spontaneously act restore equilibrium movement equilibrium position associate decrease gibbs free energy δg < 0

spontaneous system release energy say exergonic show figure 7.12 exergonic reaction profile exergonic reaction release energy spontaneous δgrxn < 0 careful confuse endergonic exergonic describe gibbs free energy endothermic exothermic describe enthalpy hand movement away equilibrium position associate increase gibbs free energy δg > 0 nonspontaneous reaction say endergonic show figure 7.13 figure 7.13 endergonic reaction profile endergonic reaction absorb energy nonspontaneous δgrxn > 0 energy minimum state equilibrium system resist change state change free energy zero 1 δg negative reaction spontaneous 2 δg positive reaction nonspontaneous 3 δg zero system state equilibrium δh = tδs recall phase equilibrium state phase exist equilibrium change gibbs free energy equal zero δg = 0 equilibrium gas solid δg = g g g s = 0 g g = g s recall thermodynamic kinetic separate topic reaction thermodynamically spontaneous bearing fast go mean proceed eventually external energy input temperature gibbs free energy kelvin positive effect sign δh δs spontaneity process summarize table 7.2 table 7.2 effect δh δs t spontaneity spontaneous high t nonspontaneous t spontaneous t spontaneous low t δg temperature dependent δh δs sign phase change example temperature dependent process phase change water familiar wonder water boil 20 ° c instead 100 ° c water boil hydrogen bond break water molecule gain sufficient energy escape gas phase boiling endothermic process δh positive thermal energy transfer water molecule energy distribute molecule enter gas phase entropy positive term tδs positive δh tδs positive reaction spontaneous tδs great δh result negative δg condition meet temperature system great 373 k 100 ° c 100 ° c free energy change positive boiling nonspontaneous water remain liquid 100 ° c δh tδs = 0 equilibrium

establish liquid gas phase way water vapor pressure equal ambient pressure definition boiling point temperature vapor pressure equal ambient important remember rate reaction depend activation energy ea δg spontaneous reaction fast slow reversible reaction produce product differ stability measure change free energy associate production kinetic measure respective activation energy thermodynamically stable product slow kinetic high activation energy

situation talk kinetic vs. thermodynamic reaction control discuss chapter 6 mcat general chemistry review period time reaction begin major product produce quickly result low activation energy reaction say kinetic control time give time assume reversible reaction dominant product thermodynamically stable product result low free energy value reaction say thermodynamic control eventually reaction reach equilibrium define keq standard gibbs free energy free energy change reaction measure standard state condition yield standard free energy δg ° rxn standard free energy determination concentration solution reaction 1 m. standard free energy formation compound δg ° f free energy change occur 1 mole compound standard state produce respective element standard state standard state condition standard free energy formation element standard state condition definition zero standard free energy reaction δg ° rxn free energy change occur reaction carry standard state condition reactant convert product standard condition temperature 298 k pressure 1 atm like enthalpy entropy free energy reaction calculate free energy formation reactant free energy keq q derive standard free energy change reaction equilibrium constant keq reaction equation δg ° rxn = rt ln keq r ideal gas constant t temperature kelvin keq equilibrium constant equation allow quantitative evaluation free energy change reaction qualitative assessment spontaneity reaction great value keq positive value natural logarithm positive natural logarithm negative standard free energy change negative standard free energy change spontaneous reaction reaction begin standard state condition specifically 1 m solution long apply value equilibrium constant replace number reflective reaction path equilibrium

apply value equilibrium constant replace number reflective reaction path equilibrium determine free energy change reaction progress relate δgrxn δg ° rxn reaction quotient q note right equation similar equation 7.12 use q indicate system equilibrium describe chapter 6 mcat general chemistry review q < keq natural logarithm negative free energy change negative reaction spontaneously proceed forward equilibrium reach ratio great q > keq natural logarithm positive free energy change positive case reaction spontaneously reverse

direction equilibrium reach course ratio equal reaction quotient equal equilibrium constant reaction equilibrium free energy change zero ln 1 = 0 reaction profile free energy alter presence catalyst overall free energy change reaction alter activation energy require accomplish reaction reduce significantly presence catalyst

show figure 7.14 catalyst alter kinetic equilibrium free energy change mcat concept check 7.6 assess understanding material 1 haber bosch process create ammonia reaction final step determine gibbs free energy reaction standard condition 500 k standard condition 500 k 2 temperature reaction describe equilibrium 3 suddenly flood reaction vessel significant amount ammonia occur begin discussion thermochemistry review different way characterize system open closed isolated process isothermal adiabatic isobaric isovolumetric classify system accord state function system property pressure density temperature volume enthalpy internal energy gibbs free energy entropy describe equilibrium state examine equilibrium exist different phase note change gibbs free energy phase change equilibrium zero case equilibria define enthalpy heat content system change enthalpy change heat content system move equilibrium state enthalpy define energy find intermolecular interaction bond compound system explore way hess law apply calculate total enthalpy change series reaction move entropy describe property measure degree energy system spread process danger think literally entropy disorder system entropy increase observable change system macroscopic disorder ice warm 10 ° c 5 ° c gibbs free energy combine effect temperature enthalpy entropy change gibbs free energy determine process spontaneous nonspontaneous change gibbs free energy negative process spontaneous change gibbs free energy positive process reaction body spontaneous order cell function nonspontaneous reaction body able couple thermodynamically favorable exergonic reaction allow cell perform review content test knowledge critical thinking skill complete test like passage set online resource system process systems classify base exchange isolated system exchange matter energy environment closed system exchange energy matter environment open system exchange energy matter

environment process characterize base single constant property isothermal process occur constant temperature adiabatic process exchange heat environment isobaric process occur constant pressure isovolumetric isochoric process occur constant volume state state functions state function describe physical property equilibrium state pathway independent include pressure density temperature volume

property equilibrium state pathway independent include pressure density temperature volume enthalpy internal energy gibbs free energy entropy standard condition define 298 k 1 atm 1 m concentration standard state element prevalent form standard condition standard enthalpy standard entropy standard free energy calculate standard condition phase change exist characteristic temperature pressure fusion melting freezing crystallization solidification occur boundary solid liquid phase vaporization evaporation boiling condensation occur boundary liquid gas phase sublimation deposition occur boundary solid temperature critical point liquid gas phase triple point phase matter exist equilibrium phase diagram system graph phase phase equilibrium function temperature pressure temperature heat thing temperature scale measure average kinetic energy heat transfer energy result difference temperature substance heat content system undergo heating cooling phase change sum respective energy change enthalpy measure potential energy system find intermolecular attraction chemical bond hess law state total change potential energy system equal change potential energy individual step process enthalpy calculate heat formation heat combustion bond dissociation energy entropy think disorder measure degree energy spread system system entropy ratio heat transfer mole unit kelvin entropy maximize equilibrium gibbs free energy gibb free energy derive enthalpy entropy value give change gibbs free energy determine process spontaneous $\delta g < 0$ reaction proceed forward direction spontaneous $\delta g = 0$ reaction dynamic equilibrium $\delta g > 0$ reaction proceed reverse direction nonspontaneous gibbs free energy depend temperature temperature dependent process change spontaneous nonspontaneous depend answer concept check

1 boundary system surrounding place commonly ice pack consider chemical system energy person remainder universe constitute surrounding provide heat ice pack function isothermal change temperature δu = 0 q = w adiabatic heat exchange q = 0 δu = w isobaric change pressure line appear flat p v graph isovolumetric isochoric change volume w = 0 δu = q 1 kinetic equilibrium thermodynamic calculation use standard condition 25 ° c 298 k 1 atm pressure 1 m concentration 2 state function property system equilibrium independent path take achieve equilibrium dependent process function define path equilibrium state include q heat w work 3 state function include pressure p density ρ temperature t volume v enthalpy h internal energy u gibbs free energy g entropy s 4 triple point specific combination temperature pressure phase equilibrium critical point temperature pressure liquid gas phase indistinguishable heat vaporization zero 1 temperature indirect measure thermal content system look average kinetic energy particle sample heat thermal energy transfer object result difference temperature 2 specific heat c energy require raise temperature gram substance degree celsius heat capacity mc product mass specific heat energy require raise give substance degree celsius 3 constant pressure calorimeter coffee cup calorimeter expose constant atmospheric pressure reaction proceed temperature content measure determine heat reaction constant volume calorimeter bomb calorimeter heat certain reaction like combustion measure indirectly assess temperature change water bath reaction vessel 1 endothermic reaction involve increase heat content system surrounding δh > 0 exothermic reaction involve release heat content system δh < 0 2 reach

net equation second reaction reverse sign enthalpy reaction add enthalpy give 3 enthalpy reaction = bond break bond form o h bond break h h bond form o = o bond form 1 solid low entropy follow liquid gas have 2 entropy increase system disorder freedom movement energy disperse spontaneous system entropy universe decrease spontaneously h2o l h2o s dry ice sublimate carbon dioxide nacl s nacl aq n2 g + 3 h2 g 2 nh3 g decrease few mole gas ice

pack place wound increase heat transfer 1 standard condition 500 k 2 system equilibrium δg = 0 3 value q increase significantly cause system shift left form reactant system reach equilibrium science mastery assessment process adiabatic give gas cool maintain constant temperature eliminate c isobaric isovolumetric process appear horizontal vertical line pressure volume graph respectively eliminate b d adiabatic process appear hyperbolic pressure volume graph illustrate temperature phase change constant phase change isothermal process boiling heat add system break intermolecular attraction water molecule water molecule vaporize expand outward occupy large volume boiling isothermal expansion consistent solve question equation δg ° rxn = rt ln keq δg ° rxn negative spontaneous reaction r t positive ln keq positive sign convention work correctly ln(1 = 0 natural logarithm number great 1 positive natural logarithm number 1 negative order ln keq positive number keq

great 1 combustion involve reaction hydrocarbon oxygen produce carbon dioxide water long hydrocarbon chain yield great amount combustion product release heat process reaction exothermic hydrocarbon list n pentane long glance like math heavy problem require calculation track bond break bond form remember break bond require energy form bond release energy bond break c o bond carbonyl carbon oxygen acetic acid o h bond hydroxyl oxygen hydrogen methanol bond form c o bond carbonyl carbon oxygen methyl acetate o h bond hydroxyl group hydrogen form water give bond break form reaction energy change triple point triple phase solid liquid gas phase exist equilibrium consistent b hand critical point refer temperature pressure gas liquid indistinguishable eliminate part computation water heat 40oc 100oc vaporize calculate energy require heat water use formula q = mcδt plug value yield 10 g 60oc)(4.2 j goc calculate energy require vaporize equation q = ml. plug value yield 2,260 j g)(10 g

finally combine energy 10 g)(60oc)(4.2 j goc + 2,260 j g)(10 g match information available

determine free energy reaction entropy clearly increase particle system unclear enthalpy change bond break reaction endothermic mean δs δh positive case temperature dependent process temperature give determine sign δg problem ask free energy reaction nonstandard condition determine equation δg = δg ° + rt ln q. reaction negative enthalpy definition exothermic enthalpy entropy negative temperature dependent process reaction endergonic exergonic particular temperature eliminate c d process progress forward spontaneously q keq tendency direction equilibrium spontaneous reaction free energy negative convention question ask reaction great decrease entropy phase reactant product evaluate general entropy gas high entropy solid low reaction gas react produce solid significant entropy decrease reaction b gaseous reactant form solid product entropy decrease make b correct contrast reaction minimal change increase entropy reaction mole gaseous reactant mole gaseous product entropy increase c liquid reactant form gaseous product entropy likewise increase reaction d equation solid aqueous component approximately change entropy eliminate c d describe free energy reaction determine graph reaction coordinate graph explore book use free energy y axis use potential energy enthalpy heat formation product great reactant reaction endothermic determine information relative position graph product high reactant endothermic reaction entropy change calculate formula δs = q t. note information give question necessary ignore mass plug value yield δs = 30,000 j 1,060 k = 28 j k. correct explosion significant heat energy release mean reaction exothermic δh < 0

eliminate b entropy change associate explosion positive energy disperse large area eliminate c true expression δh tδs negative indicate exergonic process δg < 0 absolute temperature negative eliminate d equation remember 7.1 law thermodynamic δu = q w 7.2 heat transfer phase change q = mcδt 7.3 heat transfer phase change q = ml 7.4 generalized enthalpy reaction δhrxn = hproduct hreactant 7.5 standard enthalpy reaction δh ° rxn = σ δh ° f product σ 7.6 bond enthalpy δh ° rxn = σ δhbond break σ δhbond form = total energy absorb total energy release 7.8 second law thermodynamic δsuniverse = δssystem + δssurrounding >

0 7.9 standard entropy reaction δs ° rxn = σ δs ° f product σ 7.10 gibbs free energy δg = δh tδs 7.11

standard gibbs free energy reaction δg ° rxn = σ δg ° f product σ δg ° f reactant 7.12 standard gibbs free energy equilibrium constant δg ° rxn = rt ln keq 7.13 gibbs free energy reaction quotient general chemistry chapter 3 bonding chemical interaction general chemistry chapter 4 compound stoichiometry general chemistry chapter 5 general chemistry chapter 6 physics math chapter 2 work energy physics math chapter 3 gas phase pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 following set condition likely result ideal a. high pressure low temperature b. low temperature large volume c. high pressure large volume d. low pressure high temperature 2 density neon gas 3 leak helium gas small hole occur rate leakage rate neon oxygen gas compare helium temperature pressure a. neon leak fast helium oxygen leak fast helium b. neon leak fast helium oxygen leak slow helium c. neon leak slow helium oxygen leak fast helium d. neon leak

slow helium oxygen leak slow helium 4 0.10 g piece magnesium place beaker hydrochloric acid hydrogen gas generate accord following equation mg s + 2 hcl aq mgcl2 aq + h2 g gas

collect water 25 ° c gauge pressure experiment read 784 mmhg gas displace volume 100 ml. vapor pressure water 25 ° c approximately 24.0 mmhg base datum mole hydrogen produce reaction note a. 4.04 × 105 mole hydrogen b. 4.09 × 103 mole hydrogen c. 3.07 × 102 mole hydrogen d. 3.11 mole hydrogen 5 ideal gas i. volume ii particle attractive force iii mass a. b. ii c. ii d. ii iii 6 following well explain difference ideal behavior nitrogen fluoromethane gas a. nitrogen gas ideal small form strong b. nitrogen gas ideal small form weak c. fluoromethane ideal large form strong d. fluoromethane ideal small form weak 7 kinetic molecular theory state a. average kinetic energy molecule gas directly proportional temperature gas kelvin b. collision gas molecule inelastic c. gas particle occupy discrete area space d. gas molecule kinetic energy temperature 8 plot gas stp show gas 1.0 l helium 1.0 l bromine plot correspond gas a. curve helium curve b bromine helium small molar mass bromine b. curve helium curve b bromine average kinetic energy bromine great average kinetic energy helium c. curve bromine curve b helium helium small molar mass bromine d. curve bromine curve b helium average kinetic energy bromine great average kinetic energy helium 9 sea level 25 ° c solubility oxygen gas water 1.25 × 103 m. denver city united states lie high sea level atmospheric pressure 0.800 atm solubility oxygen water a. 1.00 × 103 m b. 1.05 × 103 m c. 1.50 × 103 m d.

2.56 × 103 m 10 give gas center sun average molar mass compress density 1.30 × 109 atm pressure temperature center sun a. 2.6 × 104 k b. 2.6 × 106 k c. 2.6 × 107 k d. 2.6 × 1010 k 11 gaseous state matter characterize follow i. gas compressible ii gas assume volume container iii gas particle exist diatomic molecule a. b. ii c. ii iii d. ii iii 12 gas temperature 27 ° c volume 60.0 ml. temperature change need increase gas volume 90.0 ml a. reduction 150 ° c b. increase 150 ° c c. reduction 13.5 ° c d. increase 13.5 ° c 13 significant decrease temperature volume affect ideal gas a. lead ideal behavior b. low temperature lead deviation ideal behavior low volume cause ideal behavior c. low temperature lead ideal behavior low volume cause ideal behavior d. lead deviation ideal behavior 14 follow situation impossible

predict pressure change gas sample a. gas cool constant volume b. gas heat constant volume c. gas heat volume simultaneously increase d. gas cool volume simultaneously increase 15 experimenter notice molar concentration dissolve oxygen enclose water tank decrease half original value attempt counter decrease quadruple partial pressure oxygen container final concentration gas a. half original concentration b. original concentration c. double original concentration d. quadruple original concentration gas phase chapter 8.1 gas phase 8.2 ideal gas ideal gas law dalton law partial pressure 8.3 kinetic molecular theory 8.4 real gas deviation pressure deviation temperature van der waals equation state content chapter relevant 9 question general chemistry mcat chapter cover material following aamc content category 3b structure integrative function main organ system 4b importance fluid circulation blood gas movement gas exchange let start chapter thought experiment imagine helium balloon tie gearshift lever seat car allow float freely think happen balloon car accelerate forward think base feel accelerate vehicle balloon push backwards inertia balloon movement predict balloon shift forward car accelerate molar mass helium air nitrogen oxygen mean air seven time dense helium air balloon float dense balloon air great inertia car accelerate forward significant mass include air car resist forward motion inertia shift car course car accelerate forward quickly car air shift pressure gradient build great air pressure car pressure difference result push force balloon direct respond force balloon shift forward direction car acceleration think general chemistry physic chapter discuss mcat favorite gas phase ideal gas law begin discussion ideal gas law govern behavior examine kinetic molecular theory describe ideal gas conclude evaluation way behavior real gas deviate predict ideal gas law 8.1 gas phase chapter 8.1 able identify unique characteristic gas phase predict pressure change different position location recall condition stp standard condition matter exist different physical form call phase

stp standard condition matter exist different physical form call phase state gas liquid solid discuss liquid context intermolecular force solid context organize crystal chapter 3 mcat

general chemistry review gaseous phase simple understand gas display similar behavior follow similar law regardless particular chemical identity like liquid gas classify fluid flow shape container atom molecule gaseous sample rapidly far apart addition weak intermolecular force exist gas particle result certain characteristic physical property ability expand fill volume gas easily infinitely compressible distinguish liquid define state gaseous sample variable pressure p volume v temperature t number mole gas pressure usually express unit atmosphere atm millimeter mercury mmhg equivalent torr si unit pressure pascal pa mathematical relationship unit follow 1 atm = 760 mmhg 760 torr = 101.325 kpa

medical device measure blood pressure term sphygmomanometer clinically relevant unit measurement mmhg fact medical device utilize conceptual design barometer show figure 8.1 continuously monitor blood pressure blood pressure measure sphygmomanometer use unit mmhg normal adult blood pressure consider 120 mmhg systolic 80 mmhg diastolic < 120/80 hypertension high blood pressure define have blood pressure reading > 140 mmhg systolic > 90 mmhg diastolic figure 8.1 schematic simple mercury barometer order explain mercury rise barometer summarize force play atmospheric pressure create downward force pool mercury base barometer mercury column exert oppose force weight base density weight mercury create vacuum tube external air exert high force weight mercury column column rise external air exert low force weight mercury column fall reading obtain measure height mercury column mm directly proportional atmospheric pressure apply fluid dynamic important concept discuss chapter 4 mcat physics math review apply multiple aspect gas law cover include functionality mercury barometer important mention atmospheric pressure external pressure exert force instance clinical blood pressure cuff create force oppose person systolic diastolic arterial blood pressure volume gas generally express liter l milliliter ml temperature usually give kelvin k celsius ° c instead process involve gas place standard temperature pressure stp refer condition 273 k 0 ° c 1 atm note caution stp condition identical standard state condition standard involve different temperature different purpose stp 273 k 1 atm

generally gas law calculation standard state condition 298 k 1 atm 1 m concentration measure standard enthalpy entropy free energy change electrochemical cell voltage mcat remember stp different standard state temperature stp 0 ° c 273 k temperature standard state 25 ° c 298 k mcat concept check 8.1 assess understanding material 1 characteristic gas phase unique 2 mercury barometer primarily affect atmospheric pressure happen level mercury column barometer move mountain barometer place meter

happen level mercury column barometer move mountain barometer place meter water 3 condition stp 4 standard condition 8.2 ideal gas chapter 8.2 able apply ideal gas equation calculation pressure temperature volume number mole calculate density substance give molecular formula current pressure current temperature apply avogadro principle boyle law charles law gay lussac law combined ideal gas law give scenario solve problem dalton law partial pressure henry law examine behavior gas vary condition temperature pressure assume gas ideal ideal gas represent hypothetical gas molecule intermolecular force occupy volume real gas deviate ideal behavior high pressure low volume low temperature compressed real gas demonstrate behavior close ideal ideal gas follow gas law discuss pressure temperature real gas deviate law high pressure low volume low temperature intermolecular force volume effect ideal gas law ideal gas law state 1834 benoît paul émile clapeyron 170 year sir robert boyle perform experimental study relationship pressure volume gas state fact time ideal gas law find expression boyle law charles law dalton law establish historical consideration aside benefit examine ideal gas law understand law identify early special case ideal gas law ideal gas law show relationship variable define sample gas pv = nrt p pressure v volume n number mole t temperature r represent ideal gas constant value aware gas constant express unit mcat encounter r derive si unit pascal pressure cubic meter volume substitute ideal gas law relevant value r provide test day need important recognize appropriate value r base unit variable give passage question ideal gas law determine miss term give calculate change term hold constant commonly solve volume pressure give temperature number mole figure 8.2 show graph p−v

relationship increase figure 8.2 ideal gas isothermal curve n r t hold constant easily analyze relationship pressure volume example volume 12 g helium occupy 27 ° c

volume example volume 12 g helium occupy 27 ° c pressure solution ideal gas law variable convert unit correspond expression gas constant round number speed arithmetic test day instance constant 0.0821 round 0.08 choice sufficiently different estimate answer nearly identical true answer choice arithmetic math strategy discuss chapter 10 mcat physics math review ideal gas law useful standard calculation pressure volume temperature gas give set condition determination gas density molar define density ρ ratio mass unit volume substance density gas usually express unit gram liter ideal gas law contain variable volume number mole rearrange law calculate density gas different approach start fact mole ideal gas stp occupy 22.4 l. calculate effect change pressure temperature differ stp condition predict volume gas finally calculate density divide mass predict volume follow equation combined gas law amalgam special case discuss follow section relate change temperature volume pressure subscript 1 2 refer state gas stp condition actual temperature pressure example equation assume number mole stay calculate change volume equation rearrange v2 find density gas nonstandard test day helpful visualize change pressure temperature affect volume gas serve check avoid accidentally switch value pressure temperature numerator denominator example predict double temperature gas result double volume double pressure gas result halve volume double temperature pressure time result final volume equal original volume example density co2 gas 2 atm 273 ° c solution stp mole gas occupy 22.4 l.

increase pressure 2 atm decrease volume proportionally 22.4 l multiply increase temperature increase volume proportionally temperature factor identity gas unknown molar mass discuss chapter 4 mcat general chemistry review

determine order identify equation density derive ideal gas law calculate molar mass gas

experimentally following way pressure temperature gas contain bulb give volume measure mass bulb sample measure bulb evacuate gas remove mass bulb determine mass bulb sample minus mass evacuate bulb give mass sample finally density sample determine divide mass sample volume bulb give density give temperature pressure calculate volume gas stp substitute 273 k t2 1 atm p2 ratio sample mass divide v2 give density gas stp molar mass calculate product gas density stp stp volume mole gas example molar mass 22.4 l sample gas mass 225 g temperature 273 ° c pressure 10 atm solution determine current condition compare stp use set proportional relationship careful note difference degree c k current versus stp condition consider ideal gas law mathematical relationship variable define state gas pressure volume temperature mole gas examine law precede discovery follow law develop ideal gas law conceptually helpful think special case general ideal important discovery precede clapeyron formulation ideal gas law avogadro principle state gas constant temperature pressure occupy volume directly proportional number mole gas present equal amount gas temperature pressure occupy equal volume discuss mole gas irrespective chemical identity occupy 22.4 liter k constant n1 n2 number mole gas 1 gas 2 respectively v1 v2 volume gas respectively summarize follow statement number mole gas increase volume increase direct example 2.0 l sample 100 ° c 20 atm contain 5 mole gas additional 25 mole gas pressure temperature add final volume gas solution pressure temperature hold constant ideal gas law reduce avogadro principle robert boyle conduct series experimental study 1660 lead formulation law bear boyle law work show give gaseous sample hold constant temperature isothermal condition volume gas inversely proportional pressure pv = k p1v1 = p2v2 k constant subscript 1 2 represent different

p1v1 = p2v2 k constant subscript 1 2 represent different set pressure volume condition careful examination boyle law show simply special case ideal gas law n t constant boyle law derivation ideal gas law state pressure volume inversely relate increase decrease plot volume vs. pressure gas inverse curve figure 8.2 show figure 8.3 figure 8.3 boyle law isothermal

compression pressure increase volume easy remember shape graph help recall variable relationship test day pressure increase volume decrease vice versa ratio relationship allow answer question mcat have math example volume 1 l sample helium pressure change 12 atm 4 atm isothermal condition solution number mole gas temperature hold constant ideal gas law reduce boyle law early 19th century joseph louis gay lussac publish finding base early unpublished work jacques charles law charles gay lussac commonly know simply charles law law state constant pressure volume gas proportional absolute temperature express kelvin express mathematically charles law k proportionality constant subscript 1 2 represent different set temperature volume condition careful examination charles law show special case ideal gas law n p constant charles law derivation ideal gas law state volume temperature directly proportional increase increase direct plot temperature vs. volume show figure 8.4 note extrapolate v vs. t plot gas t = 0 absolute zero find v = 0 figure 8.4 charles law isobaric expansion temperature increase volume temperature 0 k physically attain curve charles law originally figure value example temperature 2 l gas constant pressure change 290 k 580 k final volume solution number mole gas pressure hold constant ideal gas law reduce charles law gay lussac law complementary charles law utilize derivation ideal gas law relate pressure temperature instead express mathematically gay lussac law k proportionality constant subscript 1 2 represent different set temperature pressure condition careful examination gay lussac law show special

temperature pressure condition careful examination gay lussac law show special case ideal gas law n v figure 8.5 graph concept nearly identical charles law increase temperature increase pressure figure 8.5 gay lussac law isovolumetric heating temperature increase example pressure sample gas temperature 300 k change 2 atm 5 atm heating final temperature volume hold constant solution number mole gas volume hold constant ideal gas law reduce gay lussac law combined gas law discuss early combined gas law equation 8.3 combination precede law law relate pressure volume boyle law numerator relate variation

temperature volume charles law pressure gay lussac law simultaneously equation care place variable right place understand combine gas law function help avoid need memorize special case ideal gas law read question stem passage eye quantity remain constant know assumption dalton law partial pressures gas chemically interact find vessel gas behave independently gas behave gas container pressure exert gas mixture equal pressure gas exert container pressure exert individual gas call partial pressure gas 1801 john dalton derive expression know dalton law partial pressure state total pressure gaseous mixture equal sum partial pressure individual component equation dalton law pt = pa + pb + pc + pt total pressure container pa pb pc partial pressure gas b c respectively gas container contribute gas present add pressure individual gas pressure system partial pressure gas relate mole fraction determine following equation example vessel contain 0.75 mol nitrogen 0.20 mol hydrogen 0.05 mol fluorine total pressure 2.5 atm partial pressure gas solution calculate mole fraction gas calculate partial pressure difference gas solubility fluid explain william henry 1803

henry notice apply pressure concentration gas liquid increase decrease characteristic gas vapor pressure vapor pressure pressure exert evaporate particle surface liquid evaporation discuss chapter 7

mcat general chemistry review dynamic process require molecule surface liquid gain energy escape gas phase vapor pressure evaporate molecule force gas liquid phase equilibrium reach evaporation condensation mathematically express concentration solution kh henry constant pa partial pressure a. value henry constant depend identity gas solubility gas increase increase partial pressure gas accord relationship solubility concentration pressure directly relate biology critically important relationship gas nutrient exchange discuss chapter 6 mcat biology review lung tissue microscopic level organize grapelike cluster sac call alveoli sac perfuse capillary allow exchange carbon dioxide oxygen show figure 8.6 atmospheric pressure change sea level high altitude partial pressure oxygen atmosphere change explain dalton law

gas exchange alter accordingly partial pressure particular gas elevate give hyperbaric oxygen gas dissolve blood elevated figure 8.6 alveolar capillary gas exchange medicine represent alveolar concentration v represent venous concentration represent arterial example 4 × 104 mole gas dissolve 2 l solution ambient pressure 2 atm molar concentration gas 10 atm solution start determine initial concentration gas solution utilize direct relationship solubility pressure accord mcat concept check 8.2 assess understanding material 1 container 4 mole gas pressure 8 atm volume 12 liter temperature note 2 density argon gas 4 atm 127 ° c 3 20 l sample 300 ° c 5 atm pressure contain 2 mole gas additional 3 mole gas pressure temperature add final total volume gas 4 volume 2 l sample neon pressure change 1 atm 40 atm isothermal condition 5 temperature 6 l gas constant pressure change 27 ° c 127 ° c final volume 6 pressure sample gas temperature 227 ° c change 5 atm 2 atm cooling final temperature 7 vessel contain 8 mol o2 3 mol ch4 1 mol co2 total pressure 240 atm partial pressure gas 8 concentration carbon dioxide soda carbonate beverage high atmospheric carbon

