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chapter 10 mathematic 10.1 arithmetic significant figure 10.2 exponent logarithm chapter 11 reasoning design execution 11.1 scientific method 11.2 basic science research 11.3 human subject research 11.5 research real world chapter 12 data base statistical reasoning 12.1 measure central tendency 12.3 measure distribution 12.5 statistical testing 12.6 chart graph table 12.7 apply datum áine lorié phd kristen l. russell kaplan mcat faculty laura l. ambler kaplan mcat faculty krista l. buckley jason r. selzer kaplan mcat faculty 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

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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 pennsylvania 2013 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 format found 1845 cutting edge scientific american boast 200

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destination www.scientificamerican.com provide late science news exclusive feature 10 million visitor month e knowledge fill page power spark new idea paradigm vision future science race forward scientific american continue cover promising stride inevitable setback challenge new medical discovery unfold anatomy mcat general overview structure test day chemical physical foundations biological critical analysis reasoning skills cars lunch break optional biological biochemical foundations live psychological social biological foundations satisfaction survey optional e 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 score 118 132 test social science 50 foundation comprehension 30 reasoning text 30 reasoning text 40 biological biochemical foundation living systems 44 question passage base 15 discrete score 118 132 test general chemistry 5 organic chemistry 5 chemical physical foundation biological systems psychological social biological foundations 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 472 528 scientific inquiry reasoning skill e aamc define scientific inquiry reasoning skill sirs test science section mcat knowledge scientific concept principle 35 question scientific reasoning problem solving 45 question reasoning design execution research 10 question data base statistical reasoning 10 question let break specific test day behavior note bullet point specific objective sir take directly official guide mcat exam description behavior mean sample question stem write kaplan skill 1 knowledge scientific concepts principles is probably surprising sir testing science knowledge aer 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 principle use mathematical equation solve problem kaplan simply science knowledge skill 1 question way think skill 1 question step problem e single

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theory determine use scientific formula solve problem skill 1 question think step problem skill 2 question step problem difficult skill 2 question require step ese 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 e likely cause anomalous result

find experimenter impact man chest quickly reduce volume lung 70 initial value allow air escape man mouth percentage force outward air pressure increase 2 cm2 portion inner surface compress lung skill 3 reasoning design execution e 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 scientific 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 is skill unique outside knowledge need 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 passage e 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 hypothesis skill 4 data base statistical reasoning lastly science section mcat test ability analyze visual numerical result experiment study data statistical analysis question skill 4 question require 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 reason random systematic error reason statistical significance uncertainty interpret statistical significance level interpret confidence interval use datum explain relationship variable prediction 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 e 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 correlation conclusion well support finding display figure 2 medical test rare type heavy metal poisoning return positive result 98 affected individual 13 unaffected individual following type error prevalent test fourth trial experiment 1 run yield result 54 compliance following 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 inking 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

involve situation skill 4 data statistical analysis question ask let forget science content accurately read graph table moment conclusion extrapolation base information present critical analysis reasoning skills e critical analysis reasoning skills cars section mcat test discrete family textual reasoning skill family require high level reasoning ose skill foundation comprehension 30 question reasoning text 30 question reasoning text 40 question ese 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 understand basic component text infer meaning rhetorical device word choice text structure is admittedly cover wide range potential question type include main idea detail inference definition context question finde correct answer foundations comprehension question follow basic understanding

passage point view author occasionally voice passage sample foundations comprehension question stem main idea—e author primary purpose passage detail base information second paragraph follow accurate summary opinion hold schubert 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—e word obscure paragraph 3 reference historian action nearly mean reasoning 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 reasoning text question require integrate different component text draw relevant conclusion e cars section ask judge certain part passage judge author ese 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—e author discussion effect socioeconomic status social mobility primarily serve following function strengthen weaken passage)—which follow fact passage prominent piece evidence favor strengthen weaken passage)—based role play author argument e possess consider reasoning text e 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 e 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

text)—suppose jane austen write letter sister

define passage strengthen weaken text)—suppose jane austen write letter sister strong character force circumstance confront basic question society live relevance passage strengthen weaken text)—which follow sentence add end passage weaken author conclusion paragraph rough 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 cars skill foundations comprehension question ask understand passage main idea passage particular detail true author reasoning text question ask logical relationship idea passage argued author thesis reasoning text question ask principle passage apply new situation new piece information influence argument section mcat score 118 132 median 125 is mean total score range 472 528 median 500 peculiar number e aamc stress scale emphasize importance central portion score distribution student score 125 section 500 total put undue focus high end scale note wrong answer penalty mcat select answer question guess e aamc release 2020–2021 correlation scale score percentile show follow page note percentile scale adjust renormalize time shi slightly year year source aamc 2020 summary mcat total section score access november information score reporting include end section aer 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 e way register mcat online access aamc registration system www.aamc.org/mcat able access site approximately month test day e aamc designate registration zones”—gold silver bronze register gold zone opening registration approximately month test day provide flexibility

low test fee e silver zone run approximately week test day flexibility high fee bronze zone run

approximately week test day flexibility high fee fee fee assistance program fap 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 prefer test day soon possible register ere ancillary benefit have set test day know date work study hard likely push exam e aamc offer fee assistance program fap student financial hardship help reduce cost take mcat american medical college application service amcas ® application information fap find www.aamc.org/students/applying/fap

test day require present qualifying form id generally current driver license united states passport sufficient consult aamc website list qualifying criterion register care spell first name middle name suffixe prefixe require verifie test day precisely appear id failure provide id test center difference spelling registration id consider 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 prohibited 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 testing center video surveillance aamc potential violation testing security lightly e 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 find test mcat matter feel good leave test center celebrate nap watch movie ride bike plan trip neglect friend stalk facebook totally consume cheesesteak drink dirty martini night assume 21 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 e aamc know seek individual violate agreement retain right prosecute individual discretion is 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 aer test day e release

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kaplan mcat review series key concept ese sidebar draw attention important takeaway give topic offer synopsis overview complex information understand sure grasp key concepts give

subject mcat expertise ese sidebar point information test mcat offer key strategy point test taking tip apply test day mnemonic ese sidebar present memory device help recall certain real world ese sidebar illustrate concept text relate practice medicine world large information need know test day topic real world sidebar excellent example concept appear passage discrete stand question mcat book cover e information present kaplan mcat review 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 chapter profile first page chapter represent holistic look content chapter include pie chart text information e pie chart analysis base directly datum release aamc rough estimate importance chapter relation book text portion chapter profile include aamc content category cover chapter ese reference directly aamc mcat exam content listing available test maker website new high yield badge scatter section chapter 1.1 amino acid find protein note terminology stereochemistry amino acid structure amino acid hydrophobic hydrophilic amino acid amino acid abbreviation 1.2 acid base chemistry amino acid protonation deprotonation titration amino acid 1.3 peptide bond formation hydrolysis peptide bond formation peptide bond hydrolysis 1.4 primary secondary protein structure 1.5 tertiary quaternary protein structure folding solvation layer 1.1 amino acid find protein chapter 1.1 able ese badge represent 100 topic test aamc word accord testmaker experience resource high yield badge mean question test day

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single question study integrated manner effective way

prepare test customize content draw attention difficult critical content ensure overlook read read section e good way visual highlight tab use stickie work recommend highlight important difficult section text selective highlighting 10 percent text give chapter great emphasize part text over- 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 first time stop think read jot thought margin note content important topic come mind read associate learning memory fantastic way retain information is work answer question aer answer question moment think step take arrive solution lead answer choose understand step take help good decision answer future question 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 e first 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 e 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 e good time create study plan beginning mcat preparation use calendar want start purchase planner print free calendar internet use build calendar app smart device track interactive online calendar pick option practical likely use consistently calendar able start plan study schedule following step fill obligation choose day off.

write school extracurricular work obligation first class session work shi meeting attend en add personal obligation appointment lunch date family social time etc make appointment

calendar hang friend go movie strange first plan social activity advance help achieve balance personal professional obligation life get busy have happy balance allow focused productive come time study stay round neglect important addition schedule personal professional obligation plan time off. take time off important study kaplan recommend take day off week ideally study obligation minimum study 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 study 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 studying sound like lot break allow deal distraction rest brain 50 minute study block remain fully engaged completely focused 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 final review know online resource find sample study calendar different test day timeline use starting point e sample calendar include focus need area fit timeline test day need customize study calendar need step e 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

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 e mcat cover large material study test day initially daunting combat tip control studying time 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 aer 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 opportunity limit have minimal time prepare test day focus big area opportunity first area opportunity topic area highly test master likely will time detailed note page book instead use result practice material determine area big opportunity seek aer take 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 practice question length test tempt aer practice push ahead cover new material quickly possible fail schedule ample time review actually throw away great opportunity

fail schedule ample time review actually throw away great opportunity improve performance e brain rarely remember see carefully review question solve explanation process retrieve information reopen reinforce connection build brain is build long- term retention repeatable skill set exactly need beat review note specific reason miss question get wrong guess spreadsheet like add fix sheet hifis complete practice question periodically review hifis identify pattern consistently miss question certain content area fall test maker trap mcat prep adjust study plan base available study time result review strength weakness likely change course prep address area important score shie focus area change help review make length test

include fix sheet template sure check video resource online syllabus fix fix absorption emission practice keq problem read answer choice slow rephrase scope passage prediction study oen overlook aspect study environment learning actually occur study home student first 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 is eliminate usual distraction promote efficient studying instead study off home course entire day stay library hour effective studying enjoy rest day off mcat matter study practice like test day possible require official test snack chew gum study block turn off 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 studying environment easy test day recall information put work learn chapter 1 kinematic dynamic chapter 1 kinematic dynamic running track science mastery assessment pre med know feeling content know mcat know important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal quiz take online

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 get correct ensure thinking match explanation review concept summary end chapter

1 man walk 30 m east 40 m north difference travel distance displacement 1 0 m 2 20 m 3 50 m 4 70 m 2 1000 kg rocket ship travel 100 act average force 20 kn apply direction motion 8 s. change velocity rocket 3 car travel driver put brake bring car rest time 6 s. magnitude average acceleration car 4 elevator design carry maximum weight 9800 n include weight upward speed initial period acceleration relationship maximum tension elevator cable maximum weight elevator elevator accelerate upward 1 tension great 9800 n. 2 tension 9800 n. 3 tension equal 9800 n. 4 determine information give 5 student lift mass 4 kg distance 0.5 m. ambient temperature 298 k student lift mass 30 second following value necessary calculate power 6 firefighter jump horizontally burn building initial speed time angle velocity acceleration vector great 1 instant jump 2 reach terminal velocity 3 halfway fall 4 right land ground 7 10 kg wagon rest inclined plane plane make angle 30 ° horizontal approximately large force require wagon slide plane note sin 30

approximately large force require wagon slide plane note sin 30 ° = 0.5 cos 30 ° = 0.866 1 10 n 2 49 n 3 85 n 4 98 n 8 follow expression correctly illustrate si base unit variable formula mδv = fδt 1 lb × mph = ft × lb × s 9 diagram show vector vector b meet tail angle 60 degree student use formula ab sin 60o b magnitude respective vector b following well describe compute value 1 positive scalar 2 negative scalar 3 vector page 4 vector page 10 follow quantity vector 11 30 kg girl sit seesaw distance 2 m fulcrum father sit balance seesaw mass 90 1 67 cm girl 2 67 cm fulcrum 3 133 cm girl 4 267 cm fulcrum 12 physics major build potato gun test open field launch potato velocity 12 m s angle 30 ° potato find 60 meter launch site following represent maximum height achieve potato note cos(60 ° = 0.86 1 0.3 m 2 1.8 m 3 5 m 4 18 m 13 rock m = 2 kg shoot vertically time ball m = 0.5 kg project horizontally start height 1 rock ball reach ground time 2 rock reach ground 3 ball reach ground 4 rock ball collide air reach 14 centrifugal force apparent outward force circular motion describe reaction force accord newton law follow statement likely correct centrifugal force 1 centrifugal force exist uniform circular motion nonuniform circular motion 2 centrifugal force exist tension normal force

provide centripetal acceleration 3 centrifugal force act antiparallel centripetal force 4 centrifugal force result repulsive electrostatic interaction 15 follow statement true movement plane 1 acceleration function apply force 2 force need accelerate stationary object identical move object 3 force friction independent mass object 1 2 ii 3 ii 4 iii

independent mass object 1 2 ii 3 ii 4 iii 1 b ch 1.3 2 ch 1.3 3 c ch 1.4 4 ch 1.5 5 c ch 1.1 6 ch 1.4 7 b ch 1.5 8 c ch 1.1 9 d ch 1.2 10 d ch 1.2 11 b ch 1.7 12 b ch 1.6 13 c ch 1.6 14 c ch 1.7 15 b ch 1.4 chapter 1 kinematic dynamic chapter 1 1.1 unit 2 fundamental measurement 3 1.2 vector scalar 4 vector addition 5 vector subtraction 6 multiply vector scalar 7 multiply vector vector 8 1.3 displacement velocity 11 1.4 force acceleration 13 mass weight 15 1.5 newton law 16 law 17 second law 18 law 19 1.6 motion constant acceleration 20 linear motion 21 projectile motion 22 inclined plane 23 circular motion 24 1.7 mechanical equilibrium 25