8 concentration carbon dioxide soda carbonate beverage high atmospheric carbon dioxide 8.3

kinetic molecular theory chapter 8.3 able recall assumption kinetic molecular theory calculate average speed gas give temperature compare relative speed different gas temperature apply graham law situation involve gas effusion kinetic molecular theory develop second half 19th century law describe gas behavior develop kinetic molecular theory explain behavior gas law merely describe gas law demonstrate gas similar physical characteristic behavior irrespective particular chemical identity behavior real gas deviate ideal behavior predict assumption theory deviation correct calculation combine effort james maxwell ludwig boltzmann lead simple explanation gaseous molecular behavior base motion individual molecule like gas law kinetic molecular theory develop reference ideal gas apply reasonable accuracy real gas simplify model propose kinetic molecular theory certain assumption 1 gas particle volume negligible compare container volume 2 gas atom molecule exhibit intermolecular attraction 3

gas particle continuous random motion undergo collision particle container wall 4 collision gas particle particle container wall elastic mean conservation momentum kinetic energy 5 average kinetic energy gas particle proportional absolute temperature gas kelvin gas give temperature irrespective chemical identity atomic mass fairly straightforward imagine gas particle little rubber ball bounce wall container course rubber ball like real gas particle measurable mass volume bouncy rubber ball collide completely elastic manner provide apt visualization behavior describe kinetic molecular theory average molecular speed accord kinetic molecular theory gas average kinetic energy gas particle proportional absolute temperature gas kb boltzmann constant bridge macroscopic microscopic behavior gas bridge behavior gas individual gas molecule equation show speed gas particle relate absolute temperature large number rapidly randomly move gas particle travel nanometer collide particle container wall speed individual gas molecule nearly impossible define speed gas define term average molecular speed way define average speed determine average kinetic energy particle calculate speed correspond resultant quantity know root- mean square speed urm give follow equation r ideal

root- mean square speed urm give follow equation r ideal gas constant t temperature m understand concept fruitful test day memorize fact high temperature fast molecule large molecule slow maxwell boltzmann distribution curve show distribution gas particle speed give temperature figure 8.7 show distribution curve molecular speed temperature t1 t2 t2 great t1 notice bell shaped curve flatten shift right temperature increase indicate high temperature molecule move figure 8.7 maxwell boltzmann distribution curve molecular speed example average speed xenon difluoride molecule 20 ° c solution ideal gas constant molar mass xenon difluoride m express joule derive kilogram graham law diffusion effusion movement molecule high concentration low concentration medium air water call diffusion show figure 8.8 figure 8.8

diffusion solute solvent kinetic molecular theory gas predict heavy gas diffuse slowly light one differ average speed show figure 8.9 gas particle average kinetic energy temperature true particle great mass travel slow figure 8.9 maxwell boltzmann distribution curve molecular speed gas different molar masse massive gas particle slow 1832 thomas graham show mathematically isothermal isobaric condition rate gas diffuse inversely proportional square root molar masse call graham law write r1 r2 diffusion rate gas 1 gas 2 respectively m1 m2 molar masse gas 1 gas 2 respectively equation gas molar mass time gas travel half fast light gas clinically pleural effusion condition fluid enter intrapleural space small opening capillary lymphatic vessel cause pressure buildup lung hinder breathing effusion flow gas particle pressure compartment small opening show figure 8.10

graham kinetic molecular theory gas gas temperature rate effusion proportional average speed express rate effusion term molar mass find relationship diffusion figure 8.10 effusion gas particle effusion flow gas particle pressure compartment small opening diffusion gas mix effusion gas move small hole pressure slow large molecule condition use equation example oxygen molecule travel average speed approximately give temperature calculate average speed hydrogen molecule temperature solution oxygen molar mass hydrogen molar mass plug graham law mcat concept check 8.3 assess understanding material 1 assumption kinetic molecular theory 2 average speed helium atom 173 ° c 3 neon gas travel give temperature calculate average speed krypton temperature 4 hydrogen sulfide h2s strong rotten egg odor methyl salicylate c8h8o wintergreen odor benzaldehyde c7h6o pleasant almond odor vapor substance release time room order smell odor explain answer 8.4 real gas chapter 8.4 able distinguish real gas ideal gas predict difference attractive force volume affect real gas discussion law theory describe explain behavior gas stress fundamental assumption gas behave ideally world ideal gas real one real gas particle occupy nonnegligible volume interact measurable way general ideal gas law good approximation behavior real gas real gas deviate ideal gas behavior extent particularly gas atom molecule force close proximity high pressure

low volume low temperature effect imply figure 8.11 show isothermal line pressure volume graph real gas compare line ideal isotherm figure 8.2 nonideal condition intermolecular force particle volume significant figure 8.11

real gas isothermal curve compare line ideal gas isotherm figure 8.2 high temperature low pressure high volume deviation ideality usually small good approximation ideal gas law deviation pressure pressure gas increase particle push close close condensation pressure give temperature approach intermolecular attraction force significant gas condense liquid mcat understanding nonideal condition help determine gas behavior deviate moderately high pressure atmosphere gas volume predict ideal gas law intermolecular attraction extremely high pressure size particle relatively large compare distance cause gas large volume predict ideal gas law ideal gas law assume gas compress zero volume actually physically possible gas particle space deviation temperature temperature gas decrease average speed gas molecule decrease attractive intermolecular force increasingly significant condensation temperature approach give pressure intermolecular attraction eventually cause gas condense liquid state like deviation pressure temperature gas reduce condensation point boiling point intermolecular attraction cause gas small volume predict ideal gas law close gas boiling point ideally act extremely low temperature gas occupy space predict ideal gas law particle compress zero volume van der waals equation state gas equation attempt correct deviation ideality occur gas closely follow ideal gas law van der waals equation state note b zero van der waals equation state reduce ideal b physical constant experimentally determine gas term correct attractive force molecule small gas small polarizable helium large gas large polarizable xe n2 large polar molecule hcl nh3 b term correct volume molecule large molecule large value b. numerical value generally large b. van der waals term attractive force b van der waals term big particle example percentage real pressure 1 mole ammonia 1 liter flask 227 ° c deviate

ideal pressure note nh3 = 4.2 b = 0.037 solution accord ideal gas law accord van der waals

equation state pressure approximately 41.5 38.8 = 2.7 atm predict ideal gas law represent error familiar concept embody equation bother memorize testmaker want apply equation provide passage question mcat concept check 8.4 assess understanding material 1 way real gas differ ideal gas 2 gas exert high pressure nonideal condition methane chloromethane 3 methane isobutane place size container condition exert high pressure consider have negligible attractive force chapter review basic characteristic behavior gas ideal gas law show mathematical relationship variable associate gas pressure volume temperature number mole examine special case ideal gas law temperature boyle law pressure charles law volume gay lussac law hold constant henry law help explain principle dissolution gas liquid gas exchange biological system examine dalton law relate partial pressure gas mole fraction sum partial pressure gas system total pressure system kinetic molecular theory gas provide explanation behavior ideal gas describe ideal gas law finally examine way real gas deviate predict behavior ideal gas van der waals equation state useful equation correct deviation cause molecular interaction helium fill balloon bubble carbon dioxide glass soda pressurize gas scuba diving air breathe land gas different gas bubble flow settle daily living experience behave remarkably similar way human life dependent exchange gas oxygen carbon dioxide end expect mcat frequently test gas importance everyday life review content test knowledge critical thinking skill complete test like passage set online resource gas phase gases dense phase matter gas fluid conform shape container gas easily compressible gas system describe variable temperature t pressure p volume v number mole n important pressure equivalencie include 1 atm = 760 mmhg 760 torr = simple mercury barometer measure incident usually atmospheric pressure pressure increase mercury force column increase height

usually atmospheric pressure pressure increase mercury force column increase height pressure decrease mercury flow column weight decrease height standard temperature pressure stp 273 k 0 ° c 1 atm equation

ideal gas assume negligible mass volume gas regardless identity gas equimolar amount gas occupy volume temperature pressure stp mole ideal gas occupy 22.4 l. ideal gas law describe relationship variable gas state ideal gas avogadro principle special case ideal gas law pressure temperature hold constant show direct relationship number mole gas volume boyle law special case ideal gas law temperature number mole hold constant show inverse relationship pressure volume charles law special case ideal gas law pressure number mole hold constant show direct relationship temperature volume gay lussac law special case ideal gas law volume number mole hold constant show direct relationship temperature pressure combined gas law combination boyle charles gay- lussac law show inverse relationship pressure volume direct relationship pressure volume temperature dalton law partial pressure state individual gas component mixture gas exert individual pressure proportion mole fraction total pressure mixture gas equal sum partial pressure component gas henry law state gas dissolve solution directly proportional partial pressure gas surface solution kinetic molecular theory kinetic molecular theory attempt explain behavior gas particle make number assumption gas particle gas particle negligible volume gas particle intermolecular attraction repulsion gas particle undergo random collision wall collision gas particle wall container average kinetic energy gas particle directly proportional graham law describe behavior gas diffusion effusion state gas low molar masse diffuse effuse fast gas high molar masse temperature diffusion spreading particle high low concentration effusion movement gas compartment small opening pressure real gas deviate ideal behavior high pressure low volume low temperature condition moderately high pressure low volume low temperature real gas occupy volume predict ideal gas law particle intermolecular attraction extremely high pressure low volume low temperature real gas occupy volume predict ideal gas law particle occupy physical space van der waals equation state correct ideal gas law intermolecular attraction molecular volume

equation state correct ideal gas law intermolecular attraction molecular volume b answer concept check 1 gas compressible fluid rapid molecular motion large intermolecular distance

weak intermolecular force 2 mountain atmospheric pressure low cause column fall water hydrostatic pressure exert barometer addition atmospheric pressure cause column rise 3 stp t = 273 k 0 ° c p = 1 atm 4 standard condition t = 298 k 25 ° c p = 1 atm concentration = 1 m 7 total mole gas mole fraction gas multiply mole fraction total pressure partial pressure typically simple fraction decimal 8 high pressure carbon dioxide gas force liquid soda increase concentration liquid 1 assumption kinetic molecular theory include negligible volume gas particle intermolecular force random motion elastic collision proportionality absolute temperature energy 4 rotten egg odor hydrogen sulfide almond benzaldehyde wintergreen methyl salicylate gas temperature kinetic energy light molecule travel fast 1 real gas molecule nonnegligible volume attractive force real gas deviate ideal gas high pressure low volume low 2 accord van der waals equation increase b remain negligible correction term get large pressure drop compensate methane behave ideally chloromethane small methane real pressure methane high close ideal 3 isobutane large large correction term size molecule b. make term v nb small pressure volume rise compensate gas size container isobutane exert high pressure science mastery assessment gas deviate ideal behavior high pressure low volume temperature force molecule close close participate intermolecular force violate definition ideal gas low temperature kinetic energy particle reduce collision particle wall container likely result significant change kinetic energy density equal mass divide volume mass 1 mole neon gas equal 20.2 gram stp 1 mole neon occupy 22.4 l. graham law effusion state relative rate effusion gas temperature pressure give inverse ratio square root masse gas particle word gas high molar

ratio square root masse gas particle word gas high molar mass leak slowly gas low molar mass neon oxygen gas leak slow rate helium mass helium pressure gas calculate subtract vapor pressure water measure pressure experiment 784 mmhg 24 mmhg = 760 mmhg 1 atm reaction carry aqueous environment water present contribute partial pressure gas liquid ideal gas law calculate mole hydrogen gas volume gas 0.100 l temperature 298 k plug give

incorrectly substitute 8.314 gas law 0.0821 remember value r depend variable equation 1 atm numerator necessitate 0.0821 c incorrectly substitute wrong r keep pressure mmhg d keep pressure mmhg ideal gas say attractive force molecule particle gas consider negligible volume ideal gas certainly measurable volume option eliminate gas molar masse option iii eliminate deviation ideal behavior large particle size and/or strong intermolecular force molecule nitrogen gas consist nitrogen atom triple bond molecule relatively small nonpolar triple bond lead weak intermolecular force observation support b correct answer contrast fluoromethane consist single bond make molecule somewhat large furthermore polarity carbon fluorine bond molecule participate dipole dipole interaction fluoromethane exhibit great deviation ideal behavior average kinetic energy directly proportional temperature gas kelvin kinetic molecular theory state collision molecule elastic result loss energy eliminate b gas particle assume negligible space kinetic molecular theory eliminate c average kinetic energy gas give temperature particle distribution speed see maxwell boltzmann distribution curve eliminate d stp difference distribution speed helium bromine gas difference molar mass helium small molar mass bromine particle small masse travel fast large masse helium gas correspond curve b high average speed gas temperature 273 k average kinetic energy eliminate b d solubility gas liquid directly proportional atmospheric pressure show henry law note use fraction allow problem simplify readily decimal ideal gas law modify include density ρ number mole gas n equal mass

modify include density ρ number mole gas n equal mass divide molar mass isolate temperature give gas easily compressible travel freely large amount space molecule gas particle far apart rapid motion tend volume container gas exist diatomic molecule property characterize gas eliminate option iii use charles law convert temperature kelvin add 273 300 k initial temperature think proportionality volume multiply temperature multiply final temperature 450 k represent 150 k increase equivalent increase 150 ° c decrease temperature lead decrease kinetic energy particle intermolecular interaction significant change lead

deviation ideal behavior similarly decrease volume cause volume particle significant change lead deviation ideal behavior d correct change temperature change volume affect gas pressure variable keep constant b definitely able predict way pressure change constant volume heat gas increase pressure cool gas decrease temperature volume change change effect pressure predict way change case d cool gas increase volume decrease pressure c hand present vague scenario predict definitively change pressure heat gas amplify pressure increase volume decrease know magnitude influence impossible pressure increase decrease stay initially concentration gas decrease half original value recall concentration solubility partial pressure directly relate increase increase experimenter quadruple partial pressure oxygen vessel solubility increase factor half time give twice original concentration value misread answer choice relate concentration experimenter increase partial pressure lead d equation remember 8.1 ideal gas law pv = nrt 8.2 density gas 8.3 combined gas law 8.4 avogadro principle 8.5 boyle law pv = k p1v1 = p2v2 8.6 charles law 8.7 gay lussac law 8.8 dalton law total pressure partial pressure pt = pa + pb + pc + 8.9 dalton law partial pressure total pressure pa = 8.10 henry law = kh × pa 8.11 average kinetic energy gas 8.12 root mean square speed 8.13 graham law 8.14 van der waals equation state biology

8.13 graham law 8.14 van der waals equation state biology chapter 6 respiratory system general chemistry chapter 3 bonding chemical interaction general chemistry chapter 6 physics math chapter 2 work energy physics math chapter 3 physics math chapter 4 pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond

subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 aqueous solution prepare mix 70 g unknown nondissociating solute 100 g water solution boiling point 101.0 ° c molar mass solute note 2 phase solvent solute form solution i. solid solvent gaseous solute ii solid solvent solid solute iii gaseous solvent gaseous solute a. ii b. iii c. ii iii d. ii iii

3 organic liquid picture figure combine form solution base structure solution closely obey raoult law a. yes liquid differ additional methyl group toluene deviate raoult law b. yes liquid similar deviate raoult c. liquid differ additional methyl group toluene deviate raoult law d. liquid contain benzene ring interact cause deviation raoult law 4 follow explanation well describe mechanism solute particle affect melting point ice a. melting point elevate kinetic energy substance b. melting point elevate kinetic energy substance c. melting point depress solute particle interfere lattice d. melting point depress solute particle enhance lattice 5 process formation salt solution well understand break process step 1 break solute individual component 2 make room solute solvent overcome intermolecular force solvent 3 allow solute solvent interaction occur form solution follow correctly list enthalpy change step a. endothermic exothermic endothermic b. exothermic endothermic endothermic c. exothermic exothermic endothermic d. endothermic endothermic exothermic 6 entropy change solution form express term water molecule order ion dissolve ordering

expect negative contribution ion charge density great hydration effect ordering water molecule experiment equimolar following aqueous soluble compound dissolve test tube contain 100 ml water negative contribution assume charge density ion equal actual 7 ammonia nh3 solvent form complex ion example dissolve agcl nh3 result complex ion

ag(nh3)]2 + effect formation complex ion solubility compound like agcl nh3 a. solubility agcl increase complex ion formation cause ion exist solution interact agcl cause b. solubility agcl increase complex ion formation consume ag+ ion cause equilibrium shift away solid agcl c. solubility agcl decrease ag+ ion complex ag+ ion complexe associate cl form solid d. solubility agcl decrease complex ion formation consume ag+ ion cause equilibrium shift solid agcl 8 gram sucrose dissolve cup hot water 80 ° c cup water contain 300.00 ml water percent composition mass sugar result solution note sucrose = c12h22o11 density 9 following combination liquid expect vapor pressure high vapor pressure predict a. ethanol hexane b. acetone water c. isopropanol methanol d. nitric acid water 10 salt kcl dissolve beaker observer hold beaker solution begin feel cold kcl dissolve observation conclude large overcome unfavorable b. kcl insoluble water negative kcl dissolve d. boiling point depression occur solution 11 following cause great increase boiling point water dissolve 1.00 kg h2o a. 0.4 mol calcium sulfate b. 0.5 mol iron(iii nitrate c. 1.0 mol acetic acid d. 1.0 mol sucrose 12 reverse osmosis process allow fresh water obtain pressure force impure water source semi permeable membrane allow water molecule pass minimum pressure require purify seawater 25 ° c total osmolarity 1,000 a. 23.5 atm b. 24.5 atm c. 24,000 atm d. 24,500 atm 13 lead toxic element cause symptom include intellectual disability child body water pollute lead ion 200 ppb part billion

concentration lead express molarity note density water ppb = gram 109 gram a. 9.7 × 1010 m pb2 + b. 9.7 × 107 m pb2 + c. 6.2 × 107 m pb2 + d. 6.2 × 106 m pb2 + 14 saturated solution aqueous cobalt(iii hydroxide ksp = 1.6 × 1044 add saturated solution aqueous thallium(iii hydroxide ksp = 6.3 × 1046 likely occur a. cobalt(iii hydroxide thallium(iii hydroxide remain stable b. thallium(iii hydroxide precipitate cobalt(iii hydroxide remain stable c. cobalt(iii hydroxide precipitate thallium(iii hydroxide remain stable d. thallium(iii hydroxide cobalt(iii hydroxide precipitate 15 following equilibrium exist agbr ksp = 5.35 × 1013 solution agbr s ag+ aq + br aq solubility agbr solution 0.0010 m nabr answer key follow page chapter 9.1

nature solution complex ion formation unit concentration 9.3 solution equilibria solubility product constant common ion effect 9.4 colligative property boil point elevation freeze point depression content chapter relevant 8 question general chemistry mcat chapter cover material following aamc content category 2a assembly molecule cell group cell single cellular 5a unique nature water solution aid instant cold pack sweet tea common think fact demonstrate principle solution chemistry instant cold pack contain compartment hold water ammonium nitrate barrier compartment break allow ammonium nitrate dissolve water sweet tea dissolve large sugar strongly brew tea creation ammonium nitrate sugar solution endothermic process formation ammonium nitrate solution endothermic formation sugar solution ammonium nitrate useful instant cold pack dissolve water system absorb energy equal ammonium nitrate heat absorb surround environment pack feel cool touch dissolution sugar water strongly endothermic intuitive understanding process endothermic know easy way dissolve lot sugar water tea coffee heat water add sugar heat water increase solubility sugar dissolution sugar water endothermic process think le châtelier principle change temperature chapter 6 chapter focus characteristic behavior solution nature solution formation

chapter 6 chapter focus characteristic behavior solution nature solution formation aqueous solution measurement solution concentration finally qualitative quantitative evaluation solution equilibrium 9.1 nature solutions chapter 9.1 able describe process solvation define key term involve solution complex solubility explain increase solubility compound recall solubility rule apply predict solubility compound important chemical reaction laboratory nature place solution include reaction live organism solution homogeneous mixture substance combine form single phase usually liquid phase mcat focus exclusively solid dissolve aqueous solution important remember solution form different combination phase matter example gas dissolve liquid carbonate soda liquid dissolve liquid ethanol water solid dissolve solid metal alloy incidentally gas dissolve gas think solution properly define mixture

gas molecule interact chemically describe kinetic molecular theory gas point clarification solution consider mixture mixture consider solution solution consist solute nacl nh3 c6h12o6 co2 dissolve disperse solvent h2o benzene ethanol solvent component solution remain phase mix substance phase example solution liquid solvent component present great quantity phase component equal proportion solution component commonly solvent context consider solvent solute molecule freely solvent interact way intermolecular force ion dipole dipole dipole hydrogen bonding dissolved solute molecule relatively free interact dissolve molecule different chemical identity consequently chemical reaction occur easily solution solvation electrostatic interaction solute solvent molecule know dissolution water solvent call hydration solvation involve break intermolecular interaction solute molecule solvent molecule form new intermolecular interaction solute solvent molecule show figure 9.1 show chapter 4 mcat general chemistry review context ion figure 9.1 solvation polar covalent compound s indicate solvent particle new interaction strong original one solvation exothermic process favor low temperature dissolution gas liquid co2 water exothermic process significant interaction break water molecule co2 gas demonstrate minimal intermolecular interaction le châtelier principle tell reason lower temperature liquid favor solubility gas liquid new interaction weak original one solvation endothermic process favor high temperature

interaction weak original one solvation endothermic process favor high temperature dissolution type example give dissolve ammonium nitrate sugar water new interaction solute solvent weak original interaction solute molecule solvent molecule energy heat supply facilitate formation weak stable interaction overall strength new interaction approximately equal overall strength original interaction case overall enthalpy change dissolution close zero type solution approximate formation ideal solution enthalpy dissolution equal zero spontaneity dissolution dependent enthalpy change solution form spontaneously endothermic exothermic dissolution second property contribute spontaneity dissolution entropy change occur process constant temperature pressure entropy increase dissolution

process spontaneity dissolution depend change gibbs free energy spontaneous process associate decrease free energy nonspontaneous process associate increase free energy dissolution happen spontaneously depend change enthalpy change entropy solute solvent system protein dissolve solution hydrophilic amino acid outside hydrophobic amino acid inside maximize increase entropy dissolution describe chapter 1 mcat biochemistry review protein dissolve form solvation layer consider example formation common solution sodium chloride dissolve water nacl dissolve water component ion dissociate surround water molecule new interaction occur ionic bond na+ cl break hydrogen bond water molecule break step require energy endothermic water polar interact component ion ion dipole interaction partially positive hydrogen end water molecule surround cl ion partially negative oxygen end water molecule surround na+ ion show figure 9.2 formation ion dipole bond exothermic magnitude slightly energy require break ionic bond hydrogen bond result overall dissolution table salt water endothermic favor figure 9.2 solvation na+ ions aqueous solution consider enthalpy change formation sodium chloride solution need examine entropy change remember entropy think degree energy disperse system energy distribute system surrounding give temperature way understand entropy measure molecular disorder number energy microstate available system give temperature solid sodium chloride dissolve water rigidly order arrangement sodium chloride ion break ion ion interaction disrupt new ion dipole interaction water molecule

ion ion interaction disrupt new ion dipole interaction water molecule form ion free lattice arrangement great number energy microstate available simple term free different way consequently energy distributed entropy increase water restricted movement interact ion number energy microstate available water molecule ability different way reduce entropy water decrease end increase entropy experience dissolve sodium chloride great decrease entropy experience water overall entropy change positive energy overall disperse dissolution sodium chloride water relatively low endothermicity relatively large positive change entropy

sodium chloride spontaneously dissolve liquid water δg = δh tδs want know dissolution solute solvent spontaneous nonspontaneous want know solute dissolve give solvent solubility substance maximum substance dissolve particular solvent give temperature maximum solute add dissolve solute equilibrium undissolved state solution saturate solute add dissolve example 25 ° c maximum 90.9 g glucose dissolve 100 ml h2o.

solubility glucose glucose add

saturate glucose solution dissolve remain solid form precipitate container solution proportion solute solvent small say dilute proportion large say concentrated note dilute concentrated solution consider unsaturated maximum equilibrium concentration saturation solubility substance different solvent ultimately function thermodynamic change gibbs free energy dissolution reaction negative give temperature process spontaneous solute say soluble change gibbs free energy positive process nonspontaneous solute say insoluble solute solvent system negative change free energy large magnitude equilibrium reaction strongly favor dissolution solute general solute consider soluble molar solubility 0.1 m solution slightly negative change free energy equilibrium position lie close undissociated reactant reaction solute dissolve minimally solvent molar solubility 0.1 m call sparingly soluble salt common type solution aqueous solution solvent water aqueous state denote symbol aq aqueous solution rely interaction water molecule solute solution mention previously hydration process dissolution occur important note solution acid formation complex call hydronium ion h3o+ occur facilitate transfer hydrogen ion h+ molecule solution water molecule h2o reaction acetic acid h+ donor water show figure 9.3 figure 9.3 transfer proton solution form hydronium ion transfer proton highlight green important realize h+ find solution free proton difficult isolate find bond electron pair donor carrier molecule water molecule example coordinate covalent bond hydronium ion effect solubility compound le châtelier principle describe chapter 10 mcat general chemistry review aqueous solution common important biological system mcat focus

aqueous solution seven general solubility rule 1 salt contain ammonium nh4 + alkali metal group 1 cation 2 salt contain nitrate no3 acetate ch3coo anion water- 3 halide cl br i exclude fluoride water soluble exception form ag+ pb2 + hg22 + 4 salt sulfate ion water soluble exception form ca2 + sr2 + ba2 + pb2 + 5 metal oxide insoluble exception form alkali metal ammonium cao sro bao hydrolyze form solution correspond metal hydroxide 6 hydroxide

sro bao hydrolyze form solution correspond metal hydroxide 6 hydroxide insoluble exception form alkali metal ammonium ca2 + sr2 + ba2 + 7 carbonate sulfide s2 sulfite insoluble exception form alkali metal ammonium solution real world involve water solvent surprise solution common mcat solubility rule bad know memorize little excessive bad thing know fact able apply important know rule 1 2 sure aware common insoluble exception like pb2 + ag+ mcat expect memorization solubility rule worth know absolute salt group 1 metal nitrate salt soluble familiarity rule list suffice mcat generally supply solubility information compound sodium nitrate ion generally counterion actually chemically important example ph problem give sodium formate concentration 0.10 m indicate concentration formate ion 0.10 m sodium ion concentration affect ph. time need worry nitrate ion concentration oxidation reduction reaction nitrate ion function weakly oxidize agent case nitrate ion focus cation chemically react species complex ion formation mention hydronium ion complex form acidic solution worthwhile mention varied form complex ion appear solution definition complex ion coordination compound refer molecule cation bond electron pair donor include water molecule electron pair donor molecule call ligand example complexation reaction show tetraaquadiox ouranyl cation water aqua oxygen oxo ligand figure 9.4 structure tetraaquadioxouranyl complex cation water oxygen act ligand u6 + cation complex hold coordinate covalent bond electron pair donor lewis base electron pair acceptor lewis acid form stable lewis acid base adduct general chemistry course stress biological importance coordination compound complex ion profound biological application macromolecule protein

instance active site protein utilize complex ion binding transition metal complex carry function classic example iron cation hemoglobin carry oxygen carbon dioxide carbon monoxide ligand show figure 9.5 figure 9.5 hemoglobin classic example biochemical complex formation iron hemoglobin bind gas lead formation oxyhemoglobin o2 carbaminohemoglobin co2 carboxyhemoglobin co coenzyme vitamin cofactor contain complex transition

carbaminohemoglobin co2 carboxyhemoglobin co coenzyme vitamin cofactor contain complex transition metal cobalamin vitamin b12 show figure 9.6 presence transition metal allow coenzyme cofactor bind ligand assist electron transfer figure 9.6 cobalamin vitamin b12 contain cobalt complex physical chemical property complex ion diverse include wide range solubility varied chemical reaction inorganic complex ion fun characterize tend vibrant distinctive color illustrate figure 9.7 figure 9.7 nickel(ii ion complex display distinctive color characteristic color

nickel ii ion complex

left right 1 hexaamminenickel(ii 2 tris(ethylenediamine)nickel(ii 3 tetrachloronickelate(ii 4 complex central cation bond ligand multiple place call chelation generally require large organic ligand double form second bond central cation chelation therapy sequester toxic metal lead arsenic mercury biologically necessary metal iron toxic overload state example iron chelate show figure 9.8 chelation iron molecule deferasirox mcat concept check 9.1 assess understanding material 1 describe process solvation 2 describe difference solubility saturation 3 way solubility compound increase 4 ion form salt soluble chapter 9.2 able calculate molality molarity normality compound solution apply mivi = mfvf calculate dilution solution calculate mole fraction percent composition mass concentration denote solute dissolve solvent different way express concentration different unit standardize specific everyday situation example alcohol content liquor like vodka gin rum express volume percent volume solute

divide volume solution times 100 percent alcoholic proof twice volume percent sugar content orange juice fruit juice measure unit degree brix ° bx mass percent mass glucose divide mass solution times 100 unit concentration mcat concentration commonly express percent composition mass mole fraction molarity molality normality percent composition mass percent composition mass give equation important good idea work way express concentration test day percent composition aqueous solution metal alloy solid solid solution example percent composition mass salt water solution 100 g solution contain 20 g nacl mole fraction x compound give equation sum mole fraction system equal 1 mole fraction calculate vapor pressure depression solution describe later chapter partial pressure gas system describe chapter 8 mcat general chemistry review example 184 g glycerol c3h8o3 mix 180 g water mole fraction component note molar mass molar mass solution determine number mole compound determine mole fraction molarity m solution define solution concentration usually express term molarity common unit concentration mcat specify representation concentration bracket na+]—indicate molarity note volume term denominator molarity refer

concentration bracket na+]—indicate molarity note volume term denominator molarity refer solution volume volume solvent prepare solution value close approximate solution volume solvent volume molarity rate law law mass action osmotic pressure ph poh nernst note dilute solution volume solution approximately equal volume solvent simplify calculation test day technical question ask distinguish example add kilogram sucrose table sugar liter water room temperature achieve saturation volume solution certainly large 1 l example water add 11 g cacl2 100 ml solution molarity solution solution calculate number mole cacl2 determine molarity molality m solution define dilute aqueous solution 25 ° c molality approximately equal molarity density water temperature 1 kilogram liter note approximation true dilute aqueous solution aqueous solution concentrated solute density significantly different pure water water soluble solute molar masse significantly great water density solution increase concentration increase will use molality mindful special situation require boiling point

elevation freezing point depression example 10 g naoh dissolve 500 g water molality solution calculate number mole naoh determine molality discuss related concept gram equivalent weight equivalent normality chapter 4 mcat general chemistry review normality n solution equal number equivalent interest liter solution equivalent measure reactive capacity molecule simply equivalent equal mole species interest proton hydroxide ion electron ion calculate normality solution need know purpose solution serve concentration reactive specie concerned example acid base reaction concerned concentration hydrogen ion oxidation reduction reaction concerned concentration electron normality unique concentration unit reaction dependent example acidic solution 1 mole permanganate ion mno4 readily accept 5 mole electron 1 m solution 5 n. alkaline solution 1 mole permanganate accept 1 mole electron alkaline solution 1 m permanganate solution 1 n. simple idea test day thing easy come normality think molarity stuff interest reaction solution dilute solvent add solution high concentration produce solution low concentration concentration solution dilution determine mivi =

produce solution low concentration concentration solution dilution determine mivi = mfvf m molarity v volume subscript f refer initial final value respectively equation worthy memorization note similar equation equivalence point acid base chemistry discuss chapter 10

mcat general unique means measure concentration dilution term part indicate concentration dissolve substance solution commonly water part million ppm 10–6 common usage problem state ppm substance x water indicate 1 mg l water 1 millionth gram gram water density water 1 g ml. test day prior convert ppm sure assess conversion

different unit measure actually require conversion typically avoid example chemist wish prepare 300 ml 1.1 m naoh solution 5.5 m naoh stock solution volume stock solution dilute pure water obtain desire solution note use ml l equation long unit mcat concept check 9.2

assess understanding material 1 mix 180 g following compound 250 l water concentration molality molarity normality acid base chemistry 2 work sewage treatment facility assay chlorine water sample need dilute water sample 100 ppm stock 25 ppm create 100 ml solution calculate stock solution need determine create final solution 3 stock solution make typical iv saline bag contain 90.0 g nacl 10 liter water mole fraction percent composition mass nacl saline solution percent composition mass 9.3 solution equilibrium chapter 9.3 able calculate molar solubility compound give ksp vice versa calculate ion product solution give ksp predict solute dissociate precipitate order predict impact common ion dissolution compound process solvation like reversible chemical physical process tend equilibrium position define low energy state system give set temperature pressure condition system spontaneously equilibrium position movement away equilibrium nonspontaneous process create solution equilibrium define saturation point solute concentration maximum value give temperature pressure immediately solute introduce solvent change take place dissociation dissolve solute initially present solute dissolve reverse process precipitation solute begin occur solution dilute unsaturated thermodynamically favor process dissolution initially rate dissolution great rate precipitation solution concentrated approach saturation rate dissolution lessen rate precipitation increase eventually saturation point solution reach solution exist state dynamic equilibrium rate dissolution precipitation equal concentration dissolve solute reach steady state constant value dissolution precipitation thermodynamically favor equilibrium favor necessarily result solution long state equilibrium point change free energy zero case system equilibrium ionic solid introduce polar solvent dissociate component ion dissociation solute solution represent ambn s m an+ aq + n bm aq test day

m an+ aq + n bm aq test day step solution stoichiometry solution equilibrium question write balanced dissociation reaction ionic compound question step essential correctly calculate solubility product constant ion product molar solubility determine outcome common ion effect word essential step nearly solution chemistry problem mcat solubility product

constant solubility problem mcat deal solution sparingly soluble salt ionic compound low solubility aqueous solution wonder ionic compound highly soluble water degree solubility determine relative change enthalpy entropy associate dissolution ionic solute give temperature pressure common sparingly soluble salt silver chloride agcl dissociate water accord agcl s ag+ aq + cl aq law mass action apply solution equilibrium solution saturate solute concentration maximum dynamically stable saturated solution ionic compound formula ambn equilibrium constant solubility aqueous solution call solubility product constant ksp express ksp = an+]m[bm–]n

concentration ionic constituent equilibrium saturation concentration example express ksp silver chloride ksp = ag+][cl mcat remember ksp specialized form keq simplify lot problem concept equilibrium include le châtelier principle notice law mass action solution denominator remember pure solid liquid appear equilibrium constant silver chloride solution form add pure solid silver chloride pure water solid silver chloride water include dissociation reaction definition solid salt reactant ksp expression denominator solubility product constant like equilibrium constant keq ka kb kw temperature dependent solution consist gas dissolve liquid value equilibrium constant position equilibrium saturation depend pressure generally speak solubility product constant increase increase temperature non gas solute decrease gas solute high pressure favor dissolution gas solute ksp large gas high pressure low one gas soluble solution pressure increase diver spend time significant depth water nitrogen gas dissolve blood nitrogen gas main inert gas air breathe diver rise surface quickly abrupt decompression lead abrupt decrease gas solubility plasma result formation nitrogen gas bubble bloodstream gas bubble lodge small vasculature peripheral tissue large joint body cause pain tissue damage bend condition painful dangerous fatal solute dissolve solvent system approach saturation point solute dissolve excess precipitate container know solution reach saturation determine system respect equilibrium position calculate value call ion product ip analogous reaction quotient q chemical reaction ion product equation form equation solubility product

constant ip = an+]m[bm–]n difference concentration ion product equation concentration ionic constituent give moment time differ equilibrium concentration reaction quotient q utility ion product lie compare value attain equilibrium ksp salt distinct ksp give temperature give set condition salt ip salt ksp solution equilibrium consider unsaturated unsaturated solution dissolution thermodynamically favor precipitation ip great ksp solution equilibrium solution consider supersaturated possible create supersaturated solution dissolve solute hot solvent slowly cool solution supersaturated solution thermodynamically unstable disturbance solution addition solid solute solid particle

solution thermodynamically unstable disturbance solution addition solid solute solid particle cooling solution cause spontaneous precipitation excess dissolve solute calculate ip equal know ksp solution equilibrium rate dissolution precipitation equal solution consider saturated molarity solute saturated solution call molar solubility substance ip < ksp unsaturated solute continue dissolve ip = ksp saturated solution equilibrium ip > ksp supersaturated precipitation occur example molar solubility fe(oh)3 aqueous solution determine value ksp fe(oh)3 temperature pressure solution molar solubility give 4 × 1010 m. equilibrium concentration ion determine molar solubility balanced dissociation reaction fe(oh)3 dissociation reaction fe(oh)3 s fe3 + aq + 3 oh aq ksp = fe3+][oh]3

molar solubility express x fe(oh)3 dissolve saturated solution equilibrium dissolve fe(oh)3 dissociate create x fe2 + 3x oh–.

enter ksp equation ksp = x][3x]3 molar solubility x 4 × 1010 m x = 4 × 1010 m fe(oh)3 dissolve yield x = 4 × 1010 m fe3 + 3x = 3 × 4 × 1010 m oh oh ion release fe(oh)3 molecule dissolve example concentration ion saturate solution cubr give ksp cubr 6.27 × 109 25 ° c 3 g cubr dissolve water 1 l solution 25 ° c solution saturated unsaturated supersaturated solution step write dissociation reaction cubr s cu+ aq + br aq ksp = cu+][br let x equal molar

solubility cubr cubr dissolve equilibrium concentration cu+ br equal x. cu+ 8 × 10–5 m br 8 × 105 m. note 8 × 105 m represent molar solubility copper(i bromide convert 3 g cubr mole 2 × 102 mol cubr 1 l solution represent molarity 2 × 102 m 100 time high molar solubility cubr supersaturated solution sparingly soluble salt general formula mx ksp = x2 x molar solubility assume common ion effect sparingly soluble salt general formula mx2 ksp = 4x3 x molar solubility assume common ion effect sparingly soluble salt general formula mx3 ksp = 27x4 x molar solubility assume common ion effect finally let return discussion complex ion solubility factor like example see previously solubility complex ion solution determine ksp formation complex ion increase solubility salt instance consider free iron(iii fe3 + solution water cyanide solution add exceptionally stable iron cyanide metal complex form water molecule solvate iron replace excess cyanide ion know intricacy complex stable solution isolate ion scope mcat sense complex ion contain multiple polar bond ligand central metal ion able engage large dipole dipole interaction stabilize dissolution complex ion end result complex tend high ksp value form complex ion use mixture solution reason distinction ksp solution complex ion dissolution

use mixture solution reason distinction ksp solution complex ion dissolution original solution term ksp subsequent formation complex ion solution term kf formation stability constant complex solution example show diamminesilver(i complex form silver notice formation constant kf complex ion significantly large ksp compound provide metal ion explanation initial dissolution metal ion rate limit step complex ion formation le châtelier principle play reaction ultimately complex ion form soluble solution silver ion form complex ion dissociation reaction agcl shift right provide silver complex ion formation example 0.1 mol sample cus add 1.00 l 1.00 m nh3 final concentration complex ion tetraamminecopper(ii solution determine copper ion produce copper sulfide cus solution comparison equilibrium constant show cus dissociation ksp 8 × 10 37 indicate reaction unlikely proceed forward reaction favorable formation complex ion occur simultaneously large kf 1.1 × 1013 process drive dissociation cus

forward cu2 + ion consume second reaction

le châtlier principle note quantitative analysis large value kf sign formation product second reaction highly favorable fact reaction simultaneous cus ultimately completely consume effect cu2 + available react give reaction give 1:1 relationship cu2 + available cu(nh3)4]2 + generate word cu2 + ion form complex concentration cu(nh3)4]2 + complex ion 0.1 m. common ion effect solubility substance vary depend temperature solution solvent case gas phase solute pressure solubility affect addition substance solution effect complex ion increase solubility substance typical fact opposite effect see mixture solution challenging solution chemistry problem mcat calculation equilibrium concentration salt solution contain ion salt solubility salt considerably reduce dissolve solution contain constituent ion compare solubility pure solvent reduction molar solubility call common ion effect describe molar solubility compound concentration mole liter equilibrium give temperature x mole ambn s dissolve liter solution reach saturation molar solubility ambn s x molar pay attention effect common ion presence result reduction molar solubility salt note presence common ion effect value solubility product constant example salt caf2 dissolve water contain ca2 + ion salt cacl2 solution dissolve caf2 equal pure water common ion effect le châtelier principle action solution contain constituent ion product dissociation equilibrium system shift left reform solid salt result molar solubility solid reduce solid dissolve solution ksp remain constant advantage common ion effect separate specific compound solution mixture example solution silver salt add sodium potassium chloride preferentially precipitate silver(i chloride add appropriate counterion excess dissociation reaction shift left form solid salt example ksp agi aqueous solution 8.5 × 1017 1 × 105 m solution agno3 saturate agi final concentration iodide ion solution concentration ag+ original agno3 solution 1 × 105 m agno3 fully dissociate review solubility rule early chapter small agi dissociate solution molar solubility x agi condition net silver concentration agno3 agi 1 × 105 m +

net silver concentration agno3 agi 1 × 105 m + x. iodide

present solution agi begin dissociate concentration iodide x. ksp expression dissociation agi write give value ksp reaction 10 16 minuscule agi dissociate value x sufficiently small negligible add 10 5 math simplify question ask concentration iodide base equilibrium expression represent x. i = 8.5 × 1012 m. mcat concept check 9.3 assess understanding material 1 calculate ksp ni(oh)2 water give molar solubility 5.2 × 2 ksp ba(oh)2 5.0 × 103 assume barium hydroxide salt add form solution calculate ion product follow solution base concentration ba2 + predict behavior give solution dissolution equilibrium precipitation behavior solution 3 molar solubility zn(oh)2 ksp = 4.1 × 1017 0.1 m solution naoh 9.4 colligative property chapter 9.4 able recall name equation application common colligative describe relationship molality molarity compound calculate boiling point freezing point vapor pressure osmotic pressure solution colligative property physical property solution dependent concentration dissolve particle chemical identity dissolve particle property vapor pressure depression boiling point elevation freezing point depression osmotic pressure usually associate raoult law account vapor pressure depression cause solute solution solute add solvent vapor pressure solvent decrease proportionately example consider compound figure 9.9 compound pure form mole fraction = 1.0

particular vapor pressure indicate pa ° temperature compound b low vapor pressure indicate pb ° note concentration b increase vapor pressure decrease solute dissolve solvent b dissolve vapor pressure solvent decrease figure 9.9 raoult law solute b dissolve solvent vapor pressure solvent decrease molecular level presence solute molecule block evaporation solvent molecule condensation reduce vapor pressure solution compare pure solvent see figure 9.10 figure 9.10 molecular basis raoult law raoult law express mathematically pa = xapa ° pa vapor pressure solvent solute present xa mole fraction solvent solution pa ° vapor pressure solvent pure state vapor pressure depression go hand hand boiling point elevation lowering solution vapor

pressure mean high temperature require match atmospheric pressure raise boiling point raoult law hold attraction molecule different component mixture equal attraction molecule component pure state condition hold relationship mole fraction vapor pressure deviate raoult law solution obey raoult law call ideal solution example change vapor pressure 180 gram glyceraldehyde c3h6o3 add 0.18 l water 100 ° c solution density water 100 ° c close vapor pressure water temperature 1 atm boiling point water order find mole fraction solvent find molar mass solute glyceraldehyde solvent water 180 g glyceraldehyde represent 2 mole glyceraldehyde 0.18 l water mass 180 g represent 10 mole water mole fraction water find vapor pressure change want find difference old pressure new pressure new pressure calculate change vapor pressure 1 atm 0.83 atm = 0.17 atm example vapor pressure room temperature mixture contain 58 g butane c4h10 172 g hexane c6h14 note vapor pressure pure butane pure hexane 172 kpa 17.6 kpa respectively 25 ° c solution determine number mole substance 58 g butane represent 1 mole butane 172 g hexane represent 2 mole hexane determine mole fraction component mixture calculate vapor pressure component total vapor pressure sum vapor pressure

calculate vapor pressure component total vapor pressure sum vapor pressure total vapor pressure 60 + 12 = 72 kpa actual = 69.1 kpa boiling point elevation nonvolatile solute dissolve solvent create solution boiling point solution great pure solvent boiling point temperature vapor pressure liquid equal ambient incident pressure see add solute solvent result decrease vapor pressure solvent solution vapor pressure solution low pure solvent energy consequently high temperature require vapor pressure equal ambient pressure extent boiling point solution raise relative pure solvent give formula δtb = ikbm δtb increase boiling point van’t hoff factor kb proportionality constant characteristic particular solvent provide test day m molality solution van’t hoff factor correspond number particle compound dissociate solution example = 2 nacl formula unit sodium chloride dissociate particle sodium ion chloride ion dissolve covalent molecule glucose readily dissociate water value 1 boiling point elevation formula

calculate normal boiling point raise value calculate boiling point example 400 g alcl3 dissolve 1.5 l water room temperature boiling point increase add aluminum chloride solution water room temperature density 1.5 l 1.5 kg van’t hoff factor aluminum chloride 4 break form 1 aluminum cation 3 chloride anion determine molality need know mole 400 g alcl3 represent molality plug boiling point elevation equation freeze point depression presence solute particle solution interfere formation lattice arrangement solvent molecule associate solid state great energy remove solution result low temperature order solution solidify example pure water freeze 0 ° c mole solute dissolve 1 kg water freezing point lower 1.86 ° c kf water case kb value kf unique solvent provide test day formula calculate freeze point depression solution δtf = ikfm δtf

freezing point depression van’t hoff factor kf proportionality constant characteristic particular solvent m molality solution freezing point depression colligative property depend concentration particle identity example 400 g alcl3 dissolve 1.5 l water room temperature new freezing point solution solution variable m previous example normal freezing point water 273 k. freezing point go depress decrease 15 k.

new freezing point 273 15 = 258 k = 15 ° c boiling point elevation distinction calculate value final answer freezing point depression calculate normal freezing point lower read question determine ask change temperature δt new altered boiling freezing point effect explanation people cold climate salt icy road winter salt mix snow ice initially dissolve small liquid water equilibrium solid phase snow ice solute solution cause disturbance equilibrium rate melting unchanged salt interact solid water stabilize rigid lattice arrangement rate freezing decrease solute displace water molecule solid liquid interface prevent liquid water enter solid phase imbalance cause ice melt water freeze melting endothermic process heat initially absorb liquid solution cause solution temperature fall ambient temperature temperature gradient heat flow warm air cool aqueous solution additional heat facilitate melting temperature solution actually

cold solute add ice melt liquid water solute disperse liquid result salt solution virtue presence solute particle low freezing point pure water remain liquid state temperature normally cause pure water freeze osmotic pressure cover primarily chapter 8 mcat biochemistry review brief recap provide osmotic pressure refer suck pressure generate solution water draw solution formally osmotic pressure pressure apply counteract attraction water molecule solution equation osmotic pressure = imrt osmotic pressure van't hoff factor m molarity solution r ideal gas constant t water move direction high solute concentration instance pure water solute concentration traverse semipermeable membrane solution contain solute particle nacl increase level water result show figure 9.11 figure 9.11 change water level osmotic pressure mcat concept check 9.4 assess understanding material 1 colligative property 2 molality molarity relate water relate 3 determine vapor pressure solution contain 190 g mgcl2 540 g water room temperature note vapor pressure pure water 25 ° c 3.2 kpa 4 determine new boiling point solution contain 190 g mgcl2 1500 g water

boiling point solution contain 190 g mgcl2 1500 g water room temperature 5

determine freezing point depression solution contain 58.5 g nacl 1800 g water room temperature review solution chemistry provide opportunity consider nature solution solute solvent interaction solute solvent formation solution review solubility rule reflect solubility common compound water different way express solute solution identify example give unit concentration include percent composition mole fraction molarity molality normality review thermodynamic principle solution equilibrium define unsaturated saturated supersaturated solution respect ion product ip solubility product constant ksp subsequently discuss common ion effect perspective le châtelier principle solution equilibrium finally examine colligative property solution mathematic govern colligative property vapor pressure depression boiling point elevation freezing point depression osmotic pressure physical property solution depend concentration dissolve particle chemical identity review content test knowledge critical

thinking skill complete test like passage set online resource nature solutions solutions homogeneous mixture compose combine form single phase generally liquid solvent particle surround solute particle electrostatic interaction process call solvation dissolution aqueous solution important mcat solvation water call hydration dissolution endothermic dissolution gas liquid exothermic solubility maximum solute dissolve give solvent give temperature express molar solubility molarity solute complex ion coordination compound compose metallic ion bond neutral compound anion refer ligand formation complex ion increase solubility insoluble ion opposite common ion effect process form complex ion involve electron pair donor electron pair acceptor see coordinate covalent bonding way express concentration percent composition mass mass solute mass solution times 100 aqueous solution solid in- mole fraction mole solute total mole calculate vapor pressure depression partial pressure gas system molarity mole solute liter solution common unit concentration rate law law mass action osmotic pressure ph poh nernst molality mole solute kilogram solvent boiling point elevation freezing point depression normality number equivalent liter solution molarity species interest acid base saturated solution equilibrium particular solubility product constant ksp simply equilibrium constant dissociation reaction comparison ion

product constant ksp simply equilibrium constant dissociation reaction comparison ion product ip ksp determine level saturation behavior solution ip < ksp solution unsaturated solute add dissolve ip = ksp solution saturate equilibrium change concentration ip > ksp solution supersaturated precipitate formation complex ion solution greatly increase solubility formation stability constant kf equilibrium constant complex formation value usually great formation complex increase solubility salt contain ion use product dissolution reaction shift equilibrium right opposite common ion effect common ion effect decrease solubility compound solution contain ion compound presence ion solution shift dissolution reaction left decrease dissociation colligative property physical property solution depend concentration dissolve particle vapor pressure depression follow raoult law presence solute decrease

evaporation rate solvent affect condensation rate decrease vapor pressure vapor pressure depression explain boiling point elevation vapor pressure decrease temperature energy require boil liquid raise freeze point depression boiling point elevation shift phase equilibrium dependent molality osmotic pressure primarily dependent molarity solute dissociate van’t hoff factor freezing point depression boiling point elevation osmotic answer concept check 1 solvation refer breaking intermolecular force solute particle solvent particle formation intermolecular force solute solvent particle aqueous solution water solvent 2 solubility solute contain solvent saturation refer maximum solubility compound give temperature dissolve solute add temperature 3 solubility solid increase increase temperature solubility gas increase decrease temperature increase partial pressure gas solvent henry law 4 group metal ammonium nitrate acetate salt soluble 0.004 n glucose dissociate approximately 0.024 n twice molarity note denominator molality use kilogram solvent denominator molarity use liter total solution quantity necessarily careful example help clarify difference suppose 1 mol solute add 1 l water 1 l water mass 1 kg simply use 1 kg solvent denominator molality computation molality denominator mass solvent add 1 mol solute 1 l water volume final solution likely significantly large 1 l

l water volume final solution likely significantly large 1 l solute take space simply plug 1 l molarity equation molarity denominator depend total volume final mixed solution instead need remeasure total final volume use number compute say problem concept check initial volume solvent large 250 l add solute appreciably change volume final solution case able add 250 l directly start 25 ml stock solution add 75 ml pure water 100 ml solution 25 ppm cl2 1 write balanced equation identify molar solubility x represent ni(oh)2 dissociate create x ni2 + 2x oh–.