free body diagram 26 translational equilibrium 27 rotational equilibrium 28 concept summary pie chart

indicate content chapter relevant percent question physics mcat content chapter relevant 6 question physics mcat chapter cover material following aamc content category 4a translational motion force work energy equilibrium live professor say biology chemistry chemistry physics physics life surprisingly claim physics professor walk mcat preparation student think physics applicable science medicine reflect calculus heavy premedical class medical field physics treat patient rehab hospital talk motion force bone strength ophthalmologist draw diagram help student well understand myopia hyperopia talk mitochondrion function battery cell mean fairly chapter review system unit encounter mcat mks meter kilogram second cgs centimeter gram second si international system units moment review geometry physics question especially vector mathematic true physics content consider kinematic equation deal motion object newtonian mechanic dynamic study force

effect chapter 1.1 able recall fundamental measurement unit order give set unit measure type quantity small large begin discussion motion define consistent vocabulary discussion physics book physics rely language mathematic convey important description explanation world number meaningless vague good label unit natural phenomenon occur scale show figure 1.1 assume fine detail little bearing large scale universe rapid inflation universe allow infinitesimally small affect astronomically big object size 10 ^ -35 meter 10 ^ 26 figure 1.1 size natural phenomena year system unit develop specific purpose system commonly everyday life rarely science british imperial system foot pound second fps commonly united states virtually britain basic unit length weight time foot ft pound lb second s respectively weight mass british system later derive slug unit mass mcat rarely utilize fps passage question common system unit metric system basis si unit mcat depend context passage question metric system give meter kilogram second mks centimeter gram second cgs si unit include mks system base unit show table table 1.1 si unit mass weight ampère coulomb second substance mole measurement system

unit mass weight ampère coulomb second substance mole measurement system base unit derive unit base unit standard unit system design derived unit imply create associate base unit example newton unit force derive kilogram meter second table 1.2 contain example important derive unit system describe prefix metric unit conversion metric imperial unit discuss chapter 10 mcat physics math review table 1.2 derive unit systems measurement work energy foot pound ft lb foot pound second erg second watt molecular atomic subatomic level different unit give easy work small scale example length give ångström 1 å = 10–10 m nanometer 1 nm = 10–9 m energy atomic scale express electron volt 1 ev = 1.6 × 10–19 j represent energy gain electron accelerate potential difference volt good aware system measurement system require memorize mcat si solutions concept check give chapter mcat physics math review find near end chapter concept check locate follow concept summary chapter mcat concept check 1.1 assess understanding material 1 newton product kilogram meter second2 unit comprise

pound 2 order following unit small large centimeter angstrom inch mile foot 1.2 vector scalar chapter 1.2 able explain importance order perform vector calculation calculate scalar vector product vector right hand rule applicable description give follow text vector number magnitude direction vector quantity include displacement velocity acceleration force scalar number magnitude direction scalar quantity include distance speed energy pressure mass difference vector scalar quantity pronounced nonlinear path involve example course year earth travel distance roughly 940 million kilometer circular path displacement earth year zero kilometer difference distance displacement illustrate vector representation vector represent arrow direction arrow indicate direction vector length arrow usually proportional magnitude vector quantity common notation vector quantity arrow boldface example straight line path represent vector identify a. magnitude displacement position represent |

|a| a. scalar quantity generally represent italic type distance point represent d. book book kaplan mcat review series consistently use boldface represent vector quantity italic represent magnitude vector scalar quantity sum difference vector call resultant vector way find sum resultant vector b place tail b tip change length direction arrow tip tail method length arrow proportional magnitude vector vector sum + b vector join tail tip b point tip b.

vector addition demonstrate figure 1.2 left tail b tip resultant right tail b tip tail c tip b resultant figure 1.2 tip tail method vector addition left vector b resultant + b right vector b c resultant + b + c add vector add tip tail method find resultant vector involve break vector perpendicular component case component horizontal vertical x- y component respectively instance inclined plane sense define component parallel perpendicular || respectively surface give vector v find x- y component x y draw right triangle v hypotenuse show figure 1.3 vector horizontal x vertical y component angle vector horizontal theta figure 1.3 split vector component θ angle v x component example find x- y component following vector conversely know x y find v show figure 1.4 vector x- y component v = square root x^2 + y^2 figure 1.4 pythagorean theorem

determine magnitude resultant vector calculate magnitude v require use pythagorean theorem angle resultant vector calculate know inverse trigonometric function discuss chapter 10 mcat physics math review note inverse tangent calculation scope example magnitude vector follow x component resultant vector simply sum x- component vector add similarly y component resultant vector simply sum y component vector add illustrate figure 1.5 x component resultant sum x component vector y component figure 1.5 find resultant r v1 + v2 + v3 find resultant r component method follow step 1 resolve vector add x- y component 2 add x component x component resultant rx add y component y component resultant ry 3 find magnitude resultant pythagorean theorem rx ry component resultant 4 find direction θ resultant relationship subtract vector accomplish add vector equal magnitude opposite direction vector express mathematically b = + b b represent vector magnitude b point opposite direction vector subtraction perform component vector combine create final vector vector

vector subtraction perform component vector combine create final vector vector addition x component resultant vector difference x component vector subtract similarly y- component resultant vector difference y component vector subtract notice subtract vector simply flip direction vector subtract follow rule normal multiply vector scalar vector multiply scalar magnitude change direction parallel antiparallel original direction vector multiply scalar value n new vector b create b = na.

find magnitude new vector b simply multiply magnitude |n| absolute value n. determine direction vector b look sign n. n positive number b direction n negative number b point opposite direction example vector multiply scalar +3 new vector b time long point direction vector multiply scalar 3 b time long point opposite direction multiply vector vector circumstance want able use vector quantity generate vector scalar multiplication generate scalar quantity like work multiply magnitude vector interest force displacement cosine angle

vector vector calculus call dot product b b = |a| |b| cos θ

contrast generate vector like torque need determine magnitude direction multiply magnitude vector interest force lever arm sine angle vector magnitude use right hand rule determine direction vector calculus call cross product × b × b = |a| |b| sin θ resultant cross product perpendicular plane create vector mcat dimensional test usually mean vector interest go page screen multiple version right hand rule determine direction cross product resultant vector figure 1.6 show method consider resultant c c = × b left image proton move page magnetic field page right image right hand rule figure 1.6 apply right hand rule 1 start point thumb direction vector a. 2 extend finger direction vector b. need rotate wrist correct configuration thumb finger 3 palm establish plane vector direction palm point direction resultant c. note learn version right hand rule different describe example student learn point right index finger direction right middle finger direction b hold thumb perpendicular finger point direction c. make difference version right hand rule use long comfortable skilled proper use different method determine direction cross product resultant vector choose whichever method prefer stick important skilled method somewhat familiar multiple method example magnitude direction resultant vector following cross product c = × b d = b × x = 3 n y = 0 b x = 0 y = +4 m solution magnitude resultant vector simply product magnitude factor vector sine angle case orient x direction y- direction angle 90 ° |a| × |b| × sin 90 ° = 3 n × 4 m × 1 = 12 n·m magnitude 12 n·m determine direction c start point right thumb left negative x direction finger point page positive y direction palm point determine direction d start point right thumb page positive y direction finger point left negative x direction palm point c

direction finger point left negative x direction palm point c 12 n·m page d 12 n·m cross product right hand rule order matter unlike scalar multiplication commutative 3 × 4 = 4 × 3 vector multiplication commutative × b b × mcat concept check 1.2 assess understanding material 1 calculate sum vector b + b tail b tip a. effect

reverse order b + 2 calculate difference vector b b invert b tail new vector tip a. effect reverse order b 3 scalar calculate product vector 4 true false c = × b direct right page b direct page c direct midway b 45 ° angle 1.3 displacement velocity

chapter 1.3 able describe relationship average instantaneous version velocity speed distinguish total distance total displacement connect displacement velocity equation cover basic geometry serve foundation physic examine relate physical quantity basic quantity relate kinematic displacement velocity object motion experience change position space know displacement x d vector quantity magnitude direction displacement vector connect straight line object initial position final position understand displacement account actual pathway take initial final position net change position initial final distance d travel hand consider pathway take scalar quantity example displacement man walk 2 km east 2 km north 2 km west 2 km south solution total distance travel 8 km displacement vector quantity represent change position case displacement zero man end place start square side equal 2 km start end point path mention early velocity v vector magnitude measure rate change displacement give unit time si unit meter second direction velocity vector necessarily direction displacement vector speed v rate actual distance travel give unit time distinction subtle let examine little carefully instantaneous speed object equal magnitude object instantaneous velocity measure average velocity change time δt approach zero v instantaneous velocity δx change position δt change time measure speed instantaneous speed scalar number average speed necessarily equal magnitude average velocity average velocity ratio displacement vector change time vector average speed scalar ratio total distance travel change time average speed account actual distance travel average velocity average velocity δx change position δt change time consider example give early earth orbit year earth travel roughly 940 million kilometer displacement average speed measure distance travel give period time average velocity measure displacement object give period time average speed earth year 30 kilometer second average

velocity zero mcat concept check 1.3 assess understanding material 1 relationship instantaneous velocity instantaneous speed average velocity average speed 2 true false total distance travel total

velocity average speed 2 true false total distance travel total 3 provide definition displacement velocity term 1.4 force acceleration chapter 1.4 able calculate frictional force predict direction describe relationship force velocity acceleration identify common force include frictional gravitational force explain concept normal force impact system change velocity motivate push pull force section examine force interact acceleration result force force f vector quantity experience push pull object force exist object touch common force exert object push instance force exist object near gravity electrostatic force point charge si unit force newton n equivalent newton observe apple fall tree strike fact fall perpendicularly ground sideways away ground furthermore newton begin wonder farth reach gravity apple feel attractive pull earth moon force newton later term universal gravitation acceleration gravity g decrease height earth increase close get earth center mass near earth gravity attractive force feel form matter usually think gravity act float earth surface hold planet solar system orbit object exert gravitational force small measurable force gravity mcat physics math review book chair sit object gravitational force usually significance small scale force tend large magnitude planetary level gravitational force significant value newton law state force gravity m1 m2 equal opposite force gravity m2 m1 mean force gravity earth equal opposite force gravity earth force equal masse different acceleration different f = ma discuss later chapter mass small compare earth experience large acceleration contrast earth massive experience tiny acceleration magnitude force magnitude gravitational force object g universal gravitational constant m1 m2 masse object r distance center mass equation commonly test context proportionality instance magnitude gravitational force inversely relate square distance r halve fg quadruple magnitude gravitational force directly relate masse object m1 triple fg triple example find gravitational force electron proton 10–11 m apart note mass proton = 1.67 × 10–27 kg mass electron =

mass proton = 1.67 × 10–27 kg mass electron = 9.11 × 10–31 kg solution use newton law gravitation friction type force oppose movement object unlike kind force gravity electromagnetic force cause object speed slow friction force oppose object motion cause slow stationary type friction static kinetic static friction f exist stationary object surface rest inequality describe magnitude static friction 0 fs μsn μs coefficient static friction n magnitude normal force coefficient static friction unitless quantity dependent material contact normal force component force object contact perpendicular plane contact object surface note equal sign equation signify range possible value static friction minimum course zero case object rest surface apply force maximum value static friction calculate right previous equation assume object stationary experience maximal static force friction consider try push heavy piece luggage 25 n force apply bag 50 n force apply bag 100 n force apply bag slide meter slow rest setup imply maximal value static friction 50 100 n apply force threshold sufficient bag equal opposite force static friction oppose bag motion contact point place friction occur rough surface slide past normal load force squeeze rise total area contact increase increase surface roughness govern degree friction illustrate figure 1.7 object contact push close contact figure 1.7 increase contact area increase frictional force kinetic friction fk exist slide object surface object slide student misidentify presence kinetic friction wheel example roll road experience kinetic friction tire actually slide pavement tire maintain instantaneous point static contact road experience static friction tire begin slide icy patch kinetic friction come play time surface slide kinetic friction present magnitude measure accord equation fk = μkn μk coefficient kinetic friction n normal force important distinction equation kinetic friction previous equation static friction kinetic friction equation equals sign mean kinetic friction constant value give combination coefficient

equals sign mean kinetic friction constant value give combination coefficient kinetic friction normal force matter surface area contact velocity slide object second equation different