write ksp equation plug value x solve ksp 2 start balanced reaction calculation ksp calculate q. mind x ba(oh)2 dissolve x ba2 + produce 2x oh–. behavior solution 0.5 m)(1 m)2 = 0.5 0.5 > 5.0

× 103 precipitation 0.1 m)(0.2 m)2 = 4.0 × 103 4.0 × 103 < 5.0 × 103 dissolution 0.05 m)(0.1 m)2 = 5.0 × 5.0 × 104 < 5.0 × 103 dissolution note concentration hydroxide double barium small contribution hydroxide autoionization water negligible compare value give question 3 start write balanced reaction soluble salt problem zn(oh)2 zn2 + + 2 oh write ksp equation enter variable concentration zn2 + concentration equal x molar solubility condition oh- concentration come contributor dissociate zn(oh)2 0.1 m naoh solution result following ksp expression ksp = zn2+][oh]2 = x)(0.1 + 2x)2 ksp zn(oh)2 4.1 × 10–17 x negligible compare 0.1 m naoh ksp expression simplify ksp = x)(0.1)2 4.1 × 1017 = 0.01x x = molar solubility zn(oh)2 = 4.1 × 1015 1 colligative property depend solute present actual identity solute particle example include vapor pressure depression boiling point elevation freezing point depression osmotic 2 molarity m molality m nearly equal room temperature 1 l solution approximately equal 1 kg solvent dilute solution denominator molarity molality equation respectively solvent molarity molality differ significantly density new boiling point 373 + 2 = 375 k.

science mastery assessment equation δtb = ikbm solve problem change boiling point 101.0 100 = 1.0 ° c plug van’t hoff factor solute 1 molecule dissociate small component convert gram solute definition molality mass equation 0.1 kg 100 ml water mass 0.1 kg determine molar mass close choice solution long component create mixture uniform appearance homogeneous hydrogen platinum example gas solid brass steel example homogeneous mixture solid air breathe example homogeneous mixture gas commonly refer mixture fit criterion solution benzene toluene organic liquid similar property nonpolar exactly size raoult law state ideal solution behavior observe solute solute solvent solvent solute solvent interaction similar benzene toluene solution predict behave nearly ideal solution melt point depress solute addition make b incorrect solute particle interfere lattice formation highly organized state solid molecule align colder- normal condition necessary create solid structure step likely endothermic energy require break molecule apart second step endothermic

intermolecular force solvent overcome allow incorporation solute particle step likely exothermic polar water molecule interact dissolve ion create stable solution bef2 cause negative contribution hydration effect be2 + cation high charge density compare ion ion charge density +1 1 be2 + charge density magnitude formation complex ion silver ion ammonia cause molecule solid agcl dissociate equilibrium drive dissociation ag+ ion essentially remove solution complex ammonia rationale base le châtelier principle state chemical equilibrium experience change concentration system shift counteract change mass percent solute equal mass solute divide mass total solution times 100 plug value give sucrose volume water density water determine mass sucrose mind rounding calculate denominator estimate large actual value give answer slightly low actual value correct answer b 25.5 result rounding error take account answer close mass water slightly 300 g give density value percent composition sucrose slightly high 25 solute mass add solvent calculate value 34.2 d c

neglect addition step mixture high vapor pressure predict raoult law strong solvent solvent solute solute interaction solvent solute interaction particle want stay solution readily evaporate create high vapor pressure ideal solution liquid different property like hexane hydrophobic ethanol hydrophilic small interaction cause positive deviation i.e. high vapor pressure b c compose liquid similar significant deviation raoult law d contain liquid interact actually cause negative deviation raoult law attract solute solvent prefer stay liquid form low vapor pressure predict dissolution govern enthalpy entropy relate equation δg ° soln = δh ° soln tδs ° soln cooling solution indicate heat bond break reaction word dissolution endothermic δh positive reaction occur spontaneously δg negative way positive δh result negative δg entropy δs

large positive value conceptually mean way solid dissolve increase entropy great overcome increase enthalpy b incorrect clearly state question stem kcl dissolve salt group 1 metal soluble c incorrect δs ° soln positive order kcl dissolve finally d incorrect solute dissolution

cause boiling point elevate depress piece evidence find simply observe beaker temperature equation determine change boiling point solution follow δtb = ikbm m molality solution kb boiling point elevation constant case solvent water kb solution need number dissociate particle original specie refer van’t hoff factor multiply molality normality concentration specie interest case particle normality value determine species cause great change boiling point number dissolve × m 1 2 acetic acid weak acid low percentage molecule dissociate 2 particle 1.0 2.0 choice iron(iii nitrate acetic acid fact acetic acid weak acid indicate particle dissociate h+ acetate normality acetic acid close 1.0 2.0 osmotic pressure give formula π = imrt enter value question stem give notice concentration seawater give solute represent × m. give mosm l convert mole liter multiply 10 3 question ask minimum pressure require mean correct answer choice slightly calculate pressure order reverse osmosis proceed 200 ppb pb2 + equivalent 200 gram pb2 + 109 gram solution give extremely low concentration lead mass water assume approximately 109 gram solve set dimensional analysis question unit need end mole liter molarity convert gram lead mole lead gram water liter water note denominator round small number mean estimate answer slightly large actual question actually complicated hydroxide involve aqueous solution concentration hydroxide autoionization water 10–7 m. concentration significantly great approximately 10,000 × great hydroxide produce dissociation salt concentration hydroxide set water dissociation cobalt(iii hydroxide thallium(iii hydroxide solution mix concentration hydroxide change mix solution concentration metal ion decrease consequence dilution result solution saturation justify correct answer solubility agbr determine ksp value give equation

justify correct answer solubility agbr determine ksp value give equation agbr dissolve molar solubility x condition agbr dissociate x silver(i form x bromide add 0.0010 m br- present nabr give ksp 5.4 × 10–13 x negligible compare 0.0010 m.

math simplify x molar solubility 5.35 × 1010 look like c unit answer choice gram liter molarity

result multiply molar mass close d note accurate approximation reach round number round second balance error consult online resource additional practice equation remember 9.1 percent composition mass 9.2 mole fraction 9.5 dilution formula mivi = mfvf 9.6 solubility product constant ksp = an+]m[bm]n 9.7 ion product ip = an+]m[bm]n 9.8 raoult law vapor pressure depression pa = xapa ° 9.9 boiling point elevation δtb = ikbm 9.10 freeze point depression δtf = ikfm 9.11 osmotic pressure = imrt biology chapter 10 general chemistry chapter 3 bonding chemical interactions general chemistry chapter 6 general chemistry chapter 7 general chemistry chapter 10 acid bases general chemistry chapter 12 acid bases pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read corresponding subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 follow brønsted lowry base d. h o n = o 2 follow close ph solution contain 5 mm 3 follow represent chloric acid 4 following basis weak 5 gram equivalent weight phosphoric acid a.

32 g b. 49 g c. 98 g d. 294 g 6 ph solution ammonium concentration 70 mm ammonia concentration 712 mm note pkb ammonia 3.45 question 7–9 refer titration curve acid x show 7 approximate value pka1 8 ph second equivalence point a. ph = 3.0 b. ph = 4.1 c. ph = 5.9 d. ph = 7.2 9 approximate value pka2 10 gram equivalent weight phosphoric acid a. 24.5 g b. 32.7 g c. 49.0 g d. 98.0 g 11 h3o+ 2 m aqueous solution weak acid hxo2 ka = 3.2 × 105 a. 6.4 × 105

m b. 1.3 × 104 m c. 4.0 × 103 m d. 8.0 × 103 m 12 solution prepare unknown concentration theoretical compound ka exactly 1.0 ph solution a. high 7 b. exactly 7 c. 7 d. information answer question 13 follow characteristic amphoteric species a. amphoteric species act acid base depend b. amphoteric species act oxidize reduce agent depend c. amphoteric specie amphiprotic d. amphoteric specie nonpolar 14 approximate ph 1.2 × 105 m aqueous solution naoh 15 liter 2 m ba(oh)2 need titrate 4 l solution 6 m a. 1.33 l b. 12 l c. 18 l d. 56 l acid basis chapter autoionization water

hydrogen ion equilibrium strong acid basis weak acid basis conjugate acid base pair application ka kb 10.3 polyvalence normality 10.4 titration buffer strong acid strong base weak acid strong base strong acid weak base weak acid weak base polyvalent acid basis content chapter relevant 15 question general chemistry mcat chapter cover material following aamc content category 4d light sound interact matter 5a unique nature water solution medication apply drop salve cream mucous membrane inject employ transdermal patch swallow inhale route administration drug compound relate location target tissue local systemic chemical physical property compound example compound water soluble administer intravenously aqueous solution drip directly bloodstream lipid soluble administer transcutaneously patch cream orally pill liquid suspension polarity size charge drug compound determine solubility polar nonpolar environment major contribute factor determine effective efficient route administration drug compound ionic charge usually function acidic basic nature compound example basic organic compound insoluble water neutral react acid form salt salt ionic water soluble correspondingly acidic organic compound insoluble water neutral react base form water soluble salt hand protonated acidic cationic form organic compound react base neutralize compound release salt change usually reverse solubility water medical professional one concerned drug solubility route administration science illicit drug clear example difference major form cocaine large alkaloid compound derive coca plant commonly alkaloid compound react hydrochloric acid protonate tertiary amine functional group extract water dry

water soluble powder cocaine hydrochloride powder snort insufflate nasal cavity absorb capillary bed inject directly venous circulation second form cocaine salt form high boiling point close temperature cocaine degrade smoke produce vaporizable form cocaine inhale pipe cocaine hydrochloride react base typically ammonia produce pure freebase cocaine sodium bicarbonate produce crack cocaine pure base react protonate tertiary amine remove hydrogen ion reform neutral alkaloid compound freebase cocaine water insoluble usually extract ether leave aqueous solution heat

cocaine water insoluble usually extract ether leave aqueous solution heat evaporate freebase crack form cocaine low boiling point consequently smoke risk degradation chapter focus class compound acid basis involve important reaction acid base reaction important topic mcat fact neutralization reaction commonly test reaction type test day begin review different definition acid basis property include characterization strong weak focus weak acid basis discuss significance equilibrium constant ka kb acid basis respectively finally review acid base titration buffer system chapter 10.1 able compare contrast arrhenius brønsted lowry lewis definition acid basis predict acid formula anion arrhenius acid naming identify amphoteric specie determine amphiprotic century chemist different definition identify compound acid basis definition emerge inclusive specific definition acid base arrhenius definition arrhenius acid dissociate form excess h+ solution arrhenius base dissociate form excess oh solution behavior generally limit aqueous acid basis arrhenius acid basis easily identify acid contain h beginning formula hcl hno3 h2so4 basis contain oh end formula naoh ca(oh)2 fe(oh)3 mention arrhenius definition test day likely comparison definition acid arrhenius definition far restrictive brønsted lowry lewis definition predominate mcat inclusive definition acid basis propose independently johannes brønsted thomas lowry 1923 brønsted lowry acid species donate hydrogen ion h+ brønsted lowry base species accept advantage definition arrhenius limit aqueous solution example oh nh3 f brønsted lowry basis ability accept hydrogen ion nh3 f classify arrhenius basis dissociate produce excess oh ion aqueous solution accord

definition way species acid produce hydrogen ion difference definition acid requirement aqueous medium arrhenius definition acidity water arrhenius definition water consider acid produce excess h+ solution water hand brønsted lowry acid able donate proton specie acid base chemistry reaction mcat involve transfer hydrogen ion accordance brønsted lowry arrhenius acid base classify brønsted lowry acid base brønsted lowry acid base classify lewis acid base logic work way example nh3

base classify lewis acid base logic work way example nh3 brønsted lowry base arrhenius base brønsted lowry acid basis occur pair definition require transfer proton acid base conjugate acid base pair describe section example autoionization water h3o+ conjugate acid oh conjugate base show figure figure 10.1 autoionization water conjugate acid conjugate base hydroxide ion conjugate base oxonium hydronium ion conjugate acid h2o l + h2o l h3o+ aq + oh aq approximately time brønsted lowry publication gilbert lewis propose definition acid basis lewis acid define electron pair acceptor lewis base define electron pair donor show figure 10.2 electron pair donate lone pair involve bond figure 10.2 lewis acid base chemistry boron trifluoride serve lewis acid accept lone pair ammonia serve lewis base donate lone pair brønsted lowry definition revolve proton lewis definition mcat lewis acid base chemistry appear name underlie idea species push lone pair form bond chemistry call coordinate covalent bond formation discuss chapter 3 mcat general chemistry review complex ion formation discuss chapter 9 mcat general chemistry review nucleophile electrophile interaction discuss chapter 4 mcat organic chemistry review intuitive approach understand difference definition discuss far lewis definition rely behavior vastly different brønsted lowry interaction difference focus brønsted lowry acid basis follow exchange hydrogen ion h+ essentially naked proton lewis definition focus reaction long proton instead electron form coordinate covalent bond difference see curved arrow show figure 10.3 figure 10.3 comparison brønsted lowry lewis definition acid basis brønsted lowry definition focus transfer proton lewis definition focus attack lewis acid electrophile lone pair lewis base nucleophile

note lewis definition inclusive arrhenius acid brønsted lowry acid brønsted lowry acid lewis acid likewise basis converse necessarily true lewis definition encompass specie include brønsted lowry definition example bf3 alcl3 specie accept electron pair qualify lewis acid lack hydrogen ion donate disqualify arrhenius

pair qualify lewis acid lack hydrogen ion donate disqualify arrhenius mcat encounter lewis acid context organic chemistry reaction lewis acid amphoteric species react like acid basic environment like base acidic environment brønsted lowry sense amphoteric species gain lose proton make amphiprotic mcat water common example water react base behave acid h2o + b hb + oh water react acid behave base ha + h2o h3o+ + a water amino acid partially deprotonate polyprotic acid bicarbonate bisulfate common example amphoteric amphiprotic substance metal oxide hydroxide consider amphoteric necessarily amphiprotic proton partially dissociate conjugate base polyvalent acid usually amphoteric example hso4 gain proton form h2so4 lose proton form so42.

hydroxide certain metal al zn pb cr amphoteric furthermore specie act oxidize reduce agent consider amphoteric accept donate electron pair act lewis acid complex amphoteric molecule include amino acid zwitterion intermediate cationic anionic character show figure 10.4 specie discuss great detail chapter 1 mcat biochemistry review figure 10.4 amino acid zwitterion complex amphoteric specie amino group release proton acid carboxylate group accept proton name acid relate name parent anion anion combine h+ form acid acid form anion name end ide prefix hydro ending ic acid form oxyanion call oxyacid anion end ite oxygen acid end ous acid anion end ate oxygen acid end ic acid prefix name anion retain common example include following exception nomenclature rule instance mno4 call permanganate mno3 mno2 mcat concept check 10.1 assess understanding material 1 compare contrast definition acid basis 2 utilize arrhenius acid naming trend predict acid formula following anion 3 identify reactant amphoteric specie follow reaction specie determine compound amphiprotic

amphiprotic y hco3 + hbr h2co3 + 3 hcl + al(oh)3 alcl3 + 3 amphiprotic y 2 hbr + zno znbr2 + h2o chapter 10.2 able predict behavior acid base water give ka kb value apply mathematical relationship ph poh ion recall mathematical relationship ka kb kw determine concentration hydrogen ion give molarity ka kb identify acid basis conjugate acid conjugate basis reaction h2o l + h2o l h3o+ aq + oh aq acid basis usually characterize accord relative tendency donate accept hydrogen ion furthermore aqueous acid base solution characterize accord concentration hydrogen hydroxide ion autoionization water hydrogen acid base reaction place water especially mcat important understand behavior acidic basic compound water fully appreciate meaning significance term strong acid weak base measurement ph poh acid base behavior water describe water amphoteric species presence base react acid presence

water describe water amphoteric species presence base react acid presence acid react base amphoteric compound water react process call autoionization see previously figure 10.1 autoionization water represent h2o l + h2o l h3o+ aq + oh aq water molecule donate hydrogen ion water molecule produce hydronium ion h3o+ hydroxide ion oh general chemistry course depict hydrogen ion simply h+ h3o+

acceptable

represent chemistry important remember proton isolate solution attach water species ability accept autoionization water reversible reaction expression equilibrium pure water 298 k water dissociation constant kw kw = h3o+][oh = 1014 25 ° c 298 k mole water autoionize produce mole hydrogen hydronium ion hydroxide ion concentration hydrogen ion hydroxide ion equal pure water equilibrium concentration ion pure water equilibrium 298 k 107 m. concentration ion equal fact equal solution neutral product respective concentration equal 1014 temperature solution 298 k. example species donate hydrogen ion pure water hydrogen ion

concentration increase cause system shift reactant autoionization process result decrease hydroxide ion concentration return equilibrium state le châtelier principle action addition product system equilibrium cause system shift away product reactant shift away product necessarily decrease hydroxide ion concentration product concentration dissolve ion equal kw addition species accept hydrogen ion result decrease hydrogen ion concentration cause system shift product replace hydrogen ion shift necessarily increase hydroxide ion concentration return system equilibrium introduce scale measure concentration hydrogen ion hydroxide ion different acid base solution worthwhile emphasize important thermodynamic principle water dissociation constant kw expression kw equilibrium constant temperature water change value kw change product concentration hydrogen ion hydroxide ion aqueous solution 298 k equal 1014 different temperature value kw change temperature 298 k kw increase direct result endothermic nature autoionization reaction mcat love test concept value kw like equilibrium constant dependent temperature isolate change concentration pressure volume affect kw ph poh scale concentration hydrogen ion hydroxide ion aqueous solution vary significantly make range measurement linear scale unmanageable concentration scale acidic basic solution condense manageable expression logarithmic term logarithmic scale ph poh scale concentration hydrogen hydroxide ion respectively logarithmic scale condense large absolute difference small scale difference remember sound level db use logarithmic scale discuss chapter 7 mcat physics math review logarithmic scale mathematically

discuss chapter 7 mcat physics math review logarithmic scale mathematically convenient useful calculation instance reactivity acidic solution function hydrogen ion concentration instead logarithm hydrogen ion concentration ph poh prototypical example p scale p scale define negative logarithm number item ph poh solution give pure water equilibrium 298 k concentration hydrogen ion equal concentration hydroxide ion 107 m pure water 298 k ph 7 poh 7 log 107 = 7 negative logarithm entire water dissociation constant expression h3o+][oh = 1014

find ph + poh = 14 equation 10.3 hold true aqueous solution 298 k. ph increase poh decrease relationship see figure 10.5 figure 10.5 ph poh scale ph + poh = 14 aqueous solution 298 k. kw like equilibrium constant change temperature change turn change significance ph scale careful read system condition give mcat ph = 7 = neutral valid 25 ° c aqueous solution 298 k ph 7 poh great 7 indicate relative excess hydrogen ion solution acidic ph great 7 poh 7 indicate relative excess hydroxide ion solution basic ph poh equal 7 indicate equal concentration hydrogen hydroxide ion result neutral solution estimate scale value essential skill hone test day ability quickly convert ph poh pka pkb value nonlogarithmic form vice- original value power operation relatively straightforward change sign exponent give correspond p scale value directly example h+ = 0.001 103 ph = 3 poh = 11 kb = 1.0 × 1012 pkb general math logarithm frequently appear mcat sure review mathematical concept work chapter 10 mcat physics math review specifically equation ph + poh = 14 come fact log product equal sum log log xy = log x + log y. difficulty arise value exact power rest assure mcat math test interested determine ability perform complex logarithmic calculation exact logarithmic calculation number integer power unnecessary mcat testmaker interested test ability apply mathematical concept appropriately solve certain problem obtain relatively close approximation p scale value following shortcut nonlogarithmic value write proper scientific notation form n × 10m n number 1 10 take negative logarithm simplify p value n number 1 10 logarithm decimal 0 1 log 1 = 0 log 10 = 1 close n 1 close log n 0 close n 10 close log n 1 reasonable approximation p value

m 0.n 0.n represent slide decimal point n position left divide n example ka acid 1.8 × 105 pka learn estimate logarithm important skill save lot time test day strong acid basis strong acid basis completely dissociate component ion aqueous solution example sodium hydroxide add water ionic compound dissociate accord net naoh s na+ aq + oh aq 1 m naoh solution complete dissociation yield 1 m na+ 1 m oh. ph poh solution calculate follow ph = 14 poh =

14 log[oh = 14 + log 1 m = 14 + 0 = 14 acid base reaction consist single headed arrow generally indicate strong acid basis complete dissociation reversibility virtually undissociated strong acid base naoh remain solution dissociation strong acid basis say completion naoh example assume concentration oh autoionization water negligible addition strong base contribution oh h+ ion autoionization water negligible concentration acid base significantly great 107 m. hand concentration acid base close 107 m contribution autoionization water important example calculate ph 1 × 108 m solution hcl solution calculate ph log h+ = log 108 m = 8 answer feasible ph 8 describe acidic solution 298 k presence acid increase hydrogen ion concentration 107 m result acidic ph 7 recognize acid concentration question actually time equilibrium concentration hydrogen ion pure water generate autoionization water consequently hydrogen ion concentration water significant ignore represent equilibrium expression x represent concentration h3o+ oh result autoionization water kw = h3o+][oh = x + 108][x = 1014 solve x require quadratic equation math scope mcat give x = 9.5 × 108 m. total concentration hydrogen ion h+]total = 9.5 × 108 + 1.0 × 108 = 1.05 × 107 m.

notice extremely close concentration h+ pure water ph acidic solution calculate ph = log(1.05 × 107 7 actual = 6.98 ph slightly low 7 expect dilute acidic solution point stay alert think critically matter familiar problem setup strong acid commonly encounter mcat include hcl hydrochloric acid hbr hydrobromic acid hi hydroiodic acid h2so4 sulfuric acid hno3 nitric acid hclo4 perchloric acid strong basis commonly encounter include naoh sodium hydroxide koh potassium hydroxide soluble hydroxide group ia metal calculation ph poh strong acid basis assume complete dissociation acid base solution example ph solution hclo4 = 10 m solution perchloric acid strong acid fully dissociate solution h+ = 10 m note contribution autoionization water negligible ph = log h+ = log 10 m = 1 question point ph scale end 0 14 negative

ph value ph value great 14 imply high concentration strong acid base weak acid basis go

discussion acid basis strong weak verify make distinction chemical behavior acid base respect tendency dissociate strong basis completely dissociate aqueous solution concentration acid base solution casually describe solution concentration strong weak preferable use term concentrated dilute respectively unambiguously associate concentration chemical behavior continue focus chemical behavior acid basis consider acid basis partially dissociate aqueous solution call weak acid basis weak monoprotic acid ha dissociate partially water achieve equilibrium state ha aq + h2o l h3o+ aq + a aq system exist equilibrium state write dissociation equation determine acid dissociation constant small ka weak acid consequently dissociate note water pure liquid incorporate equilibrium expression weak monovalent arrhenius base boh undergo dissociation yield b+ oh solution boh aq b+ aq + oh aq base dissociation constant kb calculate small kb weak base consequently dissociate acid dissociation expression water include pure liquid generally speak characterize species weak acid ka 1.0 weak base kb 1.0 mcat molecular nonionic weak basis conjugate acid base pair brønsted lowry definition acid base reaction hydrogen ion proton transfer acid base occur pair call conjugate conjugate acid acid form base gain proton conjugate base base form acid lose proton hco3 aq + h2o l co32 aq + h3o+ aq co32 conjugate base hco3 weak acid h3o+ conjugate acid h2o weak base find ka consider equilibrium concentration dissolve specie reaction bicarbonate water reversible reverse reaction co32 aq + h2o l hco3 aq + oh aq write kb co32 add previous reversible reaction net reaction simply dissociation water net reaction autoionization water equilibrium constant reaction kw = h3o+][oh = 1014 product ka kb remember product concentration hydrogen ion hydroxide ion equal 1014 acidic basic aqueous solution water amphoteric species weak acid

1014 acidic basic aqueous solution water amphoteric species weak acid weak base acid base reactivity water ultimately reduce acid base behavior water acidic basic aqueous solution govern dissociation constant water dissociation constant species conjugate know dissociation constant determine aware relationship conjugate acid basis need recognize entity mcat

remove proton molecule produce conjugate base add proton produce conjugate acid evident equation ka kb inversely related word ka large kb small vice versa logic strong acid ka approach

produce weak conjugate base example hcl strong acid cl weak base strong base produce weak conjugate acid example naoh strong base h2o weak acid conjugate strong acid base term inert completely unreactive hand weak acid basis tend conjugate weak see co32 weak base conjugate acid hco3 weak acid turn specific example reaction co32 water produce hco3 oh occur great extent thermodynamically favorable reaction hco3 water produce co32 h3o+ fact make equilibrium ideal buffer solution bicarbonate buffer system discuss chapter 6 mcat biology review thermodynamic preference bicarbonate ion intermediate major reason bicarbonate buffer system body ideal maintain stable ph. homeostatic mechanism involve discuss chapter 6 mcat biology review important theme acid strength effect induction electronegative element position near acidic proton increase acid strength pull electron density bond hold acidic proton weaken proton bonding facilitate dissociation acid electronegative element near acidic hydrogen strong show figure 10.6 inductive effect electronegative element increase acidity application ka kb common use acid base dissociation constant determine concentration specie solution equilibrium test day ask calculate concentration hydrogen ion ph concentration hydroxide ion poh concentration original acid base example calculate concentration h3o+ 2.0 m aqueous solution acetic acid ch3cooh note ka = 1.8 × 105 solution write equilibrium reaction ch3cooh aq + h2o l h3o+ aq + ch3coo aq write expression acid dissociation constant recognize acetic acid weak acid concentration ch3cooh equilibrium equal initial concentration 2.0 m minus dissociate x.