coefficient friction value μ large value μk maximum value static friction great constant value kinetic friction object stick start move slide easily coefficient static friction large coefficient kinetic friction require force object start slide take object slide previously mention discussion static friction pay close attention condition set mcat passage question friction assume negligible provide coefficient friction value likely need calculation friction friction incorporate examination translational equilibrium later chapter mass weight mass weight mass m measure body inertia matter object mass scalar quantity magnitude si unit mass kilogram independent gravity kilogram material earth mass kilogram material moon weight fg hand measure gravitational force usually earth object mass weight force vector quantity unit newton n mass weight synonymous relate fg = mg fg weight object m mass g acceleration gravity usually round weight object think apply single point object call center mass gravity mcat directly test ability determine center mass calculation important step problem large focus illustrate concept calculation consider tennis racquet throw air racquet move pathway possible represent motion racquet single particle point racquet move simple parabolic path similar flight ball point racquet know center mass clearly show figure racquet rotate move path central point remain precisely parabolic path figure 1.8 center mass tennis racquet center mass racquet throw air travel parabolic pathway system particle distribute dimension center mass define coordinate m1 m2 m3 sample masse x- y- z- value coordinate center gravity relate correspond single point conceptualize gravity act object homogeneous body symmetrical shape uniform density expect center gravity locate geometric center example approximate center gravity metal ball geometric center sphere say human body television asymmetrical non- center mass uniform object geometric center acceleration rate change

non- center mass uniform object geometric center acceleration rate change velocity object experience result apply force acceleration like velocity vector quantity measure si unit meter second square acceleration direction opposite initial velocity call deceleration average acceleration define average acceleration δv change velocity δt change time instantaneous

acceleration define average acceleration δt graph velocity vs. time tangent graph time t correspond slope graph time indicate instantaneous acceleration slope positive acceleration positive direction velocity slope negative acceleration negative opposite direction velocity deceleration mcat concept check 1.4 assess understanding material 1 calculate frictional force directionality assign 2 force apply velocity 3 true false earth create large force create earth 4 force addition mechanical manipulation push pull force create contact object 1.5 newton law chapter 1.5 able describe newton law motion clear understanding force mass acceleration let examine relate unlikely newton discover gravity have apple head record inspire watch apple fall tree observation object motion rest basis branch physic know mechanic newton law express equation concisely describe effect force object mass fnet = ma = 0 fnet net force m mass acceleration body rest motion constant velocity remain way net force act know law inertia newton law ought think special case second law describe fnet = ma fnet net force m mass acceleration newton second law state actually corollary object mass m accelerate vector sum force result nonzero resultant force vector acceleration occur vector sum force result cancellation force note net force acceleration vector necessarily point fab = fba law know law action reaction action opposed equal reaction formally law state force exert object object b equal opposite force exert object b object a. example

hit hand desk hand exert force desk simultaneously desk exert force equal magnitude opposite direction hand physical contact necessary newton law mutual gravitational pull earth moon traverse hundred thousand kilometer space mcat concept check 1.5 assess understanding material 1 word provide description newton law motion 2 test crash 500 kg car drive constant velocity 50 mph hit wall brake apply newton law situation 1.6 motion constant acceleration chapter 1.6 able identify force active different type motion include free fall projectile motion predict angle launch necessary maximize horizontal recall equation calculate centripetal acceleration object undergo type motion constant acceleration change acceleration object motion change indicate change velocity object experience acceleration

acceleration constant change move object experience constant acceleration present relatively simple case analysis mcat tend restrict kinematic problem involve motion constant linear motion object velocity acceleration line motion pathway move object continue straight line linear motion need limit vertical horizontal path incline surface ramp provide path linear motion angle mcat common presentation linear motion problem involve object ball drop ground start height fall object exhibit linear motion constant acceleration one- dimensional motion fully describe following equation equation 1.18 1.21 x v displacement velocity acceleration vector respectively v0 initial velocity average velocity t time motion vertical use y instead x displacement deal free fall problem choose positive negative sake simplicity habit make positive negative demonstrate typical setup kinematic problem mcat consider object fall air assume air resistance negligible mean force act object gravitational force cause fall consequently object fall constant acceleration acceleration gravity reach terminal velocity call free fall condition free fall object reach terminal velocity typical test day analyze fall relevant example ball throw vertically air window ledge 30 meter ground initial velocity 1 find velocity position ball second 2 find distance time ball reach maximum height window ledge 1 remember

distance time ball reach maximum height window ledge 1 remember velocity acceleration vector quantity question let ball initial position y0 zero consider positive initial velocity v0 + acceleration g note g negative orient downward velocity second find equation second position ball find equation 2 ball maximum height velocity decrease way zero find maximum height ball reach equation 1.20 time ball reach maximum height find equation 1.18 let consider happen air resistance negligible air resistance like friction oppose motion object value increase speed object increase object free fall experience grow drag force magnitude velocity increase eventually drag force equal magnitude weight object object fall constant velocity accord newton law velocity call terminal time object take maximum height time take object fall start height assume air resistance negligible fact make solve problem easy solve time reach

maximum height set final velocity zero multiply answer get total time flight long object end height start force act object launch gravity velocity x direction remain constant time flight multiply time velocity x direction find horizontal distance travel projectile motion motion follow path dimension velocity acceleration direction usually horizontal vertical independent accordingly analyze separately object projectile motion earth cannonball baseball bullet experience force acceleration gravity vertical direction y axis mean vy change rate g vx remain constant fact mcat generally able assume horizontal velocity vx constant usually assume air resistance negligible measurable force act x axis note gravity bold indicate vector value gravity unique constant vector calculation gravity bolde recall test day gravity direction example projectile fire ground level initial velocity initial angle elevation 37 ° show assume find follow note sin 37 ° = 0.6 cos 37 ° = 0.8 1 projectile total time flight 2 total horizontal distance travel 1 let y equal vertical displacement positive direction go use vertical displacement acceleration gravity y

displacement positive direction go use vertical displacement acceleration gravity y direction use y- component velocity problem plug height ball zero 0 second initial position 6 second hit ground 2 know time find horizontal distance travel need consider x component plug note acceleration vertical direction gravity ax = 0

inclined plane example motion dimension work incline plane question good divide force vector component parallel perpendicular plane gravity split component calculation component define fg,|| component gravity parallel plane orient plane

fg, component gravity perpendicular plane orient plane m mass g acceleration gravity θ angle incline kinematic equation problem example 5 kg block slide frictionless incline 30 ° find normal force acceleration block note sin 30 ° = 0.5 sin 60 ° = 0.866 cos 30 ° = 0.866 cos 60 ° = 0.5 solution block example force act normal force perpendicular surface gravity point gravity

coordinate system normal force force split component case concern magnitude normal force perpendicular plane acceleration parallel plane split force gravity parallel perpendicular acceleration perpendicular dimension magnitude normal force equal perpendicular component gravity acceleration determine parallel direction force dimension parallel component force gravity net force circular motion occur force cause object circular pathway completion cycle displacement object zero mcat focus uniform circular motion case speed object constant recognize nonuniform circular motion uniform circular motion instantaneous velocity vector tangent circular path show figure 1.9 mean object move circular path tendency inertia break circular pathway linear direction tangent inward circular motion resolve force radial tangential component uniform circular motion tangential force zero change speed object figure 1.9 uniform circular motion force centripetal force generate centripetal acceleration remember discussion newton law force acceleration vector acceleration direction net force acceleration generate centripetal force keep object circular pathway centripetal force long act object simply exit circular pathway assume path tangential circle point equation describe circular motion fc magnitude centripetal force m mass v speed r radius circular path note centripetal force cause tension gravity electrostatic force force mcat concept check 1.6 assess understanding material 1 force act free fall projectile motion differ 2 angle launch projectile go great horizontal displacement angle result great vertical displacement assume level surface great horizontal displacement great vertical displacement 3 equation centripetal acceleration 1.7 mechanical equilibrium chapter 1.7 able identify object equilibrium calculate torque system seesaw

chapter 1.7 able identify object equilibrium calculate torque system seesaw 10 kilogram mass left right far pay attention kinematic special case linear projectile motion time mcat require eliminate acceleration maintain system equilibrium accomplish familiar analyze force especially free body diagram special condition translational rotational equilibrium study force torque call dynamic free body diagram intuitive sense force effect everyday life student

struggle represent diagrammatically draw free body diagram take practice valuable tool mcat test day sure draw free body diagram problem perform calculation force deal dynamic question draw quick picture happen problem proper relative position help prevent make simple mistake example people pull rope tie tire force 100 n 125 n 125 n show find magnitude direction resultant force note sin 30 ° = 0.5 cos 30 ° = 0.866 sin 37 ° = 0.6 cos 37 ° = 0.8 solution

draw free body diagram show force act tire purpose identify visualize act force resultant force simply sum force find resultant force vector need sum force component show net component vector show graphically resultant force 13.4 n left translational motion occur force cause object rotation simple pathway linear child slide snowy hill sled parabolic case cannonball shoot cannon problem translational motion chemical physical foundations biological systems section solve free body diagram newton law translational equilibrium exist vector sum force act object zero call condition equilibrium merely reiteration newton law remember resultant force object zero object accelerate mean object stationary mean object move constant nonzero velocity object experience translational equilibrium constant velocity constant speed zero nonzero value constant direction acceleration net force object mean object constant velocity net force act net force equal zero mean velocity example block static equilibrium show block mass 15 kg coefficient static friction block surface 0.2 maximum mass block b solution start make free body diagram block block net force zero equilibrium magnitude t equal fg b. ask maximum mass block b mean force static friction maximize f = μsn block equilibrium fs equal magnitude t fg equal magnitude n. fs = t t = fg b

rotational motion occur force apply object way cause object rotate fixed pivot point know fulcrum application force distance fulcrum generate torque τ moment force distance apply force fulcrum term lever arm torque generate rotational motion mere application force torque depend magnitude force length lever arm angle force apply equation torque cross product τ = r × f = rf sin θ r length lever arm f magnitude force θ angle lever arm force vector remember

sin 90 ° = 1 mean torque great force apply 90 degree perpendicular lever arm know sin 0 ° = 0 tell torque force apply parallel lever arm rotational equilibrium exist vector sum torque act object zero call second condition equilibrium torque generate clockwise rotation consider negative torque generate counterclockwise rotation positive rotational equilibrium positive torque exactly cancel negative torque similar behavior define translational equilibrium possibility motion case rotational equilibrium object rotate stationary rotate constant angular velocity mcat take rotational equilibrium mean object rotate example seesaw mass 5 kg block mass 10 kg meter left fulcrum block 0.5 m right fulcrum show image describe precede text seesaw equilibrium find mass block 2 force exert fulcrum solution seesaw balance imply rotational equilibrium positive counterclockwise torque exert block 1 equal magnitude negative clockwise torque exert block 2 use fulcrum pivot point fulcrum center seesaw normal force weight seesaw eliminate equation lever arm 0 mcat concept check 1.7 assess understanding material 1 move object equilibrium 2 object time heavy lift lever lift object fulcrum need chapter equip math language physics necessary understand important topic mcat chemical physical foundations biological systems section kinematic newtonian mechanic study object motion allow describe object position displacement distance travel velocity speed acceleration respect time understand use key kinematic equation object experience constant acceleration relatively simple scenario present test day learn different kind force

relatively simple scenario present test day learn different kind force act object cause certain way application force cause object accelerate decelerate accord newton second law vector sum force act object equal zero force cancel object experience acceleration condition know translational equilibrium express newton law object touch exert force describe newton law consider linear motion projectile motion incline plane circular motion consider special condition translational rotational equilibrium hope come appreciate relevance concept principle performance mcat medical school residency training career physician careful consideration discussion topic chapter practice kind problem demonstrate earn point test day

review content test knowledge critical thinking skill complete test like passage set online mcat test si unit relate metric system si unit include meter kilogram second ampère mole kelvin vector scalar vector physical quantity magnitude direction vector quantity include displacement velocity acceleration force scalar quantity direction scalar quantity magnitude vector like speed dimensionless like coefficient friction vector addition accomplish tip tail method break vector component pythagorean vector subtraction accomplish change direction subtract vector follow procedure vector multiply vector scalar change magnitude reverse direction multiply vector dot product result scalar quantity dot product product vector magnitude cosine angle multiply vector cross product result vector quantity cross product product vector magnitude sine angle right hand rule determine resultant vector direction displacement velocity displacement vector representation change position path independent equivalent straight line distance start end location distance scalar quantity reflect path travel velocity vector representation change displacement respect time average velocity total displacement divide total average speed total distance travel divide total instantaneous velocity limit change displacement time change time approach zero instantaneous speed magnitude instantaneous force acceleration force push pull potential result gravity attractive force object result friction force oppose motion function electrostatic interaction surface object static friction exist object motion relative kinetic friction exist object motion relative

exist object motion relative kinetic friction exist object motion relative static friction value depend magnitude apply force kinetic friction constant value coefficient friction depend material contact coefficient static friction high coefficient kinetic friction mass weight synonymous mass measure inertia object weight force experience give mass gravitational attraction earth acceleration vector representation change velocity time average instantaneous acceleration consider similar velocity newton law law inertia state object remain rest constant velocity net force object newton second law state acceleration result sum force act object mass newton law state object interact experience equal opposite force result

motion constant acceleration linear motion include free fall motion velocity acceleration vector parallel antiparallel projectile motion contain x- y component assume negligible air resistance force act object gravity inclined plane example dimensional movement easy consider dimension parallel perpendicular surface plane circular motion well think have radial tangential dimension uniform circular motion force centripetal force point radially inward instantaneous velocity vector point tangentially free body diagram representation force act object useful equilibrium dynamic problem translational equilibrium occur absence net force act object object translational equilibrium constant velocity rotational rotational equilibrium occur absence net torque act object rotational motion consider pivot point center mass common object rotational equilibrium constant angular velocity mcat angular velocity usually zero answer concept check 1 force obey relationship mass acceleration regardless unit system force product mass acceleration pound lb equal 2 ångström < centimeter < inch < foot < mile 1 vector addition unlike vector multiplication commutative function resultant + b b + difference resultant 2 vector subtraction like vector multiplication commutative function resultant b magnitude b orient opposite direction 3 scalar calculate vector dot product b = |a| |b| cos θ vector calculate cross product × b = |a| |b| sin θ 4

false true addition problem vector equal magnitude true vector multiplication find direction c use right hand rule thumb point direction finger point direction b palm c point page 1 instantaneous speed magnitude instantaneous velocity vector average speed average velocity unrelated speed depend displacement total distance travel divide time 2 true displacement consider direct route point distance equal large magnitude 3 velocity rate change displacement object displacement function velocity act period time 1 direction frictional force oppose movement instantaneous velocity vector know net force case static friction frictional force opposite direction 2 net force act object object experience acceleration constant velocity 3 false force reciprocal nature earth exert force person person exert force magnitude earth opposite direction difference masse give earth apparent acceleration zero 4 gravity frictional

force discuss chapter electrostatic magnetic elastic weak nuclear strong nuclear force example force 1 answer similar follow acceptable 1 absence force net force zero change velocity 2 acceleration result sum force vector 3 interact object force act object equal opposing force act object 2 answer similar follow acceptable 1 prior collision vehicle travel constant velocity accord newton law indicate acceleration net force 2 collision wall create sudden deceleration acceleration net force value net force calculate multiply mass car times acceleration 3 car collide wall car exert force wall simultaneously wall exert force equal magnitude opposite direction car 1 force act free fall projectile motion gravity 2 product sine cosine maximize angle 45 ° horizontal displacement rely measurement maximum horizontal displacement achieve angle vertical displacement zero object return starting point object launch vertically experience great 3 equation centripetal force force simply mass time acceleration newton second law 1 move object translational rotational equilibrium translational equilibrium require net force object zero velocity constant correspond condition rotational equilibrium net torque equal zero angular velocity constant 2 place

equilibrium net torque equal zero angular velocity constant 2 place fulcrum quarter way lever close object ratio lever arm 3:1 mean original force necessary alternatively fulcrum place end object way lever result 3:1 ratio lever arm mean original force science mastery assessment explanations

pythagorean theorem calculate magnitude man total distance travel equal 30 + 40 = 70 m. difference 20 m. average force rocket equal mass times average acceleration average acceleration equal change velocity divide time change occur change velocity equal average force times time divide mass b represent new velocity rocket change velocity c d neglect divide mass rocket magnitude average acceleration change velocity divide time velocity change car come rest time hour acceleration question ask magnitude acceleration force elevator tension upward weight downward net force elevator difference elevator accelerate upwards tension

cable great maximum weight net force direct upwards unit power watt break kg·m2 s2 unit temperature formulation ambient temperature extra information support c correct answer note mass distance time compute power eliminate b d firefighter acceleration direct downward velocity start horizontal gradually rotate downwards downward velocity increase time progress angle velocity acceleration decrease mean maximum angle occur instant jump static force friction act parallel plane opposite direction parallel component gravity setup wagon equilibrium force equal magnitude remember gravity split component incline plane problem split x- y- component convenient split gravity vector parallel perpendicular component parallel component gravity give expression mg sin θ plug value question parallel component gravity static force friction equal sin 30 ° = 49 n. si unit mass measure kilogram kg velocity meter second time second s newton derive unit

consider base unit si system newton equal equation use sine angle equation compute cross product output cross product vector quantity find direction resultant vector use right hand rule thumb right hand point direction vector finger point direction vector b palm reveal direction vector product problem right hand rule indicate direction result vector page consistent d note cross product produce vector choice b immediately eliminate vector characterize magnitude direction give answer choice vector distance distance scalar numerical value lack direction order seesaw balance torque girl τg exactly counteract torque father τf word magnitude torque equal τg = τf r represent distance person fulcrum father sit 67 cm fulcrum maximum height depend y component velocity horizontal distance ignore initial y-velocity calculate vf = 12·sin(30o = 6 m s. solve max height use equation vf2 = vi2 + 2ax maximum height vertical velocity equal 0 m s.

plug value yield equation 0 = 36 20x solve x give x = 1.8 m match b need analyze motion vertical dimension answer question rock ball begin vertical velocity reach ground time rock begin upward component velocity time reach maximum height fall ground functionally rock

free fall start higher later ball rock necessarily hit ground ball question stem indicate centrifugal force reactionary act outwardly away center rotation draw conclusion reaction centripetal force accord newton law force equal magnitude opposite direction antiparallel presence friction change impact newton law net force apply cause motion net force necessarily equal apply force friction gravity act object statement eliminate static friction oppose movement stationary object necessarily great force kinetic friction statement ii correct statement iii false normal force relate mass friction relate normal force consult online resource additional practice equation remember 1.1 component vector 1.2 pythagorean theorem x2 + y2 = v2 1.3 determination direction component vector 1.4 dot product b = |a| |b| cos θ 1.5 cross product × b = |a| |b| sin θ 1.6 instantaneous velocity 1.7 average velocity 1.8 universal gravitation equation 1.9 static friction 0  fs  μsn 1.10 kinetic friction fk = μkn 1.11 force gravity weight earth fg = mg 1.12 center mass 1.13 average acceleration 1.14 instantaneous acceleration 1.15

newton law fnet = ma = 0 1.16 newton second law fnet = ma 1.17 newton law fab = fba 1.18 kinematic displacement v = v0 + 1.19 kinematic final velocity 1.20 kinematic time v2 = v02 + 2ax 1.21 kinematic acceleration 1.22 component gravity inclined plane 1.23 centripetal force 1.24 torque τ = r × f = rf sin θ general chemistry chapter 1 general chemistry chapter 3 bonding chemical interaction physics math chapter 2 work energy physics math chapter 4 physics math chapter 5 electrostatics magnetism physics math chapter 10 chapter 2 work energy chapter 2 work energy pulley background science mastery assessment pre med know feeling content know mcat know important 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 get correct ensure thinking match explanation review concept summary end chapter 1 weightlifter lift 275 kg barbell ground height 2.4 m. work lift barbell work require hold weight height 1 3234 j 0 j respectively 2 3234 j 3234 j respectively 3 6468 j 0 j respectively 4 6468 j 6468 j respectively 2 tractor pull log mass 500 kg ground 100 m. rope tractor log make angle

500 kg ground 100 m. rope tractor log make angle 30 ° ground act tensile force 5000 n. work tractor perform scenario note sin 30 ° = 0.5 cos 30 ° = 0.866 tan 30 ° = 0.577 1 250 kj 2 289 kj 3 433 kj 4 500 kj 3 2000 kg experimental car

accelerate 0 6 s. average power engine need achieve acceleration 1 150 w 2 150 kw 3 900 w 4 900 kw 4 40 kg block rest height 5 m ground block release fall ground follow close total mechanical energy height 2 m assume negligible air 1 0 j 2 400 j 3 800 j 4 2000 j 5 5 m3 gas bring initial pressure 1 kpa pressure 3 kpa isochoric process process work perform gas 1 10 kj 2 10 j 3 0 j 4 +10 kj 6 pulley system show following close tension force rope mass object 10 kg object accelerate upwards mass pulley system 1 50 n 2 60 n 3 100 n 4 120 n 7 following conservative force 1 air resistance 8 uniform circular motion following relationship necessarily true 1 work 2 centripetal force work 3 velocity work 4 potential energy depend position object 9 following well characterize work energy theorem 1 work force proportional magnitude force 2 total work object equal change kinetic energy object 3 work object force proportional change kinetic energy object 4 work apply force object equal change kinetic energy object 10 massless spring initially compress displacement centimeter compress centimeter potential energy system change 1 potential energy change 2 potential energy double 3 potential energy

increase joule 4 potential energy quadruple 11 josh mass 80 kg sarah mass 50 kg jump 20 m tall building land fire net net compress bounce time follow statement true 1 sarah bounce higher josh 2 josh change speed start jump contact net 3 josh experience great force impact sarah 4 energy event convert potential kinetic elastic kinetic 12 parachutist jump plane begin point reach terminal velocity constant velocity freefall follow true

1 jumper translational equilibrium 2 jumper act force 3 equal work gravity air 1 2 iii 3 ii iii 4 ii iii 13 mechanical advantage efficiency ratio follow true quantity ratio 1 mechanical advantage compare value work efficiency compare value power 2 mechanical advantage compare value force efficiency compare value work 3 mechanical advantage compare value power efficiency compare value energy 4 mechanical advantage compare value work efficiency compare value force 14 gravitational potential energy object double absence nonconservative force follow true assume total mechanical energy object constant 1 object lift twice initial height 2 kinetic energy object halve 3 kinetic energy decrease quantity potential energy increase 4 mass object double 15 consumer compare new car car exert 250 horsepower car b exert 300 horsepower consumer concerned peak velocity car reach nonconservative force ignore follow statement true note 1 horsepower = 745.7 w 1 car car b unlimited velocity 2 car reach peak velocity quickly car b. 3 car dissipate energy surrounding car b. 4 car low peak velocity car b. 1 c ch 2.2 2 c ch 2.2 3 b ch 2.1 4 d ch 2.3 5 c ch 2.2 6 b ch 2.3 7 c ch 2.2 8 ch 2.2 9 b ch 2.2 10 d ch 2.1 11 ch 2.1 12 b ch 2.2 13 b ch 2.3 14 c ch 2.1 15 ch 2.2 chapter 2 work energy chapter 1 2.1 energy 2 kinetic energy 3 potential energy 4 total mechanical energy 5 conservation mechanical energy 6 2.2 work hy 7 force displacement 8 pressure volume 10 work energy theorem 11 2.3 mechanical advantage 13

concept summary pie chart indicate content chapter relevant percent question physics mcat content chapter relevant 11 question physics mcat chapter cover material following aamc content category 4a translational motion force work energy equilibrium live greek myth

sisyphus tale unending pointless work eternity sisyphus sentence roll large heavy rock steep hill penance crime sisyphus nearly reach hill rock roll cycle continue eternity sisyphus near hill boulder enchant zeus roll away force sisyphus restart task story work mechanical energy transfer push boulder hill sisyphus exert force perform work rock result increase rock gravitational potential energy rock escape grasp roll backwards energy change gravitational potential energy kinetic energy sisyphus punishment futile work serve strong model exchange mechanical energy form potential kinetic number form energy exist thermal energy sound light chemical potential energy electrical potential energy mechanical energy specifically focus object motion chapter review fundamental concept energy work work energy theorem powerful expression relationship energy work simple approach kinematic question test day finally discuss topic mechanical advantage examine pulley ramp helpful raise heavy object hope convince kaplan mcat program preparation test day way sisyphean task chapter 2.1 able describe kinetic energy potential energy compare contrast conservative nonconservative force energy refer system ability work broadly happen broad definition help understand different form energy capacity perform different action example mechanical energy cause object accelerate ice cube sit kitchen counter room temperature absorb thermal energy heat transfer eventually melt water undergo phase transformation solid liquid nuclear bind energy release fission reaction run power plant let turn attention different form energy discuss way energy transfer system kinetic energy energy motion object mass move speed associate kinetic energy calculate follow k kinetic energy m mass kilogram v speed meter second si unit kinetic energy form energy joule j equal kinetic energy incredibly important mcat time object speed think kinetic

kinetic energy incredibly important mcat time object speed think kinetic energy link kinetic energy relate concept work conservation mechanical energy recall fall object chapter 1 object kinetic energy fall fast fall kinetic energy mindful fact mcat interested test student comprehension relationship kinetic energy speed equation kinetic energy function square

speed speed double kinetic energy quadruple assume mass constant note kinetic energy relate speed velocity object kinetic energy regardless direction velocity vector kinetic energy relate speed velocity object kinetic energy regardless direction velocity vector fall object kinetic energy object move way example kinetic energy fluid flow speed measure indirectly dynamic pressure term bernoulli equation discuss chapter 4 mcat physics math review object slide incline plane gain kinetic energy speed increase ramp example 15 kg block initially rest slide frictionless incline come speed show kinetic energy object ramp block plane move downward solution v = 0 kinetic energy kinetic energy potential energy refer energy associate give object position space intrinsic quality system potential energy say potential work name form energy store chemical potential energy energy absorb food eat digest metabolize electrical potential energy discuss chapter 5 mcat physics math review base electrostatic attraction charge particle chapter examine type potential energy dissipate movement gravitational potential energy elastic gravitational potential energy gravitational potential energy depend object position respect level identify datum ground zero potential energy position zero potential energy position usually choose convenience example find convenient consider potential energy pencil hand respect floor hold pencil floor respect desktop hold pencil desk equation use calculate gravitational potential energy u = mgh u potential energy m mass kilogram g acceleration gravity h height object height potential energy equation relative problem state ground level simply distance ground need zero potential energy position ledge desktop platform pay attention question stem use height discuss potential energy direct relationship variable