likewise h3o+ = ch3coo = x molecule ch3cooh dissociate h+ ion ch3coo ion note contribution h3o+ water negligible equation rewrite follow remember value x generally small approximate 2.0 m x 2.0 m. support acetic acid weak acid slightly dissociate water simplify x represent

concentration h3o+ h3o+ = 6 × 103 m. note require square root adjust coefficient need power 10 number way square root require cut power 10 half example note x significantly low initial concentration acetic acid 2.0 m validate approximation necessary solve x quadratic formula fortunately value x test day sufficiently small approximation rule thumb approximation valid long x 5 percent initial concentration typically occur ka 100 time small concentration start solution example ka 104 concentration start solution 0.01 m 102 m ratio value 102 100 error calculation hand ka 103 concentration 0.01 m ratio value 10 lead error degree error useful identify answer choice mcat student feel nervous make assumption x negligible want precise answer choice mind mcat deliberately test student ability reasonable assumption time condition arrive feasible answer choice skill take mcat round appropriately simplify math acid basis react form salt water term neutralization reaction ha aq + boh aq ba s + h2o l remember reaction type discuss chapter 4 mcat general chemistry review review section neutralization reaction equation look familiar salt precipitate remain ionized solution depend solubility produce general neutralization reaction completion reverse reaction salt ion react water acid base know combination strong weak acid basis possible strong acid + strong base hcl + naoh nacl + h2o strong acid + weak base hcl + nh3 nh4cl weak acid + strong base hclo + naoh naclo + h2o weak acid + weak base hclo + nh3 nh4clo product reaction equal concentration

strong acid strong base equimolar amount salt water acid base neutralize result solution neutral ph = 7 ion form reaction react water inert conjugate product reaction strong acid weak base salt water form weak basis hydroxide case cation salt weak acid react water solvent form weak base hydrolysis example reaction hcl aq + nh3 aq nh4 + aq + cl aq reaction ii nh4 + aq + h2o l nh3 aq + h3o+ aq nh4 + conjugate acid weak base nh3 strong conjugate base cl strong acid hcl nh4 + transfer proton h2o form hydronium ion increase concentration hydronium ion cause system shift away autoionization reduce concentration hydroxide ion consequently concentration hydronium ion great hydroxide ion equilibrium result ph solution

fall 7 sense strong acid weak base produce slightly acidic hand weak acid react strong base ph solution equilibrium basic range salt hydrolyze concurrent formation hydroxide ion increase hydroxide ion concentration cause system shift away autoionization reduce concentration hydronium ion consequently concentration hydroxide ion great hydronium ion equilibrium result ph solution rise 7

consider reaction acetic acid ch3cooh weak acid sodium hydroxide naoh strong base reaction ch3cooh aq + naoh aq na+ aq + ch3coo aq + h2o l reaction ii ch3coo aq + h2o l ch3cooh aq + oh ph solution contain weak acid weak base depend relative strength reactant example weak acid hclo ka 3.2 × 108 weak base nh3 kb = 1.8 × 105 aqueous solution hclo nh3 basic ka hclo kb nh3 hclo weak acid nh3 base equilibrium concentration hydroxide ion great concentration hydronium ion aqueous solution biology biochemistry neutralization reaction condensation reaction form bond small molecule byproduct usually water peptide bond protein example create reaction carboxyl group acid amino group base form water molecule show figure 10.7 salt reaction polypeptide break apart require hydrolysis figure 10.7 peptide bond formation acidic carboxyl group react basic mcat concept check 10.2 assess understanding material 1 amphoteric species 2 compound ka value water mean behavior solution compare solution slightly high ka water 3 compound kb value water mean behavior solution compare solution slightly high kb water 4 complete blank cell table utilize mathematical relationship ph poh ion concentration note round number give use logarithmic approximation determine p value calculator simulate test day math acid base 8.89 × 104 m 1.88 × 106 m 5 mathematical relationship ka kb kw 6 identify conjugate acid base pairing reaction h2co3 + h2o hco3 + h2po4 + h2o h3po4 + 7

determine concentration hydrogen ion ph solution 0.2 m acetic acid ka = 1.8 × 105 10.3 polyvalence normality chapter 10.3 able describe equivalent acid base calculate calculate normality solution give formula molarity relative acidity basicity aqueous solution determine

relative concentration acid base equivalent acid equivalent equal mole h+ properly h3o+ ion base equivalent equal mole oh ion acid basis polyvalent mole acid base liberate acid base equivalent brønsted lowry definition acid basis term polyprotic example divalent diprotic acid h2so4 undergo following dissociation water mole h2so4 produce acid equivalent 2 mole h3o+ notice dissociation go completion second dissociation reach equilibrium state acidity basicity solution depend concentration acidic basic equivalent liberate quantity acidic basic capacity directly indicate solution normality describe chapter 9

mcat general chemistry review example mole h3po4 yield mole equivalent h3o+ 2 m h3po4 solution 6 n. measurement useful acid base chemistry gram equivalent weight chapter 4 mcat general chemistry review define discuss term extensively gram equivalent weight mass compound produce equivalent mole charge example h2so4 molar mass divalent acid mole acid compound yield acid equivalent gram equivalent weight 98 ÷ 2 = 49 gram complete dissociation 49 gram h2so4 yield acid equivalent mole h3o+ common polyvalent acid include h2so4 h3po4 h2co3 common polyvalent basis include al(oh)3 ca(oh)2 mg(oh)2 review normality detail revisit calculation perform chapter 4 mcat general chemistry review critical calculation polyvalent acid basis mcat concept check 10.3 assess understanding material 1 specie consider equivalent acid basis 2 calculate normality following solution 2 m al(oh)3 16 m h2so4 10.4 titration buffer chapter 10.4 able select appropriate indicator give acid base reaction explain purpose buffer solution identify ph range equivalence point different combination acid basis example weak acid + weak base calculate ph poh know solution identify buffering region half equivalence point equivalence point endpoint titration reaction titration procedure determine concentration know reactant solution different type titration include acid base oxidation reduction complexometric metal ion mcat frequently test type complexometric metal ion titration outside scope mcat focus formation complex ion describe chapter 9 mcat general chemistry review titration perform add small volume solution know concentration titrant know volume solution unknown concentration titrand completion

reaction achieve equivalence point acid base equivalence point acid base titration equivalence point reach number acid equivalent present original solution equal number base equivalent add vice versa important emphasize strong acid strong base titration equivalence point ph 7 equivalence point occur ph 7 titrate polyprotic acid basis discuss later chapter multiple equivalence point acidic basic conjugate species titrate separately show speciation plot figure 10.8 figure 10.8

species titrate separately show speciation plot figure 10.8 figure 10.8 speciation plot phosphoric acid give ph form acid exist solution conjugate titrate separately equivalence point number equivalent acid base equal fact allow calculate unknown concentration titrand equation nava = nbvb na nb acid base normality respectively va vb volume acid base solution respectively note long volume use unit unit liter equivalence point acid base titration determine common way evaluate graphical method plot ph unknown solution function add titrant ph meter estimate watch color change add indicator weak organic acid basis different color protonated deprotonated state small structural change binding release proton lead change absorption spectrum molecule perceive color change indicator generally vibrant low concentration significantly alter equivalence point indicator weak acid base acid base titrate indicator titrate point indicator change final color equivalence point endpoint indicator choose correctly titration perform volume difference endpoint equivalence point negligible correct simply ignore indicator change color shift conjugate acid base form equilibrium process apply le châtelier principle add h+ shift equilibrium left add oh remove h+ shift equilibrium right acid base titration perform different combination strong weak acid basis useful combination involve strong species weak acid weak base titration accurate rarely perform ph curve titration weak acid weak base lack sharp change normally indicate equivalence point furthermore indicator useful ph change far gradual question involve selection ideal indicator require know ph reaction equivalence point graphically mathematically determine equivalence point select indicator close pka value strong acid strong base let consider titration 10 ml 0.1 n solution hcl

0.1 n solution naoh plot ph solution vs. quantity naoh add give curve show figure 10.9 figure 10.9 monoprotic strong acid strong base titration curve strong base naoh titrate solution strong acid hcl yield equivalence point ph = 7 compare relative strength solution titration determine ph equivalence

= 7 compare relative strength solution titration determine ph equivalence point equal great 7 strong acid + weak base equivalence point ph < 7 strong acid + strong base equivalence point ph = 7 weak acid + strong base equivalence point ph > 7 hcl strong acid naoh strong base equivalence point titration ph 7 solution neutral note endpoint show close exactly equal equivalence point selection well indicator change color ph 8 give well approximation error introduce use indicator change color ph 11 ph 8 especially significant represent mere fraction milliliter excess naoh solution early curve little base add acidic species predominate addition small amount base appreciably change oh ph.

similarly titration curve excess base add addition small amount base change oh significantly ph remain relatively constant addition base alter concentration h+ oh near equivalence point elicit substantial change ph region remember equivalence point strong acid strong base titration ph 7 monovalent use ph meter chart change ph function volume titrant add good approximation equivalence point locate midpoint region curve steep slope weak acid strong base titration weak acid ch3cooh strong base naoh produce titration curve

show figure 10.10 figure 10.10 weak acid strong base titration curve strong base naoh titrate solution weak acid ch3cooh yield equivalence point ph > 7 compare figure 10.10 curve figure 10.9 difference initial ph weak acid solution great initial ph strong acid solution weak acid dissociate degree strong acid concentration h3o+ generally low ph high equimolar solution weak acid second difference shape curve ph curve strong acid strong base titration show steep sudden rise ph equivalence point weak acid strong base titration ph change gradually

early titration sudden rise equivalence point difference position equivalence point equivalence point strong acid strong base titration ph 7 equivalence point weak acid strong base titration 7 reaction weak acid ha strong base oh produce weak conjugate base a weak conjugate acid h2o produce great concentration hydroxide ion hydrogen ion equilibrium common ion effect autoionization water equivalence point weak acid strong base titration basic range ph strong acid weak base appearance titration curve weak base titrand strong acid titrant look like inversion curve weak acid titrand strong base titrant initial ph basic range typical range ph 10–12 demonstrate gradual drop ph addition strong acid equivalence point acidic ph range reaction weak base strong acid produce weak conjugate acid weak conjugate base show figure 10.11 strong conjugate acid result equilibrium state concentration hydrogen ion great hydroxide ion equivalence point weak base strong acid titration acidic range ph scale figure 10.11 strong acid weak base titration curve strong acid hcl titrate solution weak base nh3 yield equivalence point ph < 7 weak acid weak base appearance titration curve weak base titrand weak acid titrant look like intermediate previous type discuss titrant titrand weak initial ph generally 3–11 range demonstrate shallow drop equivalence point equivalence point near neutral ph reaction partially dissociative identify type titration show graph identify

ph reaction partially dissociative identify type titration show graph identify starting position graph ph 7 = titrand strong base > 7

slightly = weak base < 7 slightly = weak acid 7 ph = strong acid determine equivalence point think titration like tug war strong acid base pull equivalence point ph territory polyvalent acid basis titration curve polyvalent acid base look different monovalent acid base figure 10.12 show titration na2co3 hcl divalent diprotic acid h2co3 ultimate product figure 10.12 polyvalent titration multiple equivalence point indicate polyvalent titration region little acid add predominant species co32. region ii acid add predominant specie co32 hco3 relatively equal concentration flat curve buffer region discuss section correspond pka hco3 ka = 5.6 ×

1011 pka = 10.25 center buffer region point region ii term half- equivalence point occur half give species protonate deprotonate region iii begin equivalence point co32 finally titrate hco3. curve illustrate rapid change ph occur equivalence point point region ii iii region iii predominant species hco3 h2co3 form beginning region iv acid neutralize approximately half hco3 h2co3 hco3 roughly equal concentration flat region second buffer region second half equivalence point region iii iv titration curve correspond pka h2co3 ka = 4.3 × 107 pka = 6.37 region v start second equivalence point hco3 finally convert h2co3 rapid change ph observe near equivalence point point region iv v acid add titration acidic basic amino acid acidic basic chain respectively curve similar show figure 10.12 equivalence point fact correspond titration

carboxyl group second correspond titration amino group attach central carbon correspond acidic basic chain buffer solution consist mixture weak acid salt compose conjugate base cation mixture weak base salt compose conjugate acid anion example buffer common laboratory commonly test mcat solution acetic acid ch3cooh salt sodium acetate ch3coona+ solution ammonia nh3 salt ammonium chloride nh4+cl acetic acid sodium acetate solution consider acid buffer ammonium chloride ammonia solution base buffer buffer solution useful property resist change ph small amount acid base add consider buffer solution acetic acid sodium acetate note sodium ion include involve acid base ch3cooh aq + h2o l h3o+ aq + ch3coo aq small strong base naoh add buffer oh ion naoh react h3o+ ion present solution subsequently acetic acid dissociate system shift right restore h3o+ weak acid component buffer serve neutralize strong base add result increase concentration acetate ion conjugate base create nearly large increase hydroxide ion unbuffered naoh addition strong base result significant increase oh appreciably change ph. likewise small hcl add buffer h+ ion hcl react acetate ion form acetic acid acetic acid weak add hydrochloric acid neutralize acetate ion increase concentration acetic acid significantly contribute hydrogen ion concentration solution buffer maintain h+ approximately constant value ph solution relatively bicarbonate buffer system human body important buffer h2co3 hco3 conjugate pair plasma component blood

call bicarbonate buffer system specifically carbonic acid h2co3 conjugate base bicarbonate hco3 form weak acid buffer maintain ph blood fairly narrow physiological range co2 g waste product cellular respiration low solubility aqueous solution majority co2 transport peripheral tissue lung exhale dissolve plasma disguise form bicarbonate buffer system co2 g water react following manner co2 g + h2o l h2co3 aq h+ aq + hco3 aq number condition affect delicate ph balance tissue body include

chronic obstructive pulmonary disease copd renal tubular acidosis rta diabetic ketoacidosis dka lactic acidosis metabolic disease poisoning ingestion hyperventilation buffer system maintain mitigate change bicarbonate buffer system tie respiratory system condition metabolic acidosis production excess plasma h+ cause respiratory system breathing rate increase compensate blow great carbon dioxide gas cause system shift left reduce h+ buffer dramatic dangerous change blood ph. interesting note bicarbonate buffer system pka = 6.37 maintain ph 7.4 actually slightly outside optimal buffering capacity system buffer narrow range optimal activity pka ± 1 actually make sense far common acidemia acid blood occur alkalemia base blood acidemia severe buffer system actually effective resistant lowering ph. henderson hasselbalch equation henderson hasselbalch equation estimate ph poh buffer solution weak acid buffer solution a concentration conjugate base ha concentration weak acid note conjugate base = weak acid ph = pka log 1 = 0 occur half equivalence point titration buffering capacity optimal ph. likewise weak base buffer solution b+ concentration conjugate acid boh concentration weak base similar acid buffer poh = pkb conjugate acid = weak base buffering capacity optimal henderson hasselbalch equation reality rearrangement acid base dissociation constant subtlety buffer system henderson hasselbalch calculation usually go unnoticed misunderstand student effect change concentration conjugate pair change ratio concentration clearly change ratio conjugate base acid lead change ph buffer solution change concentration maintain constant ratio happen concentration acid conjugate base double ph change buffering capacity ability system resist change ph double word addition small acid

base system cause deviation ph. mention

early buffering capacity generally maintain 1 ph unit pka value example ph solution 1 l 0.05 m acetic acid ch3cooh ka = 1.8 × 105 mix 500 ml 1 m acetate ch3coo solution determine concentration acetic acid acetate final solution solution mix dilution acetic acid acetate use henderson hasselbalch equation mcat concept check 10.4 assess understanding material 1 describe following part titration curve 2 reaction involve strong base weak acid following indicator good indicate endpoint titration circle correct answer phenolphthalein pka = 9.7 bromothymol blue pka = 7.1 bromocresol green pka = 4.7 methyl yellow pka = 3.3 3 ph range acidic basic neutral equivalence point fall follow titration

strong acid + weak base strong base + weak acid strong acid + strong base weak acid + weak base 4 purpose buffer solution 5 ph poh solution contain 5 ml 5 m benzoic acid ka = 6.3 × 105 100 ml 0.005 m benzoate solution chapter review important principle acid base chemistry clarify difference definition acid basis include nomenclature common arrhenius acid investigate important property acid basis include important acid base behavior water autoionization hydrogen ion equilibrium explain mathematic ph poh logarithmic scale demonstrate useful test day shortcut approximate logarithmic value hydrogen ion hydroxide ion concentration strong acid basis define compound completely dissociate aqueous solution weak acid basis compound partially dissociate equilibrium state discuss neutralization salt formation reaction acid basis finally apply fundamental understanding acid base reactivity titration buffer system titration useful determine concentration know acid base solution weak acid weak base buffer useful minimize change ph addition strong acid base accomplish major task overall effort earn point test day okay understand pass review concept challenge complete question end chapter mcat practice passage test knowledge alarmed find review part chapter second time repetition key success chapter away complete review general chemistry want offer congratulation prematurely want acknowledge hard work invest process

success test day review content test knowledge critical thinking skill complete test like passage set online resource arrhenius acid dissociate produce excess hydrogen ion solution arrhenius basis dissociate produce excess hydroxide ion solution brønsted lowry acid specie donate hydrogen ion brønsted lowry basis specie accept lewis acid electron pair acceptor lewis basis arrhenius acid basis brønsted lowry acid basis brønsted lowry acid basis lewis acid basis converse statement necessarily true lewis acid basis brønsted lowry acid basis brønsted lowry acid basis arrhenius acid basis amphoteric specie behave acid base amphiprotic specie amphoteric specie specifically behave brønsted lowry acid

base amphiprotic specie amphoteric specie specifically behave brønsted lowry acid brønsted water classic example amphoteric amphiprotic species accept hydrogen ion hydronium ion donate hydrogen ion hydroxide ion conjugate specie polyvalent acid basis behave amphoteric amphiprotic specie water dissociation constant kw 1014 298 k.

like equilibrium constant kw affect change ph poh calculate give concentration h3o+ oh ion respectively aqueous solution ph + poh = 14 298 k. strong acid basis completely dissociate solution weak acid basis completely dissociate solution corresponding dissociation constant ka kb brønsted lowry definition acid conjugate basis form acid deprotonate basis conjugate acid form base protonate strong acid basis weak inert conjugate weak acid basis weak conjugate neutralization reaction form salt water polyvalence normality equivalent define mole specie interest acid base chemistry normality concentration acid base equivalent solution polyvalent acid basis donate accept multiple electron normality solution contain polyvalent species molarity acid base time number proton donate accept titration buffer titration determine concentration know reactant solution titrant know concentration add slowly titrand reach equivalence point titrand unknown concentration know volume half equivalence point midpoint buffer region half titrant protonate deprotonate ha = a buffer form equivalence point indicate steep slope titration curve reach number acid equivalent

original solution equal number base equivalent add vice versa strong acid strong base titration equivalence point ph = 7 weak acid strong base titration equivalence point ph > 7 weak base strong acid titration equivalence point ph < 7 weak acid weak base titration equivalence point 7 depend relative strength acid base indicator weak acid basis display different color protonate deprotonated form indicator choose titration pka close ph expect equivalence point endpoint titration indicator reach final multiple buffering region equivalence point observe polyvalent acid base titration buffer solution consist mixture weak acid conjugate salt weak base conjugate salt resist large fluctuation ph.

buffer capacity refer ability buffer resist change ph maximal buffering capacity see 1 ph point pka acid buffer solution henderson hasselbalch equation quantify relationship ph pka weak acid poh pkb weak basis solution optimally buffer ph = pka poh = pkb answer concept check dissociate form excess h+ dissociate form excess oh electron pair acceptor electron pair donor amphiprotic y hco3 + hbr h2co3 + br 3 hcl + al(oh)3 alcl3 + 3 2 hbr + zno znbr2 + h2o 1 amphoteric species act acid base 2 high ka indicate strong acid dissociate completely solution have ka slightly great water mean acid weak acid 3 high kb indicate strong base dissociate completely solution have kb slightly great water mean base weak base acid base 8.89 104 m 1.12 1011 m 1.55 109 m 6.46 106 m 5.32 109 m 1.88 × 106 m note exact answer provide round answer relatively close list 5 ka × kb = kw h2co3 + h2o hco3 + h2po4 + h2o h3po4 + 7 x 2 × 103 m actual = 1.9 × 103 m ph = log h3o+ 3 0.2 = 2.8 actual = 2.72 1 acid use mole h+ h3o+ equivalent basis use mole oh 2 6 n al(oh)3 32 n h2so4 1

buffering region occur ha a flat portion titration curve resistant change ph half equivalence point center buffer region ha = a equivalence point steep point titration curve occur equivalent acid present equal equivalent base add vice versa endpoint ph indicator turn final color 2 phenolphthalein prefer indicator titration 3 strong acid weak base equivalence point acidic range strong base weak acid equivalence point basic range strong acid strong base

equivalence point ph = 7 neutral weak acid weak base equivalence point acidic neutral basic range depend relative strength acid base 4 buffer solution design resist change ph optimal buffering capacity 1 ph point pka 5 recall section 10.2 property concentration conjugate acid conjugate base final solution calculate dilution mix solution calculation follow step leave value unsolved component cancel simplify science mastery assessment brønsted lowry base define proton acceptor ammonia fluoride water—(a b c respectively accept proton d hno2 far well brønsted lowry acid donate proton solution convert concentration 5 × 103 m. sulfuric acid strong acid assume majority sulfuric acid molecule proton dissociate concentration hydrogen ion 2 × 5 × 103 102 equation ph ph = log h+ h+ = 102 m ph = 2 answer question simply matter know nomenclature acid end ic derivative anion end ate acid end ous derivative anion end ite clo3 b chlorate oxygen commonly occur ion clo2 name chlorite hclo3 chloric acid hclo2 c represent chlorous acid hclo d represent hypochlorous acid soluble hydroxide group ia iia metal strong basis eliminate d b c weak basis methylamine contain alkyl group electron donate increase electron density nitrogen methylamine make strong lewis base ammonia gram equivalent weight acid equal molecular weight divide equivalent h+ acid produce phosphoric acid h3po4 dissociable hydrogen atom produce 3 equivalent proton molecular weight 98 g mol gram equivalent weight 98

proton molecular weight 98 g mol gram equivalent weight 98 g mol 3 equivalent mol = 32.6 gram equivalent match question ask ph information give find poh subtract 14 ph.

use henderson hasselbalch equation poh = 2.45 ph = 14 2.45 = 11.55 pka curve estimate eye locate halfway starting point base add equivalence point steep portion graph 15 ml point approximately 7–8 ml x axis correspond ph approximately 1.9 notice region experience little change ph define characteristic buffer region second equivalence point midpoint second steep increase slope correspond approximately ph = 5.9 value second pka find midpoint second equivalence point curve correspond ph = 4.1 like pka center flat buffer gram equivalent weight

weight gram release 1 acid base equivalent compound h3po4 contain 3 proton find gram equivalent weight divide mass mole species 3 molar mass phosphoric acid gram equivalent weight 32.7 g. question require application acid dissociation constant weak acid dissociate completely specie appear balanced equation present solution hydrogen ion conjugate base anion dissociate equal amount h+ = xo2 initial concentration hxo2 2 m x dissociate x h3o+ xo2 equilibrium 2 m x hxo2 note x consider negligible add subtract usual solve x high ka imply strong acid weak acid usually ka order magnitude 1 pka compound ph equal concentration acid conjugate base pka compound log 1 = 0 low pka compound acid ph concentration compound 7 amphoteric species act acid base depend environment proton transfer classic oxidation reduction reaction b true c true amphoteric specie water bicarbonate donate accept proton d false correct answer amphoteric specie polar nonpolar nature naoh strong base 1.2 × 105 m oh solution base information poh 4 5 ph 9 10 shortcut poh 5 0.12 = 4.88 ph = 14 poh = 9.12 actual = 9.08 use equivalence point equation nava = nbvb ba(oh)2 dissociate hydroxide ion normality 2 m × 2 = 4 n. h3po4 dissociate hydronium ion normality 6 m × 3 = 18 n.

plug equation 18 n)(4 l = 4 n)(vb vb 18 l. equation remember 10.1 autoionization constant water kw = h3o+][oh = 1014 25 ° c 298 k 10.2 definition ph poh 10.3 relationship ph poh 298 k ph + poh = 14 10.4 p scale value approximation p value m 0.n 10.5 acid dissociation constant 10.6 base dissociation constant 10.7 relationship ka kb 298 k 10.8 equivalence point nava = nbvb 10.9

henderson hasselbalch equation acid buffer 10.10 henderson hasselbalch equation base buffer biology chapter 6 respiratory system biology chapter 10 general chemistry chapter 3 bonding chemical interaction general chemistry chapter 9 organic chemistry chapter 4 analyze organic reactions physics math chapter 10 pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat

prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read correspond subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 consider following equation 6 na s + 2 nh3 aq 2 na3n s + 3 h2 g species act oxidize agent b. n nh3 c. h nh3 2 electron involve following half reaction cr2o72 + h+ + e cr2 + + h2o 3 lithium aluminum hydride lialh4 laboratory tendency donate hydride ion following role lithium aluminum hydride likely play reaction a. strong reduce agent b. strong oxidize agent c. strong reduce agent strong oxidize agent d. strong reduce agent strong oxidize agent 4 oxidation number chlorine naclo 5 follow electronic configuration represent element neutral form element strong oxidize agent 6 follow correct net ionic reaction reaction copper silver(i nitrate a. cu + agno3 cu(no3)2 + ag b. cu +

cu + agno3 cu(no3)2 + ag b. cu + 2 ag+ + 2 no3 cu2 + + 2 no3 + 2 ag c. 2 ag+ + 2 no3 2 no3 + 2 ag+ d. cu + 2 ag+ cu2 + + 2 ag 7 way test presence iron solution add potassium thiocyanate solution product reagent react iron fescn2 + create dark red color solution following net ionic fe3 + + scn fescn2 + gram iron sulfate need produce 2 mole a. 110 g b. 220 g c. 400 g d. 500 g 8 assigning oxidation number following element likely determine 9 methanol convert methanal methanoic acid oxidation number carbon c. increase decrease d. decrease increase 10 compound kh2po4 element high oxidation number 11

certain metal multiple oxidation state acidity oxide generally increase oxidation state increase

following tungsten compound likely strong acid 12 consider following step reaction oxalic acid chlorine i. cl2 + h2o hocl + cl + h+ ii h2c2o4 h+ + hc2o4 iii hocl + hc2o4 h2o + cl + 2 co2 step occur aqueous solution example a. b. iii c. iii d. ii iii 13 potentiometry oxidation reduction titration analogous perform acid base titration a(n a. acidic indicator b. basic indicator c. ph meter d. oxidize agent 14 balance follow oxidation reduction reaction sum stoichiometric coefficient

reactant product s8 s + no3 aq so32 aq + g 15 assay perform determine gold content supply crush ore method pull gold ore react concentrated cyanide cn solution equation provide au + nacn + o2 + h2o na[au(cn)2 + naoh indicator reaction approximately 100 ml 2 m nacn solution reach endpoint mole au present crushed ore a. 0.01 mol b. 0.02 mol c. 0.10 mol d. 0.20 mol chapter 11.1 oxidation reduction reaction oxidation reduction assign oxidation number balance oxidation reduction reaction 11.2 net ionic equation content chapter relevant 4 question general chemistry mcat chapter cover material following aamc content category 4e atom nuclear decay electronic structure atomic chemical behavior 5a unique nature water solution night emergency department ed 5- month old infant patient chart appear screen click triage note read caregiver report poor sucking ability loss head control motor skill puzzle finding previous ed admission lactic acidosis suspect diabetic ketoacidosis dka liver kidney disease possibly poisoning fit minute later child bring examination room stop cry course hour episode lactic acidosis develop child eventually admit neonatal intensive care unit long term care later ask neonatologist patient point chart genetic test perform shortly birth child diagnose leigh disease extremely rare mitochondrial disorder leigh disease number key mitochondrial enzyme disrupt process oxidative phosphorylation achieve specifically important enzyme catalyze oxidation reduction reaction pyruvate dehydrogenase complex succinate dehydrogenase complex affect pyruvate oxidize acetyl coa instead ferment lactic acid biological system oxidation coincident loss electron form hydrogen dehydrogenation enzyme catalyze oxidation call dehydrogenase macromolecule enzyme vitamin carry function

oxidize reduce compound iron hemoglobin likewise undergo round oxidation reduction carry oxygen lung chapter focus attention movement electron chemical reaction reaction call oxidation reduction redox reaction occur pair oxidation reduction reaction particularly important tie number topic organic chemistry biochemistry fact chapter 5 10 mcat

number topic organic chemistry biochemistry fact chapter 5 10 mcat organic chemistry review chapter 9 11 mcat biochemistry review touch oxidation reduction reaction different set chapter 11.1 able separate redox reaction oxidation reduction half reaction balance redox reaction identify oxidize agent reduce agent relevant oxidation state give reaction sncl2 + pbcl4 sncl4 + pbcl2 reaction involve transfer electron chemical species classify oxidation reduction oxidation reduction law conservation charge state electrical charge create destroy isolate loss gain electron occur oxidation loss electron reduction gain electron occur simultaneously result electron transfer call redox reaction oxidize agent cause atom redox reaction undergo oxidation reduce reduce agent cause atom reduce oxidize mnemonic remember term highlight sidebar redox reaction choose mnemonic stick oil rig oxidation loss electron reduction gain electron leo lion say ger loss electron oxidation gain electron reduction leora say geroa loss electron oxidation reducing agent gain electron reduction oxidize agent familiar common oxidize reduce agent save significant time test day especially organic chemistry reaction commonly agent mcat list table 11.1 note oxidize agent contain oxygen strongly electronegative element halogen reduce agent contain metal ion hydride h table 11.1 common oxidizing reduce agent f2 cl2 br2 i2 halogen sn2 + pure metal pyridinium chlorochromate pcc oxidize agent reduce agent commonly see organic biochemical redox reagent act energy carrier note biochemical redox reagent nad+ tend act oxidize reduce agent different time metabolic pathway act mediator energy transfer metabolic process show figure 11.1 figure 11.1 oxidation reduction biochemical compound serve method energy transfer technical level term oxidize agent reduce agent apply specifically atom gain lose electron respectively science text describe compound cro3 cr6 + oxidize assign oxidation number

important course know atom oxidize reduce oxidation number assign atom order track redistribution electron chemical reaction base oxidation number reactant product possible determine electron gain lose

base oxidation number reactant product possible determine electron gain lose atom chapter 3 mcat general chemistry review illustrate metal form cation nonmetal form anion form cation metal lose electron metal like oxidize lose electron act good reduce agent nonmetal hand like reduce gain electron act good oxidize agent oxidation number atom compound assign accord following rule 1 oxidation number free element zero example atom n2 p4 s8 oxidation number zero 2 oxidation number monatomic ion equal charge ion example oxidation number na+ cu2 + fe3 + cl n3 +1 +2 +3 1 3 respectively 3 oxidation number group ia element compound +1 4 oxidation number group iia element compound +2 5 oxidation number group viia element compound 1 combine element high electronegativity example hcl oxidation number cl 1 hocl oxidation number cl +1 6 oxidation number hydrogen usually +1 oxidation number 1 compound electronegative element groups ia iia hydrogen +1 hcl 1 nah.