question stem use height discuss potential energy direct relationship variable change give factor result change potential energy factor triple height triple mass object increase gravitational potential energy factor example 80 kg diver leap 10 m cliff sea show find diver potential energy cliff meter underwater sea level datum man dive 10 m ledge solution cliff meter underwater elastic potential energy spring elastic system act store energy spring

characteristic length consider relaxed equilibrium spring stretch compress equilibrium length spring elastic potential energy determine u potential energy k spring constant measure stiffness spring x magnitude displacement equilibrium note similarity equation formula total mechanical energy sum object potential kinetic energy total mechanical energy equation e = u + k e total mechanical energy u potential energy k kinetic energy law thermodynamic account conservation mechanical energy posit energy create destroy merely transfer form mean total mechanical energy necessarily remain constant notice total mechanical energy equation account potential kinetic energy form energy thermal energy transfer result friction heat frictional force present mechanical energy transform thermal energy lost”—or accurately dissipate system account equation note violation law thermodynamic accounting form energy kinetic potential thermal sound light reveal net gain loss total energy merely transformation energy form conservation mechanical energy absence nonconservative force frictional force sum kinetic potential energy constant conservative force path independent dissipate energy conservative force potential energy associate mcat commonly encounter conservative force gravitational electrostatic elastic force approximate conservative case mcat include spring problem frictional force ignore actuality spring heat forth friction particle spring material equivalent way determine force conservative demonstrate figure 2.1 description give caption figure 2.1 determine force conservative change energy round trip path zero change energy equal despite take path point force conservative transfer energy form key feature bioenergetics metabolism discuss chapter 9 12 mcat biochemistry review look carbohydrate metabolism chemical potential

9 12 mcat biochemistry review look carbohydrate metabolism chemical potential energy bond glucose convert electrical potential energy high energy electron nadh fadh2 dissipate electron transport chain generate proton motive force example electrical potential energy force fuel atp synthase trap energy high energy phosphate bond atp method consider change energy system system bring original setup mechanical term mean object come starting position net

change energy zero regardless path take initial position force act object conservative basically mean system experience conservative force give usable energy equal take away course close path example object fall certain displacement vacuum lose measurable potential energy gain exactly potential energy lift original height regardless return pathway initial descent furthermore point fall vacuum perfect conversion potential energy kinetic energy energy lose nonconservative force air resistance course real life nonconservative force impossible avoid method consider change energy system move setup mechanical term mean object undergo particular displacement energy change equal regardless path take force act object work nonconservative force zero nonconservative force act system total mechanical energy system u + k remain constant conservation mechanical energy express δe = δu + δk = 0 δe δu δk change total mechanical energy potential energy kinetic energy respectively conservative force gravity electrostatic force conserve mechanical energy nonconservative force friction air resistance dissipate mechanical energy

thermal chemical energy nonconservative force friction air resistance viscous drag resistance force create fluid viscosity present total mechanical energy conserve equation

wnonconservative = δe = δu + δk wnonconservative work nonconservative force work nonconservative force exactly equal energy lose system reality energy simply transform form energy thermal energy account mechanical energy equation nonconservative force unlike conservative force path dependent long distance travel large energy dissipate example baseball mass 0.25 kg throw air initial speed air resistance ball return ground speed find work air resistance solution air resistance nonconservative force solve problem energy equation nonconservative system need work air resistance wnonconservative = δe = δu + δk case δu = 0 initial final height negative sign answer indicate energy dissipate system mcat concept check 2.1 assess understanding material 1 define kinetic energy potential energy 2 compare contrast conservative nonconservative force happen total mechanical energy system path

take matter example 2.2 work hy chapter 2.2 able recall unit work distinguish work energy calculate work system high yield badge section indicate content frequently test mcat term work erroneously mean form energy si unit work joule j si unit form energy work form energy miss important work actually form energy process energy transfer system fact way energy transfer transfer energy call heat focus bit chapter 3 mcat physics math review work energy measure energy transfer form energy transfer heat transfer energy work heat way occur familiar process everyday life example discuss introduction chapter time king sisyphus push rock hill rock gain kinetic potential energy energy come sisyphus muscle potential energy contain high energy phosphate bond atp molecule convert mechanical energy contract muscle exert force rock cause accelerate chemical level potential energy atp harness heat transfer fact molecular level different work involve movement molecule atom electron exert force work molecule atom like transfer energy perfectly efficient process energy lose thermal energy muscle literally warm contract repeatedly force displacement energy transfer process work exert force express mathematically

force displacement energy transfer process work exert force express mathematically $w = f d = fd \cos \theta$ w work f magnitude apply force d magnitude displacement force apply θ angle apply force vector displacement vector notice work dot product function cosine angle vector mean force component force parallel antiparallel displacement vector work transfer energy say si unit work joule suggest work energy thing remember work process quantity energy move system pressure volume describe work process energy transfer mechanic think work application force distance learn discussion fluid chapter 4 mcat physics math review pressure think energy density system gas approach work combination pressure volume change chapter 3 mcat physics math review examine change relate heat gas system contain cylinder movable piston analyze relationship pressure volume work gas expand push piston exert force cause piston volume system increase gas compress piston push gas exert force decrease volume system work volume system change apply pressure gas expansion compression process

represent graphical form volume x axis pressure y axis graph show figure 2.2 term p v graph gas decrease pressure constant volume b gas increase volume constant pressure c gas increase volume decrease pressure d gas undergo close loop process figure 2.2 pressure volume p v curve work system undergo thermodynamic process determine find area enclose corresponding pressure volume curve gas expand work gas work positive gas compress work gas work negative infinite number path initial final state different path require different amount work calculate work system find area pressure volume curve note volume stay constant pressure change δv = 0 work area calculate case figure 2.2a call isovolumetric isochoric process hand pressure remain constant volume change δp = 0 area curve rectangle length p width δv show figure 2.2b process pressure remain constant isobaric process work calculate w = pδv work system

constant isobaric process work calculate w = pδv work system gas expand work say positive work system gas compress work say negative mcat expect calculate integral p v graph calculus expect able calculate area straight line graph necessary figure 2.2c show process pressure volume hold constant total area graph regions ii give work region triangle base δv height δp area region ii rectangle base δv height p2 area aii = p2δv work sum area region ii w = ai + aii figure 2.2d show close cycle certain interchange work heat system return initial state work positive gas expand negative gas compress work area enclose curve calculate work situation require calculus mcat test power refer rate energy transfer system calculate equation p power w work equal δe change energy t time work si unit power watt w equal chapter 6 mcat physics math review identify additional way calculate power electric circuit note device use day toaster oven light bulb phone car quantify rate appliance transform electrical potential energy form thermal light sound kinetic energy power calculate different situation especially involve circuit resistor capacitor equation electric power p = iv p power current v electrical potential difference voltage equation discuss chapter 6 mcat physics math review power measure rate energy consumption transfer transformation unit time work energy theorem powerful

expression relationship work energy mechanical application offer direct relationship work force act object change kinetic energy object net work force act object result equal change object kinetic energy word wnet = δk = kf ki relationship important understand allow calculate work know magnitude force act object displacement force act calculate change kinetic energy experience object definition net work object press brake pedal car put work energy theorem practice brake pad exert frictional force rotor attach wheel frictional force work wheel cause decelerate bring

rotor attach wheel frictional force work wheel cause decelerate bring car halt net work force equal change kinetic energy car general iteration work energy theorem apply change form energy fact law thermodynamic essentially reiteration work energy theorem change internal energy δu equal heat transfer system q minus mechanical work system w example lead ball mass 0.125 kg throw straight air initial velocity assume air resistance find work force gravity time ball maximum height solution answer calculate kinematic determine maximum height ball w = fd cos θ simple use mcat concept check 2.2 assess understanding material 1 unit work work energy different 2 provide method calculate work 3 drive vehicle constant velocity flat surface accelerator slightly depress overcome resistive force work engine accelerator compare work resistance 2.3 mechanical advantage chapter 2.3 able explain work lose system 100 efficient recall meaning mechanical advantage recognize simple machine predict impact change effort value effort distance pulley system assume work output remain difference sisyphus lift rock vertically final position roll incline difference scenario mechanical advantage

measure increase force

accomplish tool slope incline hillside ramp easy lift object distribute require work large distance decrease require force give quantity work device allow work accomplish small apply force say provide mechanical advantage addition inclined plane device consider classic simple

machine design provide mechanical advantage wedge merge inclined plane wheel axle lever pulley screw rotate inclined plane incline plane lever pulley frequently test mcat mechanical advantage ratio magnitude force exert object simple machine fout force actually apply simple machine fin mechanical advantage ratio dimensionless reduce force need accomplish give work cost associate distance small force apply order work increase inclined plane lever pulley magically change work necessary object place displacement pathway independent actual distance travel initial final position matter assume force conservative apply less force great distance achieve change position displacement accomplish work consider dynamic incline plane lever chapter 1 mcat physics math review look work associate incline plane example block weigh 100 n push frictionless incline distance 20 m height 10 m show inclined plane force apply object length plane 20 m height 10 m 1 minimum force require push block 2 work force 3 force require work force block simply lift vertically 10 m 1 find minimum force require push block draw free body diagram situation block normal force apply force force gravity labeled minimum force need force push block acceleration parallel surface incline mean magnitude apply force equal parallel component gravity f = mg sin θ mg represent weight object 100 n. trigonometry sin θ ratio length opposite hypotenuse 2 work f w = fd cos θ case θ represent angle force displacement vector angle inclined plane force displacement vector parallel θ = 0 cos θ = 1 w = 50 n)(20 m)(1 = 1000 j 3 raise block vertically upward force equal object weight 100 n generate work

vertically upward force equal object weight 100 n generate work lift force w = fd cos θ = 100 n)(10 m)(1 = 1000 j work require case twice force need raise block vertically compare push pulley utilize paradigm provide mechanical advantage incline plane reduction necessary force cost increase distance achieve give value work energy transference practical term pulley allow heavy object lift much- reduce force simply lift heavy object mass m height h require work equal mgh change gravitational potential energy displacement occur distance equal displacement force require lift object equal mg distance displacement achieve great

displacement indirect path apply force mg word able lift heavy object desire height small force apply small force great distance order lift heavy object final examine pulley create mechanical advantage let consider heavy block figure 2.3 suspend rope block accelerate translational equilibrium force block exert downward weight cancel sum tension rope symmetrical system tension rope equal half weight block block hold rope t1 t2 point weight point t1 + t2 = mg weight figure 2.3 block suspend rope block translational equilibrium tension rope equal half weight block let imagine heavy block figure 2.4 represent heavy crate lift assume crate momentarily hold stationary midair system translational equilibrium weight load balance total tension rope tension vertical rope equal unequal pulley turn tension equal side rope support half crate total weight extension half force effort require lift crate decrease effort mechanical advantage provide pulley discuss mechanical advantage come expense distance lift object certain height air load distance pull length rope effort distance equal twice displacement example crate lift shelf 3 meter ground side support rope shorten 3 meter way accomplish pull 6 meter rope pulley rope hold object weight mg rope pulley tension t figure 2.4 pulley system block suspend rope bear half block weight simple machine

system block suspend rope bear half block weight simple machine approximate conservative system ignore usually small energy lose external force friction idealized pulley massless frictionless theoretical condition work system exertion force distance rope exactly equal work come system displacement mass height real pulley real machine matter fail conform idealized condition achieve 100 percent efficiency conserve energy output input define work input product effort effort distance likewise define work output product load load distance compare ratio define efficiency simple machine consider simple machine load effort force load determine necessary output force output force mechanical advantage determine necessary input force efficiency express percentage multiply efficiency ratio 100 percent efficiency machine give measure useful work generate machine give work system corollary definition percentage work system unusable nonconservative external force pulley system figure 2.5

illustrate fact add pulley increase mechanical advantage additional pair pulley reduce effort case load divide length rope effort require sixth total load remember need pull length rope time desire displacement efficiency decrease add weight pulley additional friction force free body diagram weight point 6 t rope worth tension point figure 2.5 system pulley increase number pulley decrease tension segment rope lead increase mechanical advantage setup example pulley system figure 2.5 efficiency 80 percent person lift mass 200 kg pulley 1 distance effort raise load distance 4 m 2 effort require lift load 3 work person lift load height 4 m 1 load vertical distance 4 m support rope shorten 4 m. accomplish pull 6 × 4 = 24 m rope setup effort distance 24 m. 2 calculate effort require equation efficiency load weight object lift equal mass object time acceleration gravity g. effort distance calculate 24 m. 3 work person mcat