7 compound oxidation number oxygen 2 exception peroxide o22 charge oxygen 1 compound electronegative element of2 oxygen +2 charge 8 sum oxidation number atom present neutral compound zero sum oxidation number atom present polyatomic ion equal charge ion so42 sum oxidation number 2 think oxidation number typical charge element base group number metallicity general location periodic table convention formula writing cation anion second hcl imply h+ nah imply h–. use way compound write mcat periodic table determine oxidation state forget click periodic table pull test day note trend assign oxidation number general rule help reduce need memorize individual oxidation number aware transition metal multiple oxidation state multiple oxidation number oxidation number confuse formal charge discuss chapter 3 mcat general chemistry review account perceive charge element different way oxidation number assume unequal division electron bond award

electron electronegative element formal charge hand assume equal division electron bond award electron atom bond reality distribution electron density lie extreme assigning oxidation number see figure 11.2 figure 11.2 assign oxidation number carbon dioxide assign oxidation number start know atom usually group ii halide oxygen use information determine oxidation state atom mind transition metal multiple oxidation state transition metal oxidize reduce absorption emission light metal alter different frequency absorb reason change oxidation state transition metal usually correspond color example assign oxidation number atom follow reaction determine oxidize reduce agent sncl2 + pbcl4 sncl4 + pbcl2 solution specie neutral oxidation number compound add zero sncl2 tin oxidation number +2 chlorine present chlorine oxidation number 1 similarly oxidation number sn sncl4 +4 oxidation number pb +4 pbcl4 +2 pbcl2 oxidation number sn go +2 +4 lose electron oxidize make reduce agent oxidation number pb decrease +4 +2

gain electron reduce make oxidize agent sum charge side reaction equal zero charge conserve mind oxidation state play role nomenclature reactant reaction call tin(ii chloride lead(iv chloride assign oxidation number reactant product determine mole specie require conservation charge mass necessary balance equation balance redox reaction net charge number atom equal side equation common method balance redox equation half- reaction method know ion electron method equation separate half reaction oxidation reduction half reaction balance separately add balanced overall oxidize agent oxidize molecule reduce reduce agent reduce molecule oxidize determine ion oxidize agent reduce agent example balance redox reaction half reaction method mno4 + l l2 + mn2 + step 1 separate half reaction step 2 balance atom half reaction balance atom h o. acidic solution add h2o balance o atom add h+ balance h atom basic solution use oh h2o balance o h atom step 3 balance charge half reaction add electron necessary reaction charge equal side step 4 half reaction number electron cancel step example need multiply oxidation half reaction 5 reduction half reaction 2 step 5 add half reaction cancel term appear side reaction arrow 2 mno4 + 16 h+ +

10 i 2 mn2 + + 5 i2 + 8 h2o step 6 confirm mass charge balance +4

net charge reaction equation atom stoichiometrically methodical step step approach like half reaction method great mcat usually step narrow answer choice able find correct answer partway problem little critical thinking mcat concept check 11.1 assess understanding material 1 reaction identify oxidation state relevant atom oxidize agent reduce agent 2 ki + h2 2 k + 2 al + bpo4 b + 2 identify oxidation reduction half reaction follow redox zn + cu2 + zn2 + + cu 3 balance following redox reaction half reaction method mg s + hno3 aq mg2 + aq + g 11.2 net ionic equations chapter 11.2 able identify element undergo disproportionation oxidation state product give reaction apply redox reaction principle balance solve application style problem one involve redox titration determine net ionic equation reaction zn s + cuso4 aq cu s + znso4 aq discuss reaction type chapter 4 mcat general chemistry review leave rationale certain element come discuss oxidation reduction reaction clear gain loss electron drive formation compound especially ionic one revisit important reaction type understand basis oxidation reduction reaction discussion acid basis focus presence proton hydroxide ion little concern specie actually provide ion similarly redox reaction focus shifting electron identity ion consider following single displacement zn s + cuso4 aq cu s + znso4 aq split specie ion present complete ionic equation zn s + cu2 + aq + so42 aq cu s + zn2 + aq + so42 aq note sulfate ion present side equation form ion chemically inert reaction word sulfate take overall reaction simply remain solution unchanged species spectator ion sulfate ion involve oxidation reduction reaction simplify reaction net ionic equation show specie actually participate zn s + cu2 + aq cu s + zn2 + aq write net ionic equation aqueous

s + zn2 + aq write net ionic equation aqueous compound split constituent ion solid salt hand keep single entity let return reaction see previously include combination decomposition combustion double displacement metathesis look compound polyatomic anion retain charge reaction usually spectator ion find net ionic equation combination reaction specie come form

product example relevant half reaction net ionic equation reaction molecular hydrogen act reduce agent oxidize 0 +1

molecular fluorine oxidize agent reduce 0 1 reaction spectator ion decomposition reaction product break specie example relevant half reaction net ionic equation 2 nh4 + + cr2o72 n2 + cr2o3 + 4 h2o reaction nitrogen atom ammonium cation act reduce agent oxidize 3 0 chromium dichromate anion act oxidize agent reduce +6 +3 reaction spectator ion note net ionic equation significantly different original balanced combustion reaction fuel usually hydrocarbon mix oxidant usually oxygen form carbon dioxide water relevant half reaction net ionic equation identical overall balanced equation spectator ion aqueous specie ch4 + 2 o2 co2 + 2 h2o combustion reaction complex half reaction depend type fuel instance carbon methane reduce agent oxidize 4 +4 molecular oxygen oxidize agent reduce 0 2 double displacement metathesis reaction involve switching counterion ion generally retain oxidation state usually oxidation reduction reaction specie retain oxidation number consider oxidation reduction net ionic reaction ag+ + cl agcl nitrate anion hydrogen cation act spectator ion double displacement reaction reactant product aqueous net ionic reaction example reaction oxidation reduction reaction specie change oxidation state specie aqueous complete ionic reaction na+ + no3 + h+ + cl h+ + no3 + na+ + cl ion appear side reaction net ionic reaction disproportionation dismutation specific type redox reaction element undergo oxidation reduction produce product biological enzyme utilize disproportionation mechanism example reaction catalysis peroxide catalase enzyme find peroxisome catalase critical biological enzyme protect cell excessive oxidation free radical reactive oxygen specie activity catalase see disinfect wound see reaction oxygen disproportione water molecular oxygen hydrogen peroxide oxygen oxidation state 1 peroxide ion charge 2 overall water oxygen oxidation state 2 molecular oxygen oxidation state 0

oxygen reduce oxidize reaction related biological disproportionation mechanism enzyme

superoxide dismutase imply dismutase catalyze dismutation enzyme disproportion oxygen free radical reaction peroxide oxygen disproportioned product oxidation state oxygen free radical negative charge divide oxygen atom reduce 1 peroxide oxidize 0 molecular oxygen biochemical disproportionation reaction oxidation reduction reaction biological system general usually accomplish enzyme structurally enzyme metal cu zn active site act reduce agent show figure 11.3 figure 11.3 active site superoxide dismutase cu zn atom act reduce agent lose electron catalysis atom stabilize position histidine residue oxidation reduction titration similar setup acid base titration focus different acid base titration follow movement proton discuss chapter 10 mcat general chemistry review redox titration follow transfer charge electron reach equivalence point redox titration utilize indicator change color particular voltage emf value common indicator list table 11.2 acid base titration necessary memorize indicator understand utility table 11.2 common indicator oxidation reduction redox titration voltage color voltage color +1 v +0.24 /–0.29 v safranin unique color change voltage dependent prototypical redox titration involve use starch indicator identify iodine complex specific redox titration call iodimetric titration rely titration free iodine radical presence iodine initially determine dark solution presence starch endpoint titration colorless solution develop common general chemistry laboratory experiment involve standardization thiosulfate solution iodimetry describe example example group student prepare standardize na2s2o3 solution 32 ml na2s2o3 solution titrate 50 ml 0.01 m kio3 solution reach equivalence point titrate kio3 solution lose color add starch indicator reaction complete reaction proceed step determine concentration sodium thiosulfate solution beginning experiment solution titration perform step step iodate convert triiodide anion initial titration create colorless l3 solution water require starch indicator remainder second step triiodide ion reduce presence thiosulfate determine concentration note reaction unbalanced tempting balance equation io3 + 2 i + 6 h+ i3 + 3 h2o reaction

i + 6 h+ i3 + 3 h2o reaction charge +3 reactant 1 product oxidation reduction chemistry

balance stoichiometry charge correct balanced equation

keep mind iodate triiodide anion triiodide anion interact thiosulfate anion mole ratio thiosulfate iodate use stoichiometry determine molarity thiosulfate solution 50 ml potassium iodate solution use volume find molarity potentiometric titration form redox titration indicator instead electrical potential difference voltage measure voltmeter redox titration progress voltage change analogous follow acid base titration ph meter instead color indicator mcat concept check 11.2 assess understanding material 1 write net ionic equation reaction cuno3 aq + nacl aq cucl s + nano3(aq mg s + alcl3 aq al s + mgcl2 aq 2 reaction element undergo disproportionation element oxidation state 3 cl2 g + 6 naoh aq 5 nacl aq + naclo3 aq + 3 h2o l s2o32 aq + 2 h+ aq s s + so2 g + h2o l element undergo disproportionation oxidation state product element undergo disproportionation oxidation state product 3 sample assay lead redox titration i3 aq 10.00 g sample crush dissolve sulfuric acid pass reduce agent lead form pb2 + pb2 + aq completely oxidize pb4 + 32.60 ml 0.7 m solution nai3 balanced equation reaction i3 + aq + pb2 + aq pb4 + aq + 3 i aq calculate mass lead sample chapter cover essential mcat topic oxidation reduction reaction review rule assign oxidation number help track movement electron specie oxidize reduce agent specie reduce oxidize agent cover sequence step involve balance half reaction redox titration addition understand fundamental chemical principle reaction begin concept resurface mcat organic chemistry review mcat biochemistry review oxidation reduction reaction energy transfer biological system deficiency system profoundly deleterious metabolic mitochondrial immunologic disease chapter mcat general chemistry review bring principle oxidation reduction reaction application electrochemical cell end chapter review general chemistry knowledge require test day review content test knowledge critical thinking skill complete test like passage set

test knowledge critical thinking skill complete test like passage set online resource oxidation loss electron reduction gain electron pair know oxidation reduction redox reaction oxidize

agent facilitate oxidation compound reduce process reduce agent facilitate reduction compound oxidize common oxidize agent contain oxygen similarly electronegative element common reduce agent contain metal ion hydride assign oxidation number know common oxidation state representative element free element diatomic species oxidation number oxidation number monatomic ion equal charge ion compound group ia metal oxidation number +1 group iia metal oxidation number compound group viia element oxidation number 1 combine element high oxidation state hydrogen +1 pair electronegative element case 1 oxidation state oxygen usually 2 peroxide charge 1 compound sum oxidation number atom present compound equal overall charge compound balance redox reaction

half reaction method call ion electron method common separate half reaction balance atom half reaction start element h o. acidic solution balance h o water h+ basic solution balance h o water oh–. balance charge half reaction add electron necessary reaction multiply half reaction necessary obtain number electron half reaction add half reaction cancel term side confirm mass charge balance net ionic equation complete ionic equation account ion present reaction write complete ionic reaction split aqueous compound relevant ion solid salt intact net ionic equation ignore spectator ion focus specie actually participate reaction obtain net ionic reaction subtract ion appear side reaction call spectator ion reaction contain aqueous salt net ionic equation generally overall balanced reaction double displacement metathesis reaction form solid salt net ionic reaction ion remain solution change oxidation number disproportionation dismutation reaction type redox reaction element oxidize reduce form molecule contain element different oxidation state oxidation reduction titration similar methodology acid base titration titration follow transfer charge indicator titration change color certain voltage solution achieve potentiometric titration form redox titration voltmeter external cell measure electromotive force emf solution indicator equivalence point determine sharp change voltage answer concept check 2 ki + h2 2 k + 2 hi k+ charge go +1 0 h2 charge go 0 +1 al + bpo4 b b3 + charge go +3 0 al charge go 0 +3)2

2 oxidation zn zn2 + + 2 e reduction cu2 + + 2 e cu 1 cu+ + cl cucl 3 mg + 2 al3 + 3 mg2 + + 2 al forget balance reaction 2 reaction chlorine undergo disproportionation 1 oxidation state nacl +5 oxidation state naclo3 second reaction sulfur undergo disproportionation 0 oxidation state elemental sulfur +4 oxidation state so2 note question 3 include extraneous value 10.0 g need calculate mass lead produce science mastery assessment oxidize agent species reduce give equation problem hydrogen atom +1 oxidation state nh3 reduce neutral h2 molecule balance atom equation adjust number electron balance charge currently left charge +12 2 dichromate +14 proton right charge +4 +2 chromium cation decrease charge left +12 +4 add 8 electron hydride ion compose hydrogen nucleus electron give negative charge considerable tendency donate electron lialh4 strong reduce agent strong reduce agent tend metal hydride strong oxidize agent tend oxygen similarly naclo sodium hypochlorite sodium carry typical +1 charge oxygen carry typical 2 charge mean chlorine atom carry +1 charge order balance overall charge zero strong oxidize agent easily reduce mean tendency gain electron atom usually gain electron electron away fill valence shell 4s orbital mean gain electron gain entire subshell b stable half 3d orbital unlikely pick electron gain c single electron outer shell likely lose ionization d fill 4p orbital gain electron easily reduce net ionic equation represent aqueous ion comprise reactant product individual ion instead combine formula unit net ionic reaction term net mean correct answer include spectator ion ion participate reaction reaction nitrate no3 remain unchanged b c show net ionic equation mole fescn create mole fe3 + mole ratio 1:1 iron sulfate formula fe2(so4)3 sulfate charge 2 iron charge +3 base net ionic equation mole iron sulfate need

charge +3 base net ionic equation mole iron sulfate need mole iron reaction molar mass iron sulfate closely match answer c common error calculate iron 111.6 g assign oxidation number

start element know oxidation state determine oxidation state element deduction noble gas

argon oxidation state 0 group viia element fluorine b oxidation state 0 1 compound group iia element strontium c oxidation state 0 +2 compound like transition metal iridium d oxidation state range 3 +8 determine oxidation state atom iridium contain compound determine iridium formula methanol h3coh methanal hcho methanoic acid hcooh assign oxidation number carbon molecule start 2 0 +2 general easy think oxidation gain bond oxygen similarly electronegative element loss bond hydrogen organic compound carbon oxidize convert alcohol aldehyde carboxylic acid oxidation number increase start atom oxidation state certain potassium group ia metal oxidation state +1 hydrogen +1 pair electronegative element case oxygen generally 2 oxygen create total negative charge 8 partially balance hydrogen +2 potassium +1 phosphorus +5 charge make high oxidation state recall oxygen oxidation state 2 tungsten(iv oxide tungsten oxidation state +4 tungsten(vi oxide b oxidation state +6 tungsten(iii oxide c +3 tungsten pentoxide d +5 step disproportionation reaction chlorine start oxidation state 0 reactant end oxidation state +1 hocl 1 cl–.

reaction element appear different oxidation state different product step disproportionation reaction potentiometry refer carry oxidation reduction titration voltmeter present precise reading reaction electromotive force emf determine endpoint analogous ph meter acid base titration use technology precise reading plot titration curve indicator b acid base redox titration provide qualitative quantitative analysis titration oxidize reduce agent redox titration acid base titration eliminate d utilize method describe early balance redox reaction balanced half reaction equal number electron half reaction oxidation half reaction multiply 3 reduction half reaction multiply 32 make overall reaction sum stoichiometric coefficient 3 + 32 + 8 + 24 + 32 + 16 = 115 balance chemical equation 4 au + 8 nacn + o2 + 2 h2o 4 na[au(cn)2 + 4 naoh

determine number mole nacn reaction 0.2 mol nacn reaction 0.2 mol = 0.1 mol au oxidize consult online resource additional practice biochemistry chapter 2 biochemistry chapter 10 carbohydrate metabolism ii biology chapter 7 cardiovascular system general chemistry

chapter 10 acid basis general chemistry chapter 12 organic chemistry chapter 4 analyze organic reaction pre med know feeling content know mcat know high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online resource guidance help ensure spend appropriate time chapter base personal strength weakness worry skip mean study later prep complete length test uncover specific piece content need review come chapter appropriate use assessment answer 0–7 question correctly spend 1 hour read chapter limited note follow review quiz question ensure understand solve answer 8–11 question correctly spend 20–40 minute review quiz question begin question miss read note correspond subchapter question answer correctly ensure thinking match explanation understand choice correct incorrect answer 12–15 question correctly spend 20 minute review question quiz miss include quick read corresponding subchapter relevant content subchapter question review question answer correctly ensure thinking match explanation review concept summary end 1 rusting occur oxidation reduction reaction iron 4 fe s + 3 o2 g 2 fe2o3 s metal react oxygen fashion follow well explain iron a. iron positive reduction potential metal make likely donate electron oxygen b. iron positive reduction potential metal make likely accept electron oxygen c. iron positive reduction potential metal make likely donate electron oxygen

d. iron positive reduction potential metal make likely accept electron oxygen 2 give following standard reduction potential standard electromotive force following reaction zn2 + + 2 ag 2 ag+ + zn a. 2.2 v b. 1.1 v c. +1.1 v d. +2.2 v 3 consider following datum anode certain galvanic cell compose copper metal datum table cathode assume equal concentration electrolyte solution 4 electrolytic cell fill water following cathode cell i. h+ ion ii o2 ion a. b. ii c. iii d. ii iii 5 value e ° cell know data need calculate δg ° a. equilibrium constant b. reaction quotient c. temperature system d. half reaction cell 6 following compound likely find salt bridge galvanic cell 7 surface area electrode material electrochemical cell triple necessarily triple a. b. ii c. ii d. ii iii 8 following alter emf electrochemical cell a. mass electrode b. length wire connect half cell

c. overall size battery d. temperature solution half cell 9 following statement true na cd cell base information a. galvanic cell sodium cathode b. electrolytic cell cadmium anode c. galvanic cell e ° cell = 3.11 v. d. electrolytic cell e ° cell = 3.11 v. 10 following expression correctly describe relationship standard electromotive force standard change free energy a. δg ° = nf(e ° red anode e ° red cathode d. δg ° = nf(e ° red anode e ° red cathode 11 follow choice indicative spontaneous reaction assume standard condition a. e ° cell negative b. q = keq c. cell concentration cell d. keq > 1 12 cell following half reaction decrease ph solution inside cell affect electromotive force emf a. emf decrease b. emf remain c. emf increase d. emf zero 13 electrolytic cell necessarily a. δs ° > 0

b. δg ° < 0 c. keq < 1 cell > 0 14 follow good explanation fact large mass electrode require lead acid battery compare battery produce certain current a. lead acid electrolyte sulfuric acid diprotic incompletely dissociate solution b. energy density lead acid electrode high c. electrolyte battery readily dissociate lead d. energy density lead acid electrode low 15

follow well describe charge ni cd battery a. energy density ni cd battery high store charge battery mass b. electrode ni cd battery discharge circuit fully charge c. ni cd battery stop accept electron outside source electrode recharge d. ni cd battery high surge current dissipate overcharge damage occur electrode answer key follow page chapter 12.1 electrochemical cell galvanic voltaic cell electrode charge designation 12.2 cell potential electromotive force 12.3 electromotive force thermodynamic gibbs free energy content chapter relevant 6 question general chemistry mcat chapter cover material following aamc content category 1d principle bioenergetics fuel molecule metabolism 3a structure function nervous endocrine system way system coordinate organ system 4c electrochemistry electrical circuit element 5e principle chemical thermodynamic kinetic mitochondrion powerhouse energy primary purpose manufacture deliverable usable form energy aware complex process potential energy chemical bond carbohydrate amino acid lipid convert potential energy phosphate bond

adenosine triphosphate atp atp deliver different part cell energize process essential maintenance life mitochondrion generate tremendous amount atp human average daily turnover atp 50 kilogram continuous supply replenishment atp survive atp power contraction heart muscle maintain membrane potential essential neurological function thousand essential role mitochondria manufacture packet life sustain energy remember mitochondrion rely double membrane structure carry electron transport chain oxidative phosphorylation mitochondrion truly act battery cell fact note similarity proton motive force mitochondria electromotive force electrochemistry term thing similar mitochondrion battery function similar way specifically mitochondrion function similarly concentration cell concentration cell mitochondrion concentration gradient ion separate compartment connect mean charge conduction establish electrical potential difference voltage voltage call electromotive force concentration cell proton motive force mitochondria provide drive charge compartment create current concentration cell oxidation reduction reaction take place electron direction cause concentration gradient dissipate mitochondria charge buildup form hydrogen ion proton gradient intermembrane space matrix embed inner membrane atp synthase serve dual role

space matrix embed inner membrane atp synthase serve dual role proton channel catalyst formation high energy phosphate bond atp hydrogen ion flow electrochemical gradient energy dissipate energy harness atp synthase form final chapter mcat general chemistry review focus attention study electrochemical cell utilize knowledge oxidation reduction reaction chapter 11 study principle apply create different type electrochemical cell include galvanic voltaic electrolytic concentration cell thermodynamic electrochemistry focus significance reduction potential examine relationship electromotive force equilibrium constant gibbs 12.1 electrochemical cell chapter 12.1 able distinguish electrolytic galvanic cell describe electrolytic galvanic cell predict electrode act cathode anode electrolytic calculate δg emf value give galvanic electrolytic cell apply nernst equation electrochemical cell question

electrochemical cell contain system oxidation reduction reaction occur fundamental type electrochemical cell galvanic cell know voltaic cell electrolytic cell concentration cell addition specific commercial cell ni cd battery understand fundamental model galvanic cell concentration cell house spontaneous reaction electrolytic cell contain nonspontaneous reaction remember spontaneity indicate change gibbs free energy δg type contain electrode oxidation reduction place electrochemical cell electrode oxidation occur call anode electrode reduction occur call cathode descriptor electrochemical cell include electromotive force emf correspond voltage electrical potential difference cell emf positive cell able release energy $\delta g < 0$ mean spontaneous emf negative cell absorb energy $\delta g > 0$ mean nonspontaneous electrode electrochemical cell ox red cat anode site oxidation reduction occur cathode furthermore state electrochemical cell movement electron anode cathode current run cathode anode point point confusion student physic typical state current direction flow positive charge circuit model propose ben franklin

continue physicist modern chemist interested flow electron discuss current theoretical flow positive charge proxy flow electron current flow electron equal magnitude opposite direction electron electrochemical cell opposite flow current important note battery influence temperature change instance lead acid battery car like galvanic cell tend fail cold weather thermodynamic reason discuss later galvanic voltaic cells nonrechargeable battery galvanic cell call voltaic cell accordingly household battery supply energy flashlight remote control reaction cell spontaneous mean reaction free energy decrease $\delta g < 0$

cell release energy environment extension free energy change negative cell electromotive force ecell positive free energy change electromotive force opposite sign galvanic cell commonly battery worthwhile produce energy power device appliance battery spontaneous let examine inner working galvanic voltaic cell electrode distinct chemical identity place separate compartment call half cell electrode connect conductive material copper wire wire