concept check 2.3 assess understanding material 1 length incline plane increase happen force require object displacement 2 effort decrease pulley system happen effort distance maintain work output 3 account difference work input work output system operate 100 efficiency 4 mean device provide mechanical advantage 5 simple machine conceptualization energy capacity happen broad definition all- encompass definition allow understand push rock hill melt ice cube stop car intersection harness energy biomolecule metabolism form energy transfer energy little significance consider transfer energy work heat work energy theorem powerful expression guide approach problem chemical physical foundations biological systems section cover application energy work simple machine lever incline plane pulley device assist accomplish work reduce force necessary displace object prepare mcat hard mental work way achieve success test day mcat physics math review book material provide kaplan program set tool simple machine provide mechanical advantage ease effort high review content test knowledge critical thinking skill complete test like passage set online energy property system enable happen include capacity work si unit form energy joules j

kinetic energy energy associate movement object depend mass speed square velocity potential energy energy store system exist gravitational elastic electrical chemical form gravitational potential energy relate mass object height zero point call datum elastic potential energy relate spring constant measure stiffness spring degree stretch compression spring square electrical potential energy exist charge particle chemical potential energy energy store bond total mechanical energy system sum kinetic conservative force path independent dissipate mechanical energy system conservative force act object total mechanical energy conserve example conservative force include gravity electrostatic force elastic force create spring nearly nonconservative force path dependent cause dissipation mechanical energy system total energy conserve mechanical energy lose thermal chemical energy example nonconservative force include friction air resistance viscous drag work process energy transfer system work express dot product

drag work process energy transfer system work express dot product force displacement product force distance travel cosine angle work express area pressure volume p v curve power rate work energy transfer si unit power watt w work energy theorem state net work system system kinetic energy change general application work system transfer form energy mechanical advantage factor simple machine multiply input force accomplish work simple machine inclined plane wedge wheel axle lever pulley screw simple machine provide benefit mechanical advantage make easy accomplish give work input force necessary accomplish work reduce distance reduce input force apply increase factor assume 100 load output force simple machine act give load distance determine work output simple machine effort input force simple machine act give effort distance determine work input simple efficiency ratio machine work output work input nonconservative force take account answer concept check 1 kinetic energy energy motion relate mass object speed square potential energy energy associate give position intrinsic property system store gravitational electrical elastic chemical form gravitational potential energy directly relate mass object height reference point happen

energy path take yes energy dissipate long path gravity electrostatic force 1 unit work joule unit energy work energy relate concept perform work energy system change work heat form energy transfer 2 method calculate work discuss chapter 1 w = fd cos θ dot product force displacement 2 w = pδv area pressure volume curve 3 wnet = δk work energy theorem 3 begin think form work affect vehicle try work happen term force displacement get tricky consider move engine part case simple think work term kinetic energy work engine increase kinetic energy car positive conversely work resistance decrease kinetic energy car mean work car negative engine work friction positive change kinetic energy resistance work change negative equal amount work change kinetic energy

resistance work change negative equal amount work change kinetic energy give vehicle maintain constant velocity change kinetic energy accord work energy theorem net work zero infer positive work engine equal negative work resistance 1 length inclined plane increase force necessary perform work move object displacement decrease 2 effort require force decrease pulley system effort distance increase generate work 3 decrease work output nonconservative external force generate dissipate energy 4 device provide mechanical advantage decrease input force require generate particular output force generally accomplish expense increase distance force act 5 simple machine incline plane wedge wheel axle lever pulley screw science mastery assessment explanation

weight barbell force act downward 2750 n follow weightlifter exert equal opposite force 2750 n barbell work lift barbell w = fd cos θ = 2750 n)(2.4 m)(cos 0  7000 j. equation follow work hold barbell place w = fd cos θ = 2750 n)(0 m)(cos θ = 0 j. barbell hold place displacement work zero close c work tractor calculate equation w = fd cos θ = 5000 n)(100 m)(cos 30 ° = 5000)(100)(0.866  5000 × 90 = 450,000 j = 450 kj. close c estimate round 0.866 0.9 expect actual answer calculate answer work engine equal change kinetic energy car average power assume negligible air resistance conservation energy state total mechanical energy block

constant fall start height 5 m block potential energy equal kinetic energy point 0 j total mechanical energy 2000 j point block descent isochoric process definition gas system undergo change volume gas expand compress work perform remember work thermodynamic system area p v curve change volume 0 area curve 0

calculate tension force rope draw free body force diagram notice tension force pull mass net force system fnet equal 2 t mg use newton second law gravity conservative force pathway independent dissipate mechanical energy air resistance friction b)—are nonconservative force dissipate energy thermally convection force method heat transfer uniform circular motion displacement vector force vector perpendicular work potential energy constant object uniform circular motion gravitational potential energy satellite orbit earth electrical potential energy electron orbit nucleus idealized atom case potential energy change depend position object circle work energy theorem relate total work object force change kinetic energy experience object work force proportional magnitude force proportional displacement object eliminate change kinetic energy equal proportional total work object net force force relate work object eliminate c finally change kinetic energy object equal work force act object combine apply force eliminate d elastic potential energy like kinetic energy relate square variable show equation increase displacement factor 2 increase potential energy factor 22 = 4 sarah bounce higher josh assume mechanical energy conserve sarah josh start give potential energy convert kinetic energy elastic potential energy kinetic energy loss energy system eliminate d logic individual return starting height josh start potential energy moment hit net potential energy convert kinetic energy eliminate b josh experience great force impact net exert force proportional weight high weight large force exert net eliminate c terminal velocity force gravity force air resistance equal magnitude lead translational equilibrium statement true force magnitude act displacement work perform make statement iii true net force equal zero force act parachutist make statement

mechanical advantage ratio output force generate give particular input force efficiency ratio useful work perform system compare work perform absence nonconservative force change potential energy meet equal change kinetic energy note difference potential energy difference kinetic energy proportionality eliminate b d true statement necessarily object mass quadruple height horsepower unit power evidence conversion factor give question stem power rate energy expenditure time give unlimited time car capable unlimited increase kinetic energy mean unlimited maximum velocity fact car b high power rating mean reach give velocity fast car eliminate b information judgment efficiency car eliminate c long car reach give velocity car unlimited maximum velocity eliminate d consult online resource additional practice equation remember 2.1 kinetic energy 2.2 gravitational potential energy u = mgh 2.3 elastic potential energy 2.4 total mechanical energy e = u + k 2.5 conservation mechanical energy δe = δu + δk = 0 2.6 work nonconservative force wnonconservative = δe = δu 2.7 definition work mechanical w = f d = fd cos θ 2.8 definition work isobaric gas piston system w = pδv 2.9 definition power 2.10 work energy theorem wnet = δk = kf ki 2.11 mechanical advantage biochemistry chapter 6 dna biotechnology biochemistry chapter 9 carbohydrate metabolism biochemistry chapter 12 bioenergetic regulation metabolism general chemistry chapter 7 physics math chapter 1 kinematic dynamic physics math chapter 3 chapter 3 thermodynamic thermometer background pre med know feeling content know mcat know important 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

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 get correct ensure thinking match explanation review concept summary end chapter object initial temperature 300 k increase temperature 1 ° c minute degree fahrenheit temperature increase

10 following choice correctly identify follow heat transfer heat transfer sun earth metal spoon heat place pot hot soup rise plume smoke fire i. radiation ii conduction iii convection i. conduction ii radiation iii convection i. radiation ii convection iii conduction i. convection ii conduction iii radiation 20 m steel rod 10 ° c dangle edge building 2.5 cm ground rod heat 110 ° c rod touch ground note α = 1.1 × 105 yes expand 3.2 cm yes expand 2.6 cm expand 2.2 cm expand 1.8 cm final temperature 3 kg work iron fireplace tool leave electric heater absorb heat energy rate 100 w 10 minute assume tool initially 20 ° c specific heat work iron heat require completely melt pair gold earring weigh 500 g give initial temperature 25 ° c melting point gold 1064 ° c heat fusion specific heat 15 kj 32 kj 66 kj 97 kj give cycle show total work gas cycle p v graph pascal vs. cubic meter triangle follow point sequence 1,5 6,2 1,2 10 j 0 j 7.5 j 17.5 j adiabatic compression process internal energy gas increase work gas negative increase work gas positive decrease work gas negative decrease work gas positive entropy system decrease decrease entropy surrounding increase decrease system isolate process irreversible decrease adiabatic reversible process student make coffee cup calorimeter fail use second coffee cup inadequately seal lid initial goal result

try create isolate system create open system instead try create isolate system create close system instead try create closed system create open system instead try create closed system create isolate system instead certain substance specific heat melting point 350 k. mole substance currently temperature 349 k energy add order melt 1 j exactly 1 j 1 j 0 j 0 j follow state function internal energy figure show depict thick metal container compartment

compartment hot gas compartment b cold gas primary mode heat transfer system adjacent rectangle b substance b freeze boiling point solid sample substance heat exact way substance boil substance b. following explain phenomenon substance b high specific heat substance b high heat vaporization substance b high heat fusion substance b high internal energy experiment student mix ink water notice liquid mix evenly experiment b student mix oil water case liquid separate different layer entropy change positive experiment negative experiment b. positive experiment zero experiment b. negative experiment positive experiment b. zero experiment negative experiment b. following process

likely accompany change kinetic energy gas increase chemical reaction energy transfer solid electromagnetic wave boil liquid heat hot plate warm gas mix cold gas c ch 3.1 ch 3.3 c ch 3.1 c ch 3.3 d ch 3.3 c ch 3.3 b ch 3.3 b ch 3.4 ch 3.2 ch 3.3 b ch 3.2 c ch 3.3 d ch 3.3 b ch 3.4 c ch 3.3 chapter 3 thermodynamic chapter 1 3.1 zeroth law thermodynamics 3 thermal expansion 4 3.2 system 5 system type 6 state function 7 3.3 law thermodynamics hy 9 thermodynamic process 10 3.4 second law thermodynamics entropy 11 energy dispersion 13 concept summary pie chart indicate content chapter relevant percent question physics mcat content chapter relevant 9 question physics mcat chapter cover material following aamc content category 4b importance fluid circulation blood gas movement 5e principle chemical thermodynamic kinetic thermodynamic study flow energy universe flow relate work heat entropy different form energy classical thermodynamics concern observation macroscopic level measurement temperature pressure volume work mcat test entropy thermodynamic probabilistic understanding briefly discuss statistical model entropy clarify confusion arise characterization entropy measure chapter review law thermodynamic specific focus zeroth second law examine zeroth law lead formulation temperature scale thermal expansion discuss example relationship thermal energy physical property like length volume conductivity moment examine thermodynamic terminology function intimately related concept discuss chapter 7 mcat general chemistry review context law conservation energy discuss relationship internal

energy heat work characterize specific heat heat transformation review process system go equilibrium state connect work discuss chapter 2 mcat physics math review heat finally investigate second law thermodynamic concept entropy measurement law thermodynamic directly test mcat briefly mention 3.1 zeroth law thermodynamics chapter 3.1 able explain zeroth law thermodynamic predict relative expansion object undergo temperature describe basis significance kelvin scale zeroth law thermodynamic base

temperature describe basis significance kelvin scale zeroth law thermodynamic base simple observation object thermal equilibrium object cup warm tea metal stirring stick second object thermal equilibrium object hand object thermal equilibrium bring thermal contact net heat flow object note thermal contact necessarily imply physical contact object thermal contact space zeroth law thermodynamic state transitive property thermal system = b b = c = c.

formulation zeroth law net heat flow object thermal equilibrium corollary heat flow object thermal equilibrium actually arise study temperature give time substance particular temperature everyday language use term temperature describe qualitatively hot cold thermodynamic precise meaning molecular level temperature proportional average kinetic energy particle substance macroscopic level difference temperature object determine direction heat flow possible heat move spontaneously material high temperature material low temperature heat refer transfer thermal energy hot object high temperature energy cold object low temperature energy net heat flow object thermal contact temperature equal thermal equilibrium temperature physical property matter relate average kinetic energy particle difference temperature determine direction heat transfer 18th century scale develop quantify temperature matter thermometer system common use include fahrenheit ° f celsius ° c kelvin k scale fahrenheit celsius old scale common use relatively convenient base phase change water show table 3.1 celsius scale 0 ° 100 ° define freeze boiling temperature water fahrenheit scale phase change temperature define 32 ° 212 ° table 3.1 relevant point major

temperature scale 460 273 0 freezing point water 32 boiling point water kelvin scale commonly scientific measurement seven si base unit define zero reference point absolute zero theoretical temperature thermal energy set freezing point water 273.15 k. law thermodynamics state entropy perfectly organize crystal absolute zero zero note negative temperature kelvin scale start absolute zero kelvin celsius scale different zero reference point size unit change degree celsius equal change unit kelvin 180 degree water phase change fahrenheit scale 100 degree celsius kelvin scale size fahrenheit unit small following formula

convert scale f c k temperature fahrenheit celsius kelvin time fahrenheit routinely mcat body temperature 98.6 ° f 37 ° c rare occasion quantitative analysis question conversion give example meteorologist say temperature reach high 86 ° f today high temperature ° c k solution convert fahrenheit celsius use convert celsius kelvin k = c + 273 = 30 + 273 = 303 k long note physical property matter change matter get hot cold length volume solubility conductivity matter change function temperature relationship temperature physical property matter develop temperature scale familiar today example daniel fahrenheit develop temperature scale bear place thermometer fill mercury bath ice water ammonium chloride cold temperature cause mercury contract level glass tube stabilize low level mark zero reference scale place mercury thermometer mixture ice water freezing point water slightly warm temperature mixture cause mercury rise glass column stabilize high level fahrenheit

assign value 32 ° stick thermometer tongue mark high mercury level 100 ° 98.6 ° detail fahrenheit come choose number history adjustment fahrenheit develop scale scope discussion important note change physical property kind matter case height column mercury correlate certain temperature marker phase change water scale set reference decide temperature marker thermometer temperature matter accordance zeroth thermal expansion bridge sidewalk gap segment allow thermal expansion temperature object change length change lot property thermal expansion integral development thermometer let look little

closely phenomenon change temperature solid result change length rise temperature cause increase length fall temperature cause decrease length length change proportional original length solid increase temperature accord equation δl = αlδt δl change length α coefficient linear expansion l original length δt change temperature coefficient linear expansion constant characterize specific material length change temperature change usually unit k–1 quote ° c–1 difference inconsequential unit size kelvin celsius scale example metal rod length 2 m coefficient linear expansion 106 k1 cool 1080 ° c 80 ° c final length solution information give problem substitute directly thermal expansion formula δl = αlδt = 106 k)(2 m)(80 k  1080 k = 2 × 103 m negative sign represent decrease length original length 2 m final length 2  2 × 103 = 1.998 m.