component circuit resistor capacitor focus surround electrode aqueous electrolyte solution compose cation anion show daniell cell illustrate figure 12.1 cation half cell solution element respective metal electrode connect solution structure call salt bridge consist inert salt electrode connect conductive material charge begin flow result oxidation reduction reaction take place half cell redox reaction galvanic cell spontaneous change gibbs free energy reaction negative δg < 0 spontaneous reaction proceed equilibrium movement electron result conversion electrical potential energy kinetic energy separate reduction oxidation half reaction compartment able harness energy use work connect electrical device circuit electrode figure 12.1 daniell cell galvanic cell zinc anode copper cathode electrode bathe electrolyte solution contain cation daniell cell zinc electrode place aqueous znso4 solution copper electrode place aqueous cuso4 solution anode cell zinc bar zn s oxidize zn2 + aq cathode copper bar site reduction cu2 + aq cu s half cell reaction write follow net reaction discuss calculation cell potential section appreciate calculation accomplish know half reaction half cell separate cu2 + ion react directly zinc bar useful electrical work solution electrode physically separate connect conductive material complete circuit wire provide electron flow reaction soon stop excess positive charge build anode excess negative charge build cathode eventually excessive charge accumulation provide countervoltage large prevent oxidation reduction reaction take place current cease charge gradient dissipate presence salt bridge permit exchange cation anion salt bridge contain inert electrolyte usually kcl nh4no3 contain ion react electrode ion solution anion salt bridge

nh4no3 contain ion react electrode ion solution anion salt bridge cl diffuse solution anode znso4 balance charge newly create zn2 + ion cation salt bridge k+ flow solution cathode cuso4 balance charge sulfate ion leave solution cu2 + ion reduce cu precipitate electrode precipitation process cathode call plating galvanization purpose salt bridge exchange anion cation balance dissipate newly generate charge course reaction electron flow zinc anode wire copper cathode voltmeter connect measure electromotive force mention early anion cl flow

externally salt bridge znso4 cation k+ flow externally salt bridge cuso4 flow deplete salt bridge finite quantity cu2 + solution account relatively short lifespan cell electron flow electrochemical cell c order alphabet electron flow anode cathode type electrochemical cell cell diagram shorthand notation represent reaction electrochemical cell cell diagram daniell cell zn s | zn2 + 1 m || cu2 + 1 m | cu s following rule construct cell diagram 1 reactant product list left right form anode | anode solution concentration || cathode solution concentration | cathode 2 single vertical line indicate phase boundary 3 double vertical line indicate presence salt bridge type barrier recognize understand shorthand cell notation electrochemical cell test day passage frequently use format spell reaction place anode cathode compare contrast galvanic electrolytic cell important straight remain consistent type cell differ type electrochemical cell reduction reaction occur cathode oxidation reaction occur anode current flow cathode anode electron flow anode cathode electrolytic cell characteristic behavior opposite galvanic cell galvanic cell house spontaneous oxidation reduction reaction generate electrical energy electrolytic cell house nonspontaneous reaction require input energy proceed change free energy electrolytic cell positive type oxidation reduction reaction drive external voltage source call electrolysis chemical compound decompose example electrolytic cell drive nonspontaneous decomposition water oxygen hydrogen gas example electrolysis molten nacl illustrate figure 12.2 figure 12.2 electrolysis

example electrolysis molten nacl illustrate figure 12.2 figure 12.2 electrolysis molten nacl electrolysis nonspontaneous electrode anode cathode consist material long resist high temperature corrosion process electrolytic cell molten nacl decompose cl2 g na l external voltage source battery supply energy sufficient drive oxidation reduction reaction direction thermodynamically unfavorable nonspontaneous example na+ ion migrate cathode reduce na l time cl ion migrate anode oxidize cl2 g notice half- reaction need separate different compartment desire reaction nonspontaneous note sodium liquid temperature molten nacl dense molten salt easily remove float reaction vessel cell industry major means sodium

chlorine production wonder work obtain pure sodium chlorine remember element find naturally elemental form reactive use elemental sodium chlorine gas reaction manufacture process michael faraday define certain quantitative principle govern behavior electrolytic cell theorize chemical change induce electrolytic cell directly proportional number mole electron exchange oxidation reduction reaction number mole exchange determine balance half reaction general reaction involve transfer n electron mn+ + n e m s faraday law state liberation gas deposition element electrode directly proportional number electron transfer oxidation reduction reaction normality gram equivalent weight observation proxy measurement current flow circuit accord equation mole metal m s logically produce n mole electron supply mole mn+ additionally number mole electron need produce certain m s relate measurable electrical property charge electron carry charge 1.6 × 10–19 coulomb c charge carry mole electron calculate multiply number avogadro number number call faraday constant faraday f equivalent charge contain mole electron 1 f = 96,485 c equivalent mcat round number calculation faraday f equivalent charge contain mole electron 1 f = 96,485 c

electrodeposition equation summarize process help determine number mole element deposit mol m metal ion deposit specific electrode current t time n number electron equivalent specific metal ion f faraday constant equation determine gas liberate electrolysis electrodeposition equation calculate mole metal fun example mass copper deposit daniell cell current 2 flow cell 3 hour solution use equation daniell cell use copper electrode copper sulfate cuso4 solution oxidation state copper solution +2 n = 2 plug equation determine actual mass copper deposit 0.1 mol cu mass 6.35 g molar mass copper actual = 7.11 g concentration cell special type galvanic cell like galvanic cell contain half cell connect conductive material allow spontaneous oxidation reduction reaction proceed generate current deliver energy distinguish characteristic concentration cell design electrode chemically identical example electrode copper metal reduction potential current generate function concentration gradient establish solution surround electrode concentration gradient result potential difference

compartment drive movement electron direction result equilibration ion gradient current stop concentration ionic specie half cell equal imply voltage v electromotive force concentration cell zero concentration equal voltage function concentration calculate nernst equation biological system concentration cell well represent cell membrane neuron show figure 12.3 sodium potassium cation chlorine anion exchange need produce electrical potential actual value depend concentration charge ion way rest membrane potential vm maintain disturbance rest membrane potential sufficiently large stimulate firing action potential figure 12.3 cell membrane example concentration cell electrochemical gradient create separation ion cell membrane analogous cell electrode compose material maintenance rest membrane potential discuss chapter 8 mcat biochemistry review conduction action potential discuss chapter 4 mcat biology review transfer ion electron action potential produce biochemical work rechargeable cell rechargeable battery function galvanic electrolytic cell lead acid battery know lead storage battery specific type rechargeable battery voltaic cell fully charge consist half cell pb anode porous pbo2 cathode

fully charge consist half cell pb anode porous pbo2 cathode connect conductive material concentrate 4 m h2so4 fully discharge consist pbso4 electroplate lead electrode dilute concentration h2so4 show figure 12.4 figure 12.4 lead acid battery charge cell contain pb anode pbo2 cathode discharge b electrode coat lead oxidation half reaction lead negative anode reduction half reaction lead(iv oxide positive cathode half reaction cause electrode plate lead sulfate pbso4 dilute acid electrolyte discharge lead anode negatively charge attract anionic bisulfate lead(iv oxide cathode bit complicated electrode porous allow electrolyte sulfuric acid solvate cathode lead oxide ion hydrogen ion solution react oxide ion produce water remain sulfate ion react lead produce electroplate lead sulfate overall net equation discharge lead acid battery charge

lead acid cell electrolytic circuit equation electrode charge designation opposite external

source reverse electroplating process concentrate acid solution external source evident use jumper cable restart car lead acid battery compare cell low energy weight ratio know energy density energy density measure battery ability produce power function weight lead acid battery require heavy battery material produce certain output compare battery nickel cadmium battery rechargeable cell consist half cell solid cadmium anode nickel(iii oxide hydroxide cathode connect conductive material typically potassium hydroxide koh familiar aa aaa cell ni cd material inside electrode layer wrap cylinder show figure 12.5 figure 12.5 nickel cadmium battery 1 metal casing 2 salt bridge 3 nio(oh cathode 4 cd anode oxidation half reaction cadmium negative anode reduction half reaction nickel oxide hydroxide positive half reaction cause electrode plate respective product overall net equation ni cd battery previous example charging reverse electrolytic cell potential ni cd design vent reason allow release build hydrogen oxygen gas ni cd battery high energy density lead acid battery electrochemistry ni cd half reaction tend provide high surge current surge current period large current amperage early discharge cycle preferable appliance remote control demand rapid response important note modern ni cd battery largely replace efficient nickel metal hydride nimh battery new battery energy density cost effective significantly toxic suggest lieu pure metal anode metal hydride electrode charge designations galvanic cell current spontaneously generate electron release oxidize specie anode travel conductive material cathode reduction take place anode galvanic cell source electron consider negative electrode cathode consider positive electrode show figure 12.1 previously electron negative low electrical potential positive high electrical potential current flow positive charge positive high electrical potential negative low galvanic cell anode negative conversely anode electrolytic cell consider positive attach positive pole external voltage source attract anion solution cathode electrolytic cell consider negative

voltage source attract anion solution cathode electrolytic cell consider negative attach negative pole external voltage source attract cation solution galvanic cell anode negative

cathode positive electrolytic cell anode positive cathode negative external source reverse charge electrolytic cell type cell reduction occur cathode oxidation occur anode cation attract cathode anion attract anode spite difference designate charge sign oxidation take place anode reduction take place cathode type cell electron flow wire anode cathode current flow cathode anode finally note regardless charge designation cathode attract cation anode attract anion daniell cell example electron create anode oxidation elemental zinc travel wire copper half cell attract copper(ii cation cathode result reduction copper ion elemental copper draw cation salt bridge compartment anode having lose electron attract anion salt bridge time zinc(ii ion form oxidation process dissolve away anode recognize system battery place important line cathode anode electronic tend + designation line electrode think jumper cable television remote button battery watch important rule understand electrochemistry chemical physical foundations biological systems section test day electrophoresi section biological biochemical foundations living systems isoelectric focusing technique separate amino acid polypeptide base isoelectric point pi positively charge amino acid protonate solution ph migrate cathode negatively charge amino acid deprotonate solution ph migrate anode technique isoelectric focusing discuss detail chapter 3 mcat anion attract anode cation attract cathode true regardless type cell galvanic electrolytic concentration cell mcat concept check 12.1 assess understanding material 1 circle electrode following statement describe galvanic voltaic cell site oxidation electron flow current flow designation 2 circle electrode following statement describe site oxidation electron flow current flow designation 3 write cell diagram discharge state lead acid battery 4 type cell positive δg positive ecell 5 current require produce 0.23 kg na molten nacl electrolytic cell run 30 hour assume cell 100 efficient 6 fill following chart summarize electrode

assume cell 100 efficient 6 fill following chart summarize electrode charge designation battery analyze 12.2 cell potential chapter 12.2 able describe standard reduction potential measure explain importance sign electromotive force determine cell give reaction galvanic electrolytic

calculate net e value redox reaction specie galvanic cell direction spontaneous movement charge anode site oxidation cathode site reduction simple remember beg question determine electrode specie oxidize reduce relative tendency different chemical specie reduce determine experimentally tendency hydrogen ion h+ reduce arbitrary zero reference point reduction potential measure volt v define relative standard hydrogen electrode give potential 0 v convention specie reaction oxidize reduce determine reduction potential species define tendency species gain electron reduce species intrinsic reduction potential positive potential great tendency standard reduction potential e ° red measure standard condition 25 ° c 298 k 1 atm pressure 1 m concentration relative reactivity different half cell compare predict direction electron flow positive e ° red mean great relative tendency reduction occur positive e ° red mean great relative tendency oxidation occur reduction potential exactly sound like tell likely compound reduce positive value likely reduce want reduce galvanic cell electrode positive reduction potential cathode electrode positive reduction potential anode species strong tendency gain electron want gain electron electrolytic cell electrode positive reduction potential force external voltage source oxidize anode electrode positive reduction potential force reduce cathode movement electron direction tendency desire respective electrochemical specie reaction nonspontaneous δg positive example give follow half reaction e ° red value determine specie oxidize reduce galvanic cell red indicate reduction potential likelihood compound reduce give reaction positive e ° red value indicate spontaneous reduction negative value indicate non spontaneous reduction galvanic cell ag+ spontaneously reduce ag s tl s spontaneously oxidize tl+ ag+ positive red favorable reduction reaction net ionic equation ag+ + tl s tl+ +

net ionic equation ag+ + tl s tl+ + ag s sum spontaneous half reaction note reduction oxidation opposite process obtain oxidation potential give half reaction reduction half reaction sign reduction potential reverse instance example oxidation half reaction oxidation potential tl s note example battery give lead acid storage battery nickel cadmium battery oxidation half-

reaction give reduction potential reverse reaction quantity equal magnitude opposite sign mcat reduction potential generally give oxidation potential reference book exception thallium example immediately give reduction potential oxidation potential electromotive force standard reduction potential calculate standard electromotive force emf e ° cell reaction difference potential voltage half cell standard condition emf reaction determine calculate difference reduction potential e ° cell = e ° red cathode e ° red anode subtract standard potential multiply number mole oxidize reduce potential electrode depend size electrode material identity material standard reduction potential electrode change chemical identity electrode change need multiply half reaction common denominator cancel electron come net ionic equation multiply reduction potential e ° number indicate change chemical identity electrode example give standard reduction potential sm3 + rhcl6]3 2.41 v +0.44 v respectively calculate electromotive force sm3 + + rh + 6 cl rhcl6]3 + sm solution determine oxidation reduction half reaction write rh oxidize sm3 + reduce simply difference samarium(iii reduction potential hexachlororhodate(iii reduction potential need change sign hexachlororhodate(iii reduction potential subtract samarium(iii equation

provide emf calculate 2.41 v +0.44 v = 2.85 v. cell electrolytic instead galvanic cell reaction proceed spontaneously left reactant case sm oxidize rhcl6]3 reduce emf +2.85 v. mcat concept check 12.2 assess understanding material 1 standard reduction potential measure 2 cell electromotive force emf denote positive value mean negative 3 give follow reaction determine cell galvanic 2 fe3 + aq + 2 cl aq 2 fe2 + aq + cl2 g e ° cell = 0.59 v 2 fe3 + aq + 2 aq 2 fe2 + aq + i2 aq e ° cell = +0.25 v 4 give half reaction spontaneous oxidation reduction reaction specie 12.3 electromotive force chapter 12.3 able apply formula δg ° = rt ln keq calculation gibbs free energy predict ecell give reaction quotient equilibrium constant discussion electrochemistry different type electrochemical cell make reference spontaneity nonspontaneity redox reaction house different cell type let look formally topic relate free energy electromotive force emf concentration oxidation reduction reactant product voltage

cell give point time gibbs free energy familiar thermodynamic criterion determine spontaneity reaction change gibbs free energy δg change energy available chemical system work electrochemical cell work dependent number coulomb charge transfer energy available δg ° emf relate follow δg ° = nfe ° cell δg ° standard change free energy n number mole electron exchange f faraday constant e ° cell standard emf cell mind faraday constant express coulomb δg ° express j kj. notice similarity relationship express physics formula w = qδv work available need transport charge q potential difference δv n × f charge e ° cell voltage application electrostatic discuss chapter 5 mcat physics math recall chapter 6 mcat general chemistry review

δg positive reaction nonspontaneous δg negative reaction spontaneous note significance negative sign right equation δg ° e ° cell opposite sign galvanic cell negative δg ° positive e ° cell value electrolytic cell positive δg ° negative e ° cell value example determine standard change free energy cell follow net reaction note standard reduction potential iron(iii +0.77 v standard reduction potential molecular chlorine +1.36 v. 2 fe3 + aq + 2 cl aq 2 fe2 + aq + cl2 g solution separate reaction half reaction reaction iron(iii reduce cathode cl oxidize anode reduction potential chlorine actually high iron(iii mean electrode serve opposite role natural tendency reaction nonspontaneous electrolytic cell negative emf value determine emf e ° cell = e ° red cathode e ° red anode = 0.77 v 1.36 v = 0.59 v use emf determine free energy change note 2 electron transfer n = 2 free energy change +120 kj represent non spontaneous far consider calculation cell emf standard condition electrochemical cell ionic concentration deviate 1 m. concentration cell concentration ion compartment different measurable voltage current concentration emf cell relate emf vary change concentration specie cell condition deviate standard condition use nernst equation ecell emf cell nonstandard condition e ° cell emf cell standard condition r ideal gas constant t temperature kelvin n number mole electron f faraday constant q reaction quotient reaction give point time following simplified version equation assume t = 298 k simplified version equation bring r t 298 k f convert natural

logarithm base logarithm calculation easy nernst equation need test day stick log10 version natural logarithm calculation tedious

remember reaction quotient q general reaction aa + bb cc + dd form expression reaction quotient q term concentration reactant term concentration product remember specie solution include consider case daniell cell example concentration zinc copper ion consider emf cell measure voltmeter potentiometer kind voltmeter draw current give accurate reading difference potential example find emf galvanic cell 25 ° c base following standard reduction potential cell fe2 + = 0.01 m cl = 0.1 m. solution determine standard cell potential chlorine half reaction high reduction potential cathode iron act anode standard cell potential e ° cell = e ° red cathode e ° red anode = 1.36 v 0.44 v = +1.80 v determine net ionic equation remember iron oxidize reduction half reaction question stem reverse net ionic equation fe + cl2 fe2 + + 2 cl equation determine value reaction quotient q = fe2+][cl–]2 = 0.01 m)(0.1 m)2 = 10–4

plug nernst equation keep mind electron transfer n = 2 case cell actually high voltage normally concentration ion present mathematically rigorous equation nernst equation powerful use biochemistry calculate rest depolarize membrane potential base concentration ion extended version goldman hodgkin katz equation discuss chapter 8 mcat biochemistry review equation 8.2 chapter look slightly different equation 12.6 temperature different 310 k 298 k unit different mv instead v discuss chapter 7 mcat general chemistry review δg ° determine manner δg ° = rt ln keq r ideal gas constant t absolute temperature keq equilibrium constant reaction combine expression solve standard free energy change δg ° = nfe ° cell = rt ln keq nfe ° cell = rt ln keq extension value n t keq know e ° cell reaction easily calculate mcat expect calculate natural logarithm value head say equation test conceptual log ln remember logarithm positive equilibrium constant great 1 negative equilibrium constant 1 0 equilibrium constant equal 1 analysis equation show redox reaction equilibrium constant 1 equilibrium

state favor reactant e ° cell negative natural logarithm number 0 1 negative property characteristic electrolytic cell house nonspontaneous oxidation reduction reaction instead equilibrium constant reaction great 1 equilibrium state favor product e ° cell positive natural logarithm number great 1 positive property characteristic galvanic cell house spontaneous oxidation reduction reaction equilibrium constant equal 1 concentration reactant product equal equilibrium e ° cell equal zero easy way remember e ° cell = 0 v concentration cell equimolar concentration half cell net ionic equation half cell contain ion e ° cell positive ln keq positive mean keq great equilibrium lie right product favor know effect concentration equilibrium derive change gibbs free energy electrochemical cell vary concentration equation δg = δg ° + rt ln q δg free energy change nonstandard condition δg °

ln q δg free energy change nonstandard condition δg ° free energy change standard condition determine equation 12.4 equation 12.8 r ideal gas constant t temperature q reaction mcat concept check 12.3 assess understanding material 1 fill table relationship equilibrium constant gibbs free energy electromotive force emf assume standard δg ° + reaction spontaneous cell + 2 × 102 2 give follow reaction quotient equilibrium constant determine direction reaction sign ecell reaction direction forward backward chapter cover essential mcat topic electrochemistry review behavior different type electrochemical cell galvanic cell rely spontaneous oxidation reduction reaction produce current supply energy concentration cell special type galvanic cell current dependent ion concentration gradient difference reduction potential chemically distinct electrode electrolytic cell rely external voltage source drive nonspontaneous oxidation reduction reaction call electrolysis finally consider thermodynamic different cell type galvanic concentration cell positive electromotive force emf negative free energy change electrolytic cell negative electromotive force positive free energy change retrospect content learn mcat general chemistry review numerous organic biological inorganic application prepare physician begin understand treat individual sum intertwine system part body system part rely electrochemical cell heart self pace electrochemical cell neuron brain spinal cord rechargeable

concentration cell cell contain mitochondrion cell erythrocyte rely proton motive force inner mitochondrial membrane function discussion inorganic system value analogy biological delay want offer hearty congratulation complete final chapter mcat general chemistry review hard work time energy invest careful thorough review topic cover page book pay test day hope successful meet goal write kaplan mcat review series assess general concept principle essential correctly efficiently answer general chemistry question mcat guide development critical thinking skill necessary analyze passage question stem answer choice provide holistic preparation test day experience addition aim relate science everyday life experience future experience physician demystify concept fun process grateful opportunity journey success mcat success medical

concept fun process grateful opportunity journey success mcat success medical education future practice great physician deserve review content test knowledge critical thinking skill complete test like passage set online resource electrochemical cell describe cell oxidation reduction reaction place certain characteristic share type electrochemical cell electrode strip metal conductive material place electrolyte solution anode site oxidation attract anion cathode site reduction attract cation electron flow anode cathode current flow cathode anode cell diagram shorthand notation represent reaction take place electrochemical cell cell diagram write anode cathode electrolyte solution vertical line represent phase boundary double vertical line represent salt bridge physical boundary galvanic voltaic cell house spontaneous reaction $\delta g < 0$ positive electromotive force electrolytic cell house nonspontaneous reaction $\delta g > 0$

negative electromotive force nonspontaneous cell create useful product electrolysis concentration cell specialized form galvanic cell electrode material potential difference cause movement charge concentration gradient solution charge electrode dependent type electrochemical cell study galvanic cell anode negatively charge cathode positively charge

electrolytic cell anode positively charge cathode negatively charge rechargeable battery electrochemical cell experience charge electrolytic discharge galvanic state rechargeable battery rank energy density energy cell produce relative mass battery material lead acid battery discharge consist pb anode pbo2 cathode concentrated sulfuric acid solution charge pbso4 plate electrode dissociate restore original pb pbo2 electrode concentrate electrolyte cell low energy density nickel cadmium battery ni cd discharge consist cd anode nio(oh cathode concentrate koh solution charge ni(oh)2 cd(oh)2 plate electrode dissociate restore original cd nio(oh electrode concentrate electrolyte cell high energy density lead acid battery nickel metal hydride nimh battery replace ni cd battery high energy density cost effective significantly toxic surge current average current transiently release beginning discharge phase wane rapidly stable current achieve reduction potential quantify tendency species gain electron reduce high reduction potential give species want reduce standard reduction potential e ° red calculate comparison standard hydrogen electrode standard condition 298 k 1 atm pressure 1 m standard hydrogen electrode standard reduction potential 0 v. standard electromotive force e ° cell difference standard reduction potential half cell galvanic cell difference reduction potential half reaction positive electrolytic cell difference reduction potential half reaction negative electromotive force electromotive force change free energy e ° cell positive δg ° negative case e ° cell negative δg ° positive case e ° cell 0 δg ° 0 case concentration cell nernst equation describe relationship concentration specie solution nonstandard condition electromotive force exist relationship equilibrium constant keq keq ratio product concentration equilibrium reactant raise stoichiometric coefficient great 1 e ° cell positive keq 1

stoichiometric coefficient great 1 e ° cell positive keq 1 e ° cell negative keq equal 1 e ° cell 0 answer concept check 1 galvanic cell anode site oxidation current flow designation cathode electron flow 2 electrolytic cell anode site oxidation current flow cathode electron flow designation attract cation 3 pb s | h2so4 4 m || h2so4 4 m | pbo2 s 4 electrolytic cell

nonspontaneous positive δg galvanic cell spontaneous negative δg positive ecell 1 sample measure set cell relative standard hydrogen electrode give reduction potential 0 v convention 2 positive emf mean cell spontaneous galvanic negative emf mean cell nonspontaneous electrolytic 3 cell electrolytic negative emf second cell galvanic positive emf 4 reduction potential triiodide high iron(iii triiodide reduce iron oxidize 2 fe + 3 i3 2 fe3 + + 9 i e ° cell = +0.57 v δg ° + reaction spontaneous cell + 2 × 102 δg ° + reaction spontaneous cell + applicable apply cell remember δg ° = rt ln keq keq < 1 ln keq < 0 δg ° > 0

keq > 1 ln keq > 0 δg ° < 0 keq = 1 ln keq = 0 δg ° = 0 reaction direction forward backward note calculation assume standard condition unlike question science mastery assessment oxidation reduction reaction metal oxygen metal oxidize donate electron oxygen reduce accept electron fact allow immediately eliminate b d species high reduction potential likely reduce species low reduction potential likely oxidize base information question iron oxidize readily metal mean iron low reduction potential determine standard electromotive force cell simply subtract standard reduction potential electrode case cathode zinc reduce anode silver oxidize e ° cell = e ° red cathode e ° red anode = 0.763 0.337 = 1.10 v multiply silver half reaction balance electron actual value reduction potential change remember standard reduction potential determine identity electrode present oxidation occur anode reduction occur cathode cu anode oxidize reduction potential cathode anode galvanic cell mercury cathode concentration cell material cathode anode question assume equal concentration electrolyte solution concentration oxidation reduction reaction anode cathode eliminate b electrolytic cell ionic compound break constituent cation positively charge ion migrate cathode anion negatively charge ion migrate anode case cation h+ ion proton option correct electron flow anode cathode type cell mean option iii correct option ii incorrect reason unlikely anion cell o2 oh–.

second significantly anion flow anode cathode answer come directly equation relate gibbs free energy e ° cell δg ° = nfe ° cell n number mole electron transfer f faraday constant determine

n look balanced half reaction occur salt bridge contain inert electrolyte ionic compound c d know strong electrolyte completely dissociate solution b consider electrolyte atom covalently bond dissociate aqueous solution b c appear similar important distinction c imply mg2 + so32 final dissociate ionic constituent b imply neutral so3 dissolve solution potential measure e ° cell dependent identity electrode present similarly equilibrium constant depend identity electrolyte solution temperature electrode material increase surface area participate oxidation reduction reaction increase electron release make statement ii e ° cell dependent change free energy system equation rt ln keq = nfe ° cell temperature t appear equation change temperature impact galvanic cell species positive reduction potential cadmium reduce cathode reduce electrochemical cell sodium cathode galvanic cell eliminate sodium cathode electrolytic cell cadmium anode answer b note determine e ° cell know answer e ° cell 2.71 0.40 = 2.31 v electrolytic cell +2.31 v galvanic cell eliminate c equation involve standard change free energy electrochemical cell δg ° = nfe ° cell δg ° = rt ln keq substitute e ° cell = e ° red cathode e ° red anode equation distribute negative sign give d opposite δg ° set equation equal rt ln keq = nfe ° cell solve e ° cell opposite b c incorrectly solve algebra spontaneous electrochemical reaction negative δg equation δg ° = rt ln keq keq > 1 result ln keq > 0

mean δg ° < 0 negative electromotive force equilibrium state b correspond spontaneous reaction concentration cell spontaneous concentration cell reach equilibrium cease spontaneous reaction eliminate c answer choice true wrong answer test change ph direct correlation hydrogen ion h+ concentration decrease ph increase h+ concentration mean concentration product increase oxidation sulfur dioxide mean hard liberate electron decrease emf view decrease oxidation potential increase reduction potential e ° red anode increase e ° cell decrease accord e ° cell = e ° red cathode e ° red anode electrolytic cell nonspontaneous δg ° positive e ° cell negative eliminate b d change entropy positive negative depend specie involve eliminate accord equation δg ° = rt ln keq keq < 1 result ln keq < 0 mean δg ° > 0

compare cell type lead acid battery characteristically low energy density d true statement incomplete dissociation sulfuric acid fully explain low energy density lead acid battery c likely opposite easily electrode dissociate easy carry oxidation reduction reaction recharge cycle ni cd cell accept current outside source cd nio(oh electrode pure point reaction stop cd(oh)2 run electron accept b true statement fail explain overcharge battery continue try run current battery electrode revert original state problem ni cd battery finally surge current refer initial burst current see battery charge surge current increase power source continue run additional charge store electrode eliminate d equation remember 12.1 mole electron transfer reduction mn+ + n e m s 12.2 electrodeposition equation 12.3 standard electromotive force cell e ° cell = e ° red cathode 12.4 standard change free energy standard emf δg ° = 12.5 nernst equation 12.6

nernst equation simplify 12.7 reaction quotient 12.8 standard change free energy equilibrium constant δg ° = rt ln keq 12.9 free energy change nonstandard condition δg = δg ° + rt ln q biochemistry chapter 3 nonenzymatic protein function protein analysis biochemistry chapter 8 general chemistry chapter 7 general chemistry chapter 11 physics math chapter 5 electrostatic magnetism physics math chapter 6 acid dissociation constant ka activation energy ea temperature substance thermal energy 0 k 273.15 ° c series discrete line characteristic frequency represent energy require excite electron ground state species donate hydrogen ion accept electron equilibrium constant measure degree dissociation acid specific condition aqueous solution contain h+ ion oh ion ph < 7 standard condition series chemical element atomic number 89 103 fall s d block periodic table minimum energy require reaction reach transition state call energy barrier experimental quantity substance obtain end reaction process occur transfer heat system element find group ia periodic table highly reactive readily lose valence electron form ionic alkaline earth metal atomic mass unit amu compound nonmetal element find group iia periodic table chemistry similar alkali metal valence electron form +2 cation species gain lose species capable react acid base depend nature reactant

rotational analog linear momentum ionic species negative charge electrode oxidation occur molecular orbital form overlap atomic orbital energy great energy combine atomic orbital solution water solvent species donate proton h+ aqueous species donate hydroxide ion oh chemical kinetics equation relate rate constant k reaction frequency factor activation energy ea ideal gas constant r temperature t kelvin small unit element retain property element break chemical mean mass give isotope element closely relate mass number unit mass define mass carbon-12 atom approximately equal mass proton number proton give element describe region space high probability find electron average distance nucleus outermost electron usually measure

probability find electron average distance nucleus outermost electron usually measure half distance azimuthal quantum number l base dissociation constant kb nucleus element elemental form weight average mass atom element take account relative abundance naturally concept electron fill energy level order increase energy completely fill sublevel begin fill process molecule usually water spontaneously dissociate cation anion number atom molecule mole substance 6.02 × 1023 mol–1 law state condition temperature pressure equal volume different gas number molecule quantum number denote sublevel subshell electron find reveal shape orbital equation chemical reaction number atom element reaction total charge reactant product emission spectrum hydrogen represent transition electron energy level n > 2 n = tool measure pressure species donate hydroxide ion electron pair equilibrium constant measure degree dissociation base specific condition aqueous solution contain oh ion h+ ion ph > 7 standard condition model hydrogen atom electron assume certain circular orbit positive nucleus temperature vapor pressure liquid equal incident pressure normal boiling point boil point elevation liquid define boiling point pressure 1 give quantity solute raise boiling point liquid colligative property energy enthalpy change require break particular bond give condition average energy require break particular type bond atom gas phase electron locate valence shell atom involve covalent bond molecular orbital form overlap atomic orbital energy

combine average distance nucleus bond number share electron pair increase bond length number share electron pair atom single bond bond order 1 double bond bond order 2 triple bond bond order 3 law state constant temperature volume gaseous sample inversely proportional pressure reaction noninteger order rate proton donor proton acceptor solution contain weak acid salt weak base salt tend resist change ph.

portion titration curve concentration acid approximately equal conjugate base ph remain relatively constant region degree system resist change ph.

unit thermal energy apparatus measure heat absorb release reaction collision theory chemical kinetic substance increase rate forward reverse direction specific reaction lower activation energy leave unchanged electrode reduction take place ionic species positive charge temperature scale define have 0 ° c equal freezing point water 100 ° c equal boiling point water know centigrade temperature scale element find group periodic table diverse chemistry group contain metal nonmetal like oxygen metalloid typically form 2 anion state electrochemical cell external electromotive force return cell original state process electron transfer nonspontaneously cathode anode law state volume gas constant pressure directly proportional absolute kelvin temperature process bind metal ion ligand interaction atom result sharing transfer electron expression describe quantity identity reactant product reaction property substance relate chemical change undergo ionization energy system exchange energy matter surrounding property solution depend number solute particle present nature particle theory state rate reaction proportional number collision second react molecule sufficient energy overcome activation energy barrier imply fraction collision sufficient combined gas law common ion effect conjugate acid base pair coordinate covalent bond reaction reactant form single product gas law combine boyle law charles law gay lussac law state pressure volume inversely proportional directly proportional reaction oxidant typically oxygen react fuel typically hydrocarbon yield water oxide carbon dioxide hydrocarbon

shift equilibrium solution addition ion species present reaction reaction central cation bind ligand polyatomic molecule central cation bond electron pair donor call ligand pure substance decompose produce element compound reduction volume gas solution high concentration value cutoff term concentrate depend purpose identity solution solute unit solvent relative component mixture cell create electromotive force emf voltage single chemical species half cell vary process gas transition liquid material electron able transfer energy form heat electricity relationship brønsted lowry acid deprotonate form brønsted lowry base protonate form dalton law partial pressure covalent bond

lowry base protonate form dalton law partial pressure covalent bond electron bonding pair donate bond atom number atom bind chemical bond form sharing electron pair atom form single bond double bond triple bond point phase diagram phase boundary liquid gas long exist vapor pressure critical temperature give substance know critical point high temperature liquid gas phase substance coexist temperature liquid gas phase solid atom ion molecule arrange regular dimensional lattice structure subshell correspond angular momentum quantum number l = 2 contain orbital find high principal energy level law state sum partial pressure component gaseous mixture equal total pressure sample electrochemical cell anode site zn metal oxidation cathode site cu2 + ion reduction reaction single compound break product molecular orbital electron density spread entire molecule portion thereof localize atom physical property substance define mass contain unit volume chemical process direct transition substance gaseous state solid state electrochemical reaction buildup solid precipitate effective nuclear charge zeff condition arise substance unpaired electron slightly repel magnetic field random motion gas solute particle concentration gradient lead uniform distribution gas solute container solution low concentration give species contain bond element different electronegativity result unequal distribution charge attractive force dipole magnitude dependent dipole moment distance specie vector quantity magnitude dependent product charge distance orient positive negative pole state rechargeable electrochemical cell

provide electromotive force allow electron flow spontaneously anode cathode oxidation reduction reaction species act oxidize agent reduce agent call dismutation separation single species separate specie usually reference salt weak acid basis reaction ion different compound swap associate counterion typically product type reaction insoluble solution precipitate property metal allow material draw thinly stretch wire charge perceive electron nucleus apply valence electron influence periodic trend atomic radius ionization energy movement gas compartment pressure small opening follow graham law electromotive force emf cell oxidation reduction reaction take place contain

electromotive force emf cell oxidation reduction reaction take place contain electrode electrical electrical conductor electrical current enter leave medium process electrical current power nonspontaneous decomposition reaction compound ionize water increase conductance solution electrochemical cell use external voltage source drive nonspontaneous oxidation reduction wave compose electric magnetic field oscillate perpendicular direction propagation range possible frequency wavelength electromagnetic radiation potential difference develop cathode anode electrochemical cell subatomic particle remain outside nucleus carry single negative charge case mass consider negligible energy dissipate gaseous species gain electron symbolic representation describe electron arrangement energy sublevel intrinsic angular momentum electron represent ms arbitrary value measure ability atom attract electron bond commonly measure pauling scale spatial arrangement pair electron central atom include bonding lone equilibrium constant keq space occupy path follow electron atom nucleus electron shell call principle energy level give electron indicate principle quantum number substance break chemical mean define number proton atomic number series discrete line characteristic frequency represent energy emit electron atom return excited state ground state simple number ratio different element compound reaction absorb heat surrounding reaction proceed positive δh point titration indicator change final color equivalence unit electrochemical energy capable store unit weight battery large energy density produce large

energy small material heat content system constant pressure change enthalpy δh course reaction difference enthalpy product reactant property relate dispersion energy system degree disorder system change entropy δs course reaction difference entropy product reactant state balance forward reverse reaction rate reversible reaction equal concentration specie remain constant time change reaction condition ratio concentration product concentration reactant certain reaction equilibrium raise point titration mole acid present equal mole base add vice versa faraday constant f law thermodynamic mole charge form electron proton ion measurable quantity produce substance transition liquid gaseous state chemical reaction reagent limit product form promotion electron high energy level absorption energy

limit product form promotion electron high energy level absorption energy quantum electronic state have high energy ground state typically attain absorption photon reaction give heat surrounding negative δh reaction proceed subshell correspond angular momentum quantum number l = 3 contain seven orbital find fourth high principal energy level total charge 1 mole electron confuse farad denote f unit capacitance law state total energy system surrounding remain constant reaction rate directly proportional concentration reactant substance flow weak intermolecular attraction molecule take shape container liquid gas consider fluid conventional assignment charge individual atom lewis structure molecule total number valence electron free atom minus total number electron atom bond assume equal splitting electron bond sum atomic weight constituent ion accord ionic compound empirical formula process liquid transition solid state know solidification crystallization freeze point depression gas constant r gibbs free energy g gram equivalent weight gew give pressure temperature solid liquid phase substance coexist equilibrium identical melting give quantity solute lower freezing point liquid colligative property electrochemical cell use spontaneous oxidation reduction reaction generate electromotive force call voltaic cell electrochemical cell precipitation process cathode call plating physical state matter possess disorder molecule

interact weak attraction find relatively low pressure high temperature proportionality constant appear ideal gas law equation pv = nrt value depend unit pressure temperature volume give situation law state pressure gaseous sample constant volume directly proportional absolute energy system available work change gibb free energy δg determine give reaction equation enthalpy change temperature entropy change negative δg denote spontaneous reaction positive δg denote nonspontaneous reaction law state rate effusion diffusion gas inversely proportional square root gas compound contain 1 mole react capacity fully dissociate gew equal molar mass divide reactive capacity specie interest obtain formula unit unexcited state electron vertical column periodic table contain element similar chemical property call family separate

periodic table contain element similar chemical property call family separate compartment house electrode solution electrochemical reaction heat formation δhf heat fusion δhfus heat sublimation δhsub heat vaporization δhvap heisenberg uncertainty principle point half give species titration protonate deprotonate reduction half oxidation half oxidation reduction reaction electrochemical cell half- reaction occur electrode active nonmetal group viia periodic table high electronegativity high electron affinity energy transfer spontaneously warm sample cool sample heat absorb release formation pure substance element constant pressure enthalpy change conversion 1 gram 1 mole solid liquid constant temperature pressure enthalpy change conversion 1 gram 1 mole solid gas constant temperature pressure enthalpy change conversion 1 gram 1 mole liquid gas constant temperature pressure concept state impossible determine momentum position electron simultaneously perfect accuracy equation show relationship ph poh solution pka pkb ratio concentration dissociate specie law state mass gas dissolve solution directly proportional partial pressure gas solution law state energy change overall reaction equal sum energy change individual reaction comprise nonuniform composition catalyst phase matter reactant example solid platinum catalyst ideal bond angle ideal gas law react hydrogen gas uniform composition catalyst phase matter reactant example

aqueous enzyme cytoplasm cell rule electron fill separate orbital parallel spin pair orbital combination atomic orbital form new orbital property intermediate original orbital strong attraction hydrogen atom bond highly electronegative atom nitrogen oxygen fluorine molecule highly electronegative atom molecule reaction water consume breakdown molecule h3o+ ion oh ion angle nonbonde bond electron pair minimize repulsion hypothetical gas behavior describe ideal gas law condition assume particle zero volume exhibit interactive force equation state pv = nrt r gas constant describe behavior real gas moderate pressure temperature significantly solution enthalpy dissolution equal zero substance low concentration titration change color certain ph range acid base titration particular electromotive force oxidation reduction titration final color change indicator

particular electromotive force oxidation reduction titration final color change indicator occur endpoint ion product ip element group viiia contain octet valence electron outermost shell unreactive call noble gas molecule transiently exist multistep reaction appear overall balanced equation attractive repulsive force attractive force atom single molecule ionic covalent bond charge atom molecule result loss gain general term reaction quotient dissolve ionic compound compare ksp determine saturation status solution chemical bond form electrostatic interaction positive negative ion average distance center nucleus edge electron cloud cationic radius generally small parent metal anionic radius generally large parent nonmetal solid consist positive negative ion arrange crystal regularly repeat unit hold ionic bond energy require remove electron valence shell gaseous atom reaction proceed direction go completion process occur constant pressure technique separate amino acid polypeptide base isoelectric point system exchange matter energy surrounding process occur constant atom contain number proton different number neutron kinetic molecular theory law conservation charge law conservation mass law constant composition law mass action le châtelier principle process occur constant volume system perform work call isochoric unit energy temperature scale unit equal unit celsius scale absolute zero define 0 k call absolute

temperature scale theory propose account observed behavior gas consider gas molecule pointlike volumeless particle exhibit intermolecular force constant random motion undergo completely elastic collision container gas particle product reaction form favorably low temperature thermal energy available form transition state require create stable thermodynamic product small overall difference free energy product reactant thermodynamic series chemical element atomic number 57 71 fall s d block enthalpy isothermal process law state give reaction charge ion product equal charge ion reactant law state give reaction mass product equal mass law state element pure compound find specific mass ratio form equilibrium constant concentration product concentration reactant raise stoichiometric coefficient london dispersion force magnetic quantum number

reactant raise stoichiometric coefficient london dispersion force magnetic quantum number ml maxwell boltzmann distribution curve observation system equilibrium disturb stress system react way relieve stress restore equilibrium electrochemical cell anode site pb metal oxidation cathode site pb4 + ion reduction electrolyte strong acid usually sulfuric acid species capable accept electron pair species capable donate electron pair method represent shared unshared electron atom molecule ion call lewis molecule bond metal ion coordination compound ligand lewis basis form coordinate covalent bond central metal ion chemical reaction reactant present quantity limit product form state matter intermolecular attraction intermediate gas solid distinguish gas phase have definite volume solid phase molecule mix freely intermolecular force arise interaction temporary dipole molecule portion emission spectrum hydrogen represent electronic transition energy level n > 1 n = 1 quantum number define particular orbital subshell electron reside convey information orientation orbital space physical property metal define element shape hammer physical property represent matter sum proton neutron atom nucleus call atomic mass number distribution molecular speed gas particle give temperature millimeter mercury mmhg mole fraction x temperature increase average speed increase distribution wide flat series step involve give reaction temperature

solid liquid phase substance coexist equilibrium identical freezing point class element left periodic table possess low ionization energy electronegativity readily electron form cation possess relatively high element possess property intermediate metal nonmetal call semimetal thermodynamic specific way energy system organize unit pressure define number millimeter mercury barometer raise surface capillary tube external pressure 1 torr equal 1 mmhg definition 1 atmosphere equal 760 mmhg reaction reaction order change time rate law system contain multiple substance 2 + physically combine chemically combine concentration unit equal number mole solute kilogram solvent concentration unit equal number mole solute liter solution mass gram mole element molarity solute saturate solution substance equal avogadro number molecule

element molarity solute saturate solution substance equal avogadro number molecule atom mass 1 mole substance gram mass molecule atom atomic mass unit unit concentration equal ratio number mole particular component total number mole specie system formula show actual number identity atom molecule compound net ionic equation nickel metal hydride battery nonpolar covalent bond number multiple empirical formula spatial arrangement bonding pair electron central atom region electron density chemical bonding result overlap atomic orbital sum atomic weight atom small polyatomic unit element compound exist distinct chemical physical property equation relate voltage electrochemical cell concentration reactant product cell reaction equation show specie actually participate reaction aqueous solution concentration h+ oh ion equal ph = 7 298 k reaction acid base salt form water subatomic particle contain nucleus atom carry charge mass slightly large rechargeable electrochemical cell anode site cd metal oxidation cathode site ni2 + ion reduction rechargeable electrochemical cell anode site metal hydride oxidation cathode site nickel ion reduction nickel oxidation state electron locate valence shell atom involve covalent bond compound ionize water class element high ionization energy electron affinity generally gain electron form anion locate upper right corner periodic table covalent bond element similar electronegativity

contain charge separation molecule exhibit net separation charge net dipole moment element expand valence shell include d- f block electron call group b process occur energy input surrounding positive change concentration unit equal number equivalent liter solution small central region atom dense positively charged area contain proton neutron valence electron subshell nucleus impart great stability atom rule state bond atom tend undergo reaction produce complete octet valence electron apply exception c n o f. system exchange energy matter surrounding region electron density atom molecule contain electron opposite spin movement water semipermeable membrane concentration gradient low solute concentration high solute concentration pressure apply solution prevent passage

solute concentration high solute concentration pressure apply solution prevent passage water semipermeable membrane concentration gradient well think suck pressure draw water solution reaction involve net loss electron increase call oxidation state number assign atom ion molecule denote real hypothetical charge assume electronegative element bond award electron bond ability substance spontaneously oxidize positive oxidation potential measure volt oxidation reduction redox reaction pauli exclusion principle pauling electronegativity scale indicative substance easy oxidize likely act anode electrochemical cell reaction involve transfer electron chemical species oxidation reduction reaction atom facilitate oxidation species oxidize agent gain electron reduce subshell correspond angular momentum quantum number l = 1 contain dumbbell shaped orbital orient perpendicular px py pz find second high principal energy level electron orbital assign quantum mechanic electron different orbital atom ms value condition arise substance unpaired electron slightly attract magnetic field pressure component gaseous mixture exert container si unit pressure equivalent emission spectrum hydrogen represent transition electron energy level n 4 n = principle state electron atom identical set quantum common scale express electronegativity element percentage total formula weight compound attributable give element percentage theoretical product yield actually recover chemical reaction occur obtain divide actual yield theoretical yield multiply pi

π bond polar covalent bond horizontal row periodic table contain element number electron shell law state chemical property element depend atomic number element change periodic fashion visual display know chemical element arrange row period column group accord atomic number electron structure measure hydrogen ion content aqueous solution define negative log h+ h3o+ concentration device measure concentration hydrogen ion solution report ph value form matter solid liquid gas reversible transition solid liquid and/or gas phase cause shift temperature pressure plot usually pressure vs. temperature show phase compound exist set form light display particulate quantal property substance unrelated chemical behavior melting point boiling point density

property substance unrelated chemical behavior melting point boiling point density bond parallel electron cloud density form p orbital limit possibility free rotation π bond second bond double bond second bond triple bond measure hydroxide oh ion content aqueous solution define negative log oh concentration covalent bond atom different electronegativity electron density unevenly distribute give bond positive negative end molecule possess polar covalent bond geometry allow bond dipole moment sum potential energy diagram principal quantum number n net dipole moment molecule capable donate proton acid capable donate acid base capable donate hydroxide accept proton graph show potential energy reactant product reaction course reaction convention x axis show progress reaction y axis show potential energy device measure electromotive force voltage potentiometer potentiometric titration redox titration indicator insoluble solid separate solution generally result mix solution average force unit area measure atmosphere atm torr mmhg pascal pa 1 atm = 760 torr 760 mmhg = 101.325 kpa

quantum number define energy level shell occupy electron system change property system occur subatomic particle carry single positive charge mass slightly 1 amu planck theory discrete bundle energy emit electromagnetic radiation matter number describe energy level

electron reside electron element describe unique set quantum number phenomenon exhibit certain unstable isotope undergo spontaneous nuclear transformation emission particle law state partial pressure component solution proportional mole fraction component reaction quotient q solution provide explanation vapor pressure depression see solution proportionality constant rate law reaction specific particular reaction give temperature slow step reaction mechanism step serve bottleneck progress reaction mathematical expression give rate reaction function concentration reactant determine exponential effect change concentration reactant change rate reaction overall rate order sum individual reactant rate order series step occur course chemical reaction include formation destruction reaction intermediate calculation rate law reaction sum exponent concentration reactant form equilibrium constant concentration product reactant equilibrium compare keq dictate direction reaction proceed spontaneously speed substance produce consume reaction gas exhibit deviation ideal gas law molecular attraction actual volume gas molecule electrochemical cell undergo reversible oxidation reduction process discharge function galvanic voltaic cell charge function electrolytic cell specific method determine concentration unknown solution reducible titrant titrand typically measure voltage change oxidation reduction reaction atom facilitate reduction species reduce agent lose root mean square speed urm second law thermodynamic electron oxidize reaction involve net gain electron decrease oxidation number ability substance spontaneously reduce positive reduction potential measure volt indicative substance easy reduce likely act cathode elements group 1 2 13 18

modern iupac table s- p block table call group element element tend valence shell follow octet rule difference arrangement electron pair bond connectivity overall charge lewis structure lewis structure represent weight average stability possible resonance structure reaction proceed forward reverse direction typically completion average speed gas molecule give temperature scalar direction account subshell correspond angular momentum quantum

number l = 0

contain spherical orbital find energy level ionic substance consist cation anion component electrochemical cell compose inert electrolyte allow charge gradient build half cell dissipate reaction occur contain ion react electrode ion solution solution contain maximum solute dissolve particular solvent give law state spontaneous process lead increase entropy sigma σ bond solubility product ksp sparingly soluble salt reaction rate directly proportional concentration reactant square single reactant quality membrane allow component solution pass usually include solvent limit passage specie head head bond orbital different atom allow free rotation axis reaction ion compound replace ion know single- phase matter possess great order molecule fix rigid structure measure solute dissolve solvent certain temperature equilibrium constant ionization reaction sparingly soluble salt component solution present less concentration solvent homogeneous mixture substance solid brass liquid hcl aq gas air electrostatic interaction solute solvent molecule call dissolution term hydration water solvent component solution present great substance solute dissolve ionic compound low solubility give temperature heat require raise temperature gram substance 1 ° c ion involve reaction change formula charge phase normally omit net ionic characteristic wavelength electromagnetic radiation emit absorb object atom molecule spin quantum number m standard free energy g ° standard heat combustion δh ° comb standard hydrogen electrode standard temperature pressure stp shorthand representation principal azimuthal quantum number azimuthal number designate letter number tool measure blood pressure fourth quantum number indicate orientation intrinsic spin electron atom assume value process occur energy input surrounding define negative change condition define 25 ° c 1 atm pressure 1 m concentration measure standard gibbs free energy enthalpy entropy cell electromotive force gibbs free energy reaction standard condition enthalpy change associate combustion fuel electrode define have potential zero standard condition oxidation reduction potential measure relative standard hydrogen electrode 25 ° c 1 m concentration ion voltage associate half

reaction specific

c 1 m concentration ion voltage associate half reaction specific oxidation reduction reaction generally tabulate reduction potential compare standard hydrogen electrode phase matter certain element define 0 ° c 273 k 1 atm measure characteristic ideal gas function depend state system path arrive state include pressure density temperature volume enthalpy internal energy gibbs free energy entropy reaction number place compound indicate relative number mole species involve form dimensional analysis focus relationship amount reactant product acid undergo complete dissociation base undergo complete dissociation graphic representation molecule depict atom arrange change phase solid gas pass liquid phase division electron shell energy level different value azimuthal quantum number s p d f compose orbital substance current state simultaneously liquid gas distinction solution equilibrium ion product great solubility product constant supersaturated solution thermodynamically unstable average current transiently release beginning discharge phase battery matter energy universe include particular system consideration matter energy consideration measure average kinetic energy particle system maximal product obtain reaction determine stoichiometric analysis product reaction form favorably high temperature thermal energy available form transition state stable product valence shell electron pair repulsion vsepr theory van der waals equation state large overall difference free energy product reactant kinetic product solution unknown concentration solution know concentration add determine concentration solution know concentration slowly add solution unknown concentration determine concentration method determine concentration unknown solution gradual reaction solution know plot ph solution vs. volume acid base add acid base titration plot

electromotive force solution vs. volume oxidize reduce agent add oxidation reduction titration element b group periodic table partially fill d subshell point reaction old bond partially break new bond partially form high energy reactant product reaction call activate complex pressure

temperature solid liquid gas phase particular substance coexist solution solute dissolve reach saturation electron high occupy energy level atom tendency give valence electron retain lose determine chemical property element outermost shell atom reflect geometric arrangement molecule base lewis dot structure dimensional structure determine repulsion bond nonbonding electron pair valence shell atom real gas law correct attractive force volume gas particle assume negligible ideal gas law van der waals force van’t hoff factor vapor pressure depression water dissociation constant kw attractive repulsive force molecule arise covalent ionic bond number particle compound dissociate solution partial pressure gaseous substance atmosphere liquid solid equilibrium decrease vapor pressure liquid cause presence dissolve solute colligative transformation liquid gas equilibrium constant water dissociation reaction give temperature equal 10–14 25 ° c 298 k acid undergo partial dissociation base undergo partial dissociation product obtain reaction reaction concentration reactant effect overall rate note material figure table indicate italic f t page number resonance hybrid 96 transition state 171 171f 185 reversible reaction 201 δ change 19 δ heat addition 134 frequency factor attempt frequency 170 170f 172 mass number 9 12 33 element representative element 51 absolute temperature scale kelvin 240 286 absorption emission spectra 17–19 acetic acid sodium acetate buffer 389 acid base nomenclature 368–369 acid buffer 389 acid dissociation constant ka 374–378 394 401 acid base equivalence point 383 acidemia 208 390 acid equivalent 381 arrhenius acid 365 brønsted lowry acid 365 365f define 364–369 365f–367f

lewis acid 366–367 366f property 369–381 372f 377f 380f acid basis acid basis neutralization reaction ph titration activate complex transition state activation energy ea catalyst effect 174–175

174f 260 261f collision theory chemical kinetic 185 define describe 169–170 reaction rate 259 relation temperature 172–173 173f spontaneous process 233 transition state formation 171 active metal 52 60 actual yield 141 150 adenosine triphosphate atp 167 211 437–438 adiabatic

heat 241 universal composition 130 wave function orbital 103–104 wavelength planck relation weak acid basis dissociation criterion 375 394 weak acid strong base reaction 378–380 weak

criterion 375 394 weak acid strong base reaction 378–380 weak acid strong base titration 386–387 386f

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