liquid experience thermal expansion meaningful parameter expansion volume expansion formula volumetric thermal expansion applicable liquid solid δv = βvδt δv change volume β coefficient volumetric expansion v original volume δt change temperature coefficient volumetric expansion constant characterize specific material volume change temperature change value equal time coefficient linear expansion material β = 3α example suppose thermometer 1 ml mercury take freezer temperature 25 ° c place near oven 275 ° c coefficient volume expansion mercury 1.8 × 104 k1 liquid expand solution use information give plug volumetric expansion mcat concept check 3.1 assess understanding material 1 zeroth law thermodynamic 2 maximum distance object adhere zeroth law thermodynamic 3 initial length object expand give temperature change relate 4 true false kelvin scale accurate measurement method temperature base absolute zero chapter 3.2 able distinguish closed isolated open thermodynamic compare contrast state process function list common state function physicist chemist tend classify world basis observable phenomenon interaction object move need familiar jargon field common specifically thermodynamic system state function note jargon discuss chapter 7 mcat general system portion universe interested observe manipulate rest universe consider surrounding isolated system capable exchange energy

matter surrounding result total change internal energy zero isolated system rare approximate bomb calorimeter attempt insulate reaction surrounding prevent energy transfer entire universe consider isolate system surrounding closed system capable exchange energy matter surrounding classic experiment involve gas vessel movable piston example close system thermodynamic purpose encounter test day close system approximate close system open system exchange matter energy environment open system matter carry energy energy transfer form heat work boil pot water human being uncontained combustion reaction example state function thermodynamic property function current equilibrium state system word state function define fact independent path take particular equilibrium state state function include pressure p density ρ temperature t volume v enthalpy h

pressure p density ρ temperature t volume v enthalpy h internal energy u gibbs free energy g entropy s hand process function work heat describe path take state mcat concept check 3.2 assess understanding material 1 following thermodynamic system transfer matter system type transfer matter transfer energy 2 difference state function process 3 list common state function 3.3 law thermodynamics high yield chapter 3.3 able recall mathematical relationship internal energy work describe conduction convection radiation draw graph temperature solid heat gas calculate work p v diagram encounter law thermodynamics discussion conservation mechanical energy chapter 2 mcat physics math review remember absence nonconservative force sum kinetic potential energy constant system present discussion thermodynamic look closely relationship internal energy heat work essentially law thermodynamic state change total internal energy system equal energy transfer form heat system minus energy transfer system form work internal system combination process change internal energy

calculate equation $\delta u = q - w$ $\delta u$ change system internal energy q energy transfer system heat w work system use equation properly carefully apply follow sign convention show table 3.2 table 3.2 sign convention law thermodynamics change internal heat flow system heat flow

system work work law thermodynamic tell increase total internal energy system cause transfer heat system perform work system total internal energy system decrease heat lose system work perform law particular iteration universal physical law energy conservation energy create destroy change form law account work heat process impact system presence nonconservative force pose problem energy transfer associate friction air resistance viscous drag account law equation example car burn rubber smoke noise come tire clear indication mechanical energy conserve include energy transfer associate frictional force consideration change internal energy system confidently energy lose loss energy car result friction precise energy find thermal energy atom molecule surround road air chapter 2 mcat physics math review define work process energy transfer result force apply distance note work heat process energy transfer object discuss early chapter zeroth law thermodynamic say object thermal contact thermal equilibrium temperature corollary second law thermodynamic object thermal contact thermal equilibrium exchange heat energy object high temperature heat energy object low temperature object temperature thermal equilibrium heat define process quantity energy transfer object result difference temperature discuss examination

second law heat spontaneously transfer energy cool object warm work system heat process energy transfer object different temperature continue object come thermal equilibrium temperature si unit heat joule j surprising base energy heat measure unit calorie cal nutritional calorie cal british thermal unit btu nutritional calorie big c thing calorie little c calorie equal 1000 calorie 1 kcal calorie little c heat require raise 1 g water degree celsius calorie big c heat require raise 1 kg water 1 degree celsius equal 1000 calorie conversion factor unit heat follow 1 cal  103 cal = 4184 j = 3.97 btu

energy transfer object thermal contact necessarily mean object touch like force energy travel tremendous distance require medium pass mean heat transfer energy conduction convection radiation conduction direct transfer energy molecule molecule molecular collision definition

suggest direct physical contact object atomic level particle hot matter transfer kinetic energy particle cool matter collision particle material metal describe good heat conductor metallic bond contain density atom embed sea electron facilitate rapid energy transfer gas tend poor heat conductor space individual molecule energy transfer collision occur relatively infrequently example heat transfer conduction heat rapidly painfully conduct finger touch hot stove convection transfer heat physical motion fluid material convection involve flow liquid gas transfer heat means convection fluid high temperature transfer energy material restaurant home kitchen convection oven use fan circulate hot air inside oven heat transfer food convection radiation radiation convection oven cook rapidly radiation oven convection wick heat energy away hot object laboratory experiment example run cold water bath rapidly cool reaction radiation transfer energy electromagnetic wave unlike conduction convection radiation transfer energy vacuum radiation method sun able warm earth home kitchen radiant oven use electrical coil gas flame heat insulated metal box form body oven hot metal box radiate energy open space oven absorb food place inside heat energy add remove system temperature system change proportion heat transfer system undergo phase change temperature constant relationship heat temperature substance call specific heat specific heat c substance define heat energy require raise gram substance degree celsius unit kelvin example specific heat liquid water calorie gram unit kelvin equivalently express specific heat substance change accord phase mcat generally provide specific heat value necessary expect know specific heat water calorie equation relate heat gain lose object change temperature object q = mcδt specific heat water calorie constant expect know test day value equation heat transfer give

constant expect know test day value equation heat transfer give specific heat test study q = mcδt look lot like q equal mcat m mass c specific heat substance δt change temperature celsius kelvin unit size celsius kelvin scale change temperature temperature measure celsius kelvin heat transformation substance undergo phase change solid liquid liquid gas heat add

remove system result change temperature word phase change occur constant temperature temperature begin change substance convert phase example water melt 0 ° c matter heat add mass ice 0 ° c temperature equilibrate system rise ice melt liquid water determine add heat raise temperature system particle system great average kinetic energy true molecule great degree freedom movement liquid state solid state gas state phase change relate change potential energy kinetic energy molecule water ice example truly frozen place unable molecule rotate vibrate wiggle bond molecule free bend stretch course molecule hold relatively stable position hydrogen bond form fairly significant kinetic energy potential energy low stability provide relative closeness molecule hydrogen bond think happen add heat ice 0 ° c heat energy cause water molecule begin away break free hydrogen bond water molecule hold rigidly place great degree freedom movement average potential energy increase statistical mechanic increase freedom movement permit great number microstate water molecule example instead able sway water molecule freedom movement able rock forward gain additional direction form motion motion decrease keep average kinetic energy liquid water 0 ° c solid water 0 ° c summary liquid water great number

microstate increase freedom movement average kinetic energy solid water temperature heat energy add remove system experience phase change heat add remove calculate equation q = mcδt temperature change phase change instead following equation q = ml q heat gain lose material m mass substance l heat transformation latent heat substance important know common term phase change solid liquid fusion melting liquid solid freezing solidification liquid gas boiling evaporation vaporization gas liquid condensation solid gas sublimation gas solid deposition phase change discuss chapter 7 mcat general phase change liquid solid freezing solidification solid liquid melting fusion occur melting point correspond heat transformation call heat fusion phase change liquid gas boiling evaporation vaporization gas liquid condensation occur boiling point correspond heat transformation call heat vaporization relevant heat fusion vaporization provide test day heat transformation sweating efficient

cooling mechanism sweat evaporate heat vaporization absorb surface body hot day intense humid sweat likely evaporate dampness environment heat lose surface skin sweating example silver melting point 962 ° c heat fusion approximately specific heat silver approximately heat require completely melt 1 kg silver chain initial temperature 20 ° c solution melt chain heat chain melting point figure heat require use tell add 219 kj heat chain temperature melting point chain solid phase melt continue add heat accordance formula total heat need melt solid silver chain 219 kj + 105 kj = 324 chapter give significant consideration work change energy system function force displacement function volume pressure briefly review relationship heat transfer system mind work accomplish change displacement likely motivate heat transfer heat transfer occur likely result friction dissipate mechanical energy system thermodynamic process system go initial equilibrium state initial pressure temperature volume equilibrium state different final pressure temperature volume thermodynamic process represent graphical form volume x axis pressure temperature y axis table 3.3 special type

x axis pressure temperature y axis table 3.3 special type thermodynamic process law thermodynamic reduce isothermal δu = 0 q = w adiabatic q = 0 δu = w

isobaric

constant pressure multiple possible form isovolumetric isochoric w = δu = q mcat focus particular thermodynamic process special case law exclude isobaric process show table 3.3 case physical property hold constant process process isothermal constant temperature change internal energy adiabatic heat exchange isovolumetric change volume work accomplish call isochoric isobaric process occur constant pressure focus mcat figure 3.1 show different type thermodynamic behavior gas p v graph isobaric horizontal line isovolumetric vertical line isothermal adiabatic negative slope upward curvature isothermal adiabatic figure 3.1 thermodynamic behaviors gases figure 3.2 show closed loop thermodynamic process work

p v graph simply area curve work closed loop process area inside loop line form enclose space p v graph figure 3.2 close loop process work area inside loop example gas cylinder keep constant pressure 3.6 × 105 pa 300 kj heat add causing gas expand 1.0 m3 1.5 m3 find work gas change internal energy gas solution pressure hold constant entire process work find equation line form enclose space p v graph change internal energy find law mcat concept check 3.3 assess understanding material 1 describe relationship internal energy work heat 2 define following form heat transfer 3 draw representative graph temperature solid object heat go phase change gas axis temperature vs. heat add 4 work calculate p v diagram 3.4 second law thermodynamics chapter 3.4 able describe entropy macroscopic level statistical term explain relationship entropy system entropy surrounding thermodynamic process second law thermodynamic state object thermal contact thermal equilibrium exchange heat energy object high temperature heat energy object low temperature object temperature thermal equilibrium energy constantly disperse consider following scenario hot tea cool frozen drink melt iron rust building crumble balloon deflate living thing die decay scenario share common denominator energy form go localize concentrate spread disperse thermal energy hot tea spread cool air

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 live flesh release environment process death decay second law thermodynamic state energy spontaneously disperse localize spread hinder entropy 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 discussion microstate early

consider ice melt freedom movement water molecule increase water remain melting point average kinetic energy molecule ice difference number available microstate water ice 0 ° c kinetic energy energy disperse large number microstate liquid water liquid water high entropy extension organized ice 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 decrease example reversible process 5.46 × 104 j heat change 200 g block ice water temperature 273 k change entropy system note heat fusion ice solution know phase change temperature constant case 273 k. information give heat add exceed need completely melt block ice calculate heat apply change temperature result liquid t remain constant notice second law state energy spontaneously disperse energy localize concentrate concentration energy 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 second law describe time arrow unidirectional limitation

movement energy temperature second law describe time arrow unidirectional limitation movement energy recognize new old example instantly recognize video recording explosion run forward backward way understand energy close system spontaneously spread entropy variably define include entire universe fact second law ultimately claim entropy universe increase δsuniverse = δssystem + δssurrounding > 0

universe close expand system know entropy universe increase space appear expansion universe space entire universe energy distribute total entropy universe increase describe process physicist use term natural unnatural reversible irreversible term confuse student needlessly term descriptive observable phenomenon example expect hot object bring thermal

contact cold object hot object transfer heat energy cold object thermal equilibrium temperature natural process describe irreversible surprised object eventually reach common temperature shock sudden hot object hot cold object cold unnatural process define reversible reaction let consider system ice liquid water equilibrium 0 ° c place mixture ice liquid water thermostat device regulate temperature 0 ° c allow infinitesimal amount heat absorb ice thermostat ice melt liquid water 0 ° c thermostat remain 0 ° c increase entropy system water exactly equal entropy decrease surrounding thermostat net change entropy system surrounding zero condition process reversible key reversible reaction make sure process go slowly require infinite time system equilibrium energy lose dissipate frank real process reversible approximate reversible process note physicist define reversible process process spontaneously reverse course example water cycle freeze melt innumerable time ice melt warm countertop expect suddenly freeze remain warm environment liquid water need place environment cold cause water freeze freeze cold environment ice expect begin melt spontaneously freezing melting water real life irreversible process physics chemically mcat concept check 3.4 assess understanding material 1 describe entropy macroscopic level statistical term 2 relationship entropy system surrounding thermodynamic process chapter review zeroth law thermodynamic reflect observation object temperature thermal equilibrium net heat exchange zero consider zeroth law ex post facto provide thermodynamic explanation function thermometer temperature scale develop year prior law formulation take time

define basic thermodynamic term system state function examination law thermodynamic reveal energy close system include universe constant total internal energy system sum potential motional energy equal heat gain system minus work system finally carefully investigate second law thermodynamic concept entropy understand entropy measure disorder degree energy spread system include universe understand constant energy universe progressively irreversibly spread continue spread distribution energy universe concept reappearance discussion general chemistry certainly see mcat chapter investigate fluid final

mechanical concept test day review content test knowledge critical thinking skill complete test like passage set online zeroth law thermodynamics zeroth law thermodynamic state object thermal equilibrium temperature object thermal equilibrium experience net exchange heat temperature qualitative measure hot cold object quantitatively relate average kinetic energy particle substance thermal expansion describe substance change length volume function change temperature thermodynamic system portion universe interested observe surrounding include system isolated system exchange matter energy closed system exchange energy matter open system exchange energy matter state function pathway independent define process pressure density temperature volume enthalpy internal energy gibbs free energy entropy state function process function describe pathway equilibrium state work heat process function law thermodynamics law thermodynamic statement conservation energy total energy universe decrease increase close system total internal energy equal heat flow system minus work system heat process energy transfer object different temperature occur object come thermal equilibrium reach temperature specific heat energy necessary raise gram substance degree celsius kelvin specific heat water phase change heat energy cause change particle potential energy energy distribution entropy kinetic energy change temperature heat transformation special type thermodynamic system give variable hold constant isothermal process temperature constant change internal energy 0 adiabatic process heat exchange isobaric process pressure hold constant isovolumetric isochoric process volume hold constant work system 0

second law thermodynamics entropy second law thermodynamic state closed system include entire universe energy spontaneously irreversibly localize spread disperse entropy measure energy spread spread energy statistical level number available microstate increase potential energy molecule distribute large number microstate increase entropy natural process ultimately irreversible highly control condition certain equilibrium process phase change treat essentially reversible answer concept checks 1 zeroth law thermodynamic state object thermal

equilibrium object thermal equilibrium extension heat flow object thermal equilibrium 2 distance thermal equilibrium impractical theoretical maximum distance long object thermal contact temperature 3 expansion result increase dimension point object object initially long experience great expansion represent formula thermal expansion direct relationship length change initial length object 4 false discuss chapter 11 mcat physics math review accuracy relate instrument scale addition kelvin use scale celsius practical difference term accuracy system type transfer matter transfers energy 2 state function variable independent path take achieve particular equilibrium property give system equilibrium dependent process function define path system get state variable 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 1 change internal energy system equal heat system minus work system law 2 conduction heat exchange direct molecular interaction convection heat exchange fluid movement radiation heat exchange electromagnetic wave depend matter graph temperature vs. heat add line positive slope plateau line positive slope plateau line positive slope 4 p v graph work area curve closed 1 macroscopic level entropy think tendency disorder statistically entropy measure spontaneous dispersal energy specific temperature increase number available microstate give molecule 2 entropy system surrounding decrease entropy remain constant increase science mastery assessment explanation kelvin unit celsius degree size change 10 k equal change 10 ° c degree celsius equal 1.8 degree fahrenheit 10 °

° c degree celsius equal 1.8 degree fahrenheit 10 ° c = 18 ° f

essentially space sun earth mean heat transfer radiation electromagnetic wave propagate space metal spoon place pot hot soup molecule soup collide surface spoon transfer heat conduction finally fire warm air warm air dense surround air rise rise column warm air mean heat transport air mass simply process convection smoke particle ride upward move air current create plume smoke magnitude degree celsius equal magnitude unit kelvin change

100 ° c equal change 100 k. find change length thermal expansion rod originally 2.5 cm ground length increase 2.2 cm conclude touch ground thermal expansion process complete answer question remember watt equal joule second word power energy transfer time 10 minute tool absorb following energy find final temperature equation final temperature 20 + 40 = 60 ° c determine heat require raise temperature gold earring melting point gold calculate heat require actually melt earring latent heat total heat require melt earring completely sum heat heat require raise temperature earring 25 ° c 1064 ° c take 60 kj heat bring earring melting point step calculate heat need melt earring use heat fusion latent heat gold overall require approximately 60 + 32 = 92 kj heat melt gold earring notice heavily approximate number calculation answer choice spread close answer d total work cycle sum work path b c area cycle area bound b c triangle base 5 m3 height 3 pa calculate area clockwise loop tend positive work environment counterclockwise loop negative work answer question sure understand term adiabatic process mean exchange heat word q = 0 gas compress positive work gas gas value work gas negative w < 0 base

determine internal energy gas change law thermodynamic δu = q  w q = 0 w negative δu entropy system decrease long entropy surrounding increase hand entropy isolate system increase real irreversible process adhere second law thermodynamic say energy disperse entropy universe remain constant increase process calorimeter good approximation isolate system energy matter exchange environment fail use insulate layer fail fully contain system heat exchange environment matter disperse create open system find heat need bring substance melting point use specific heat heat mole substance unit kelvin 1 j heat substance reach melting point additional heat need actually induce phase change total heat require great 1 state function independent path take achieve give state define process pressure density temperature volume enthalpy internal energy gibbs free energy entropy heat work process function pathway dependent situation heat transfer warm gas metal cold gas convection require flow fluid cause heat transfer invalidate b answer case gas flow contact

metal invalid answer heat transfer radiation implausible gas unlikely emit heat form wave radiation unlikely penetrate thick metal container enthalpy d form heat transfer conduction c likely option happen substance direct contact gas make contact metal container make contact gas b. say substance b high internal energy explain phenomenon internal energy irrelevant heat involve process relate specific heat heat fusion heat vaporization choice explain phenomenon heat require melt solid determine heat fusion c heat require bring liquid boiling point determine specific heat heat require boil liquid determine heat ink randomly intersperse water final state disordered initial state entropy change system positive oil separate water final state ordered initial state oil water completely separate entropy change zero answer question notice reversibility experiment experiment positive entropy change irreversible experiment b entropy change reaction reversible accord second law

thermodynamic overall entropy change system surrounding negative thermodynamic process move equilibrium state substance undergo phase change add heat overcome heat transformation phase change phase change temperature remain constant temperature measure kinetic energy molecule sample change kinetic energy essentially thing change temperature heat transfer radiation describe b definitely change temperature solid long process melt d describe heat transfer convection warm gas transfer heat cold gas reach intermediate consult online resource additional practice equation remember 3.1 temperature conversion 3.2 thermal expansion equation $\delta l = \alpha l \delta t$ 3.3 volume expansion equation $\delta v = \beta v \delta t$ 3.4 law thermodynamic $\delta u = q w$ 3.5 heat gain lose temperature change $q = mc\delta t$ 3.6 heat gain lose phase change $q = ml$ 3.7 entropy heat 3.8 second law thermodynamic $\delta suniverse = \delta ssystem + \delta ssurrounding > 0$ biochemistry chapter 12 bioenergetic regulation metabolism general chemistry chapter 6 general chemistry chapter 7 general chemistry chapter 8 gas phase general chemistry chapter 12 physics math chapter 2 work energy chapter 4 fluid sprinkler background pre med know feeling content know mcat know important 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 get correct ensure thinking match explanation review concept summary

question get correct ensure thinking match explanation review concept summary end chapter object b submerge depth 1 m liquid specific gravity 0.877 give density object b object gauge pressure object 3 atm gauge pressure object b note assume atmospheric pressure 1 atm 1 atm 2 atm 3 atm 9 atm anchor iron weigh 833 n deck ship anchor suspend seawater massless chain tension chain note density iron density seawater 100 n 724 n 833 n 957 n wooden ball equal volume different density hold beneath surface container water ball density ball b density ball release accelerate upward surface relationship acceleration ball ball b ball great acceleration ball b great acceleration ball b acceleration determine information give water flow pipe diameter 0.15 m diameter 0.2 m. speed 0.15 m pipe speed 0.2 m pipe hydraulic lever lift heavy hospital bed require work w. bed patient lift work require double cross- sectional area platform bed lift change pressure hydraulic lever remain constant cross sectional area double cross sectional area halve cross sectional area divide cross sectional area remain constant figure show represent section horizontal pipe vary diameter open vertical pipe connect water allow flow pipe direction indicate vertical pipe water level low cross sectional area wide 1 follow 4 follow 3 2 narrow vertical pipe main flow pipe pipe 1 pipe 2 pipe 3 pipe 4 speed blood aorta high speed blood capillary bed fact explain continuity equation assume

interested average flow net fluid loss aorta locate higher capillary bed pressure aorta pressure capillary bed cross sectional area capillary add great cross sectional area aorta cross sectional area capillary small cross sectional area follow data set sufficient determine linear speed area rigid pipe cross sectional area segment pipe cross sectional area region interest reynolds number viscosity fluid density diameter pipe radius pipe

interest reynolds number viscosity fluid density diameter pipe radius pipe pressure gradient viscosity length pipe absolute pressure density object density 2 g cm3

submerge depth 25 cm container dichloromethane specific gravity dichloromethane 1.33 total pressure exert submerged object 3.3 kpa 104 kpa 332 kpa 433 kpa hydraulic system design allow water level change depend force apply tank show force f1 4 n apply square flexible cover a1 = 16 area a2 = 64 force apply a2 water level change hydraulic lift force cross sectional area distance travel label 4 n 16 n 32 n force need apply ball b equal mass show fully submerge swimming pool ball produce great buoyant force large sphere b ball ball b force equal impossible know know exact volume ball follow correctly describe blood flow circulatory system flow rate constant pressure create heart move blood venous circulation volume blood enter exit heart single cycle equal resistance artery great resistance arteriole low pressure weather system decrease atmospheric pressure 1 atm 0.99 atm percent decrease force rectangular window outside note assume window 6 m 3 m glass 3 cm thick fluid b density x 2x respectively test independently assess absolute pressure vary depth depth pressure surface fluid equal depth fluid half fluid b depth fluid equal fluid b depth fluid 2 time fluid b depth fluid 4 time fluid b water tower operator interested increase pressure column water apply piston hope increase pressure increase force apply piston way increase pressure alter speed

water flow pipe piston speed water change increase pressure force increase speed decrease speed release water intermittently pipe speed water change pressure piston answer key

follow page c ch 4.1 b ch 4.2 ch 4.2 c ch 4.3 ch 4.3 b ch 4.3 c ch 4.4 c ch 4.3 b ch 4.1 b ch 4.3 ch 4.2 c ch 4.4 ch 4.3 c ch 4.2 b ch 4.3 chapter 4 fluid chapter 1 4.1 characteristic fluid solids 4 4.2 hydrostatic 5 pascal principle 6 archimedes principle 7 molecular force liquid 8 4.3 fluid dynamic hy 10 laminar turbulent flow 12 bernoulli equation 13 4.4 fluid physiology 14 circulatory system 15 respiratory system 16 concept summary pie chart indicate content chapter relevant sixteen percent question physics mcat content chapter relevant 10 question physics mcat chapter cover material following aamc content category 4b importance fluid circulation blood gas movement 4e atom nuclear decay electronic structure atomic chemical hide beneath wave mediterranean sea depth 4,000 meter lie lake water sea sea salty time salty seawater sit extreme density prevent mix ocean water form layer separation unlike oil water bottle salad dressing underwater lake behave eerily like common cousin find sea level tide shore line beach ridge swash zone deep sea exploratory vessel set surface vessel bob cause ripple emanate outward like stone drop pond suboceanic lake river present particularly fascinating opportunity illustrate physics fluid solid chapter cover important concept principle fluid mechanic test mcat begin review

important term measurement include density pressure topic hydrostatic branch fluid mechanic characterize behavior fluid rest turn attention fluid dynamic include bernoulli equation aerodynamic flight finally chapter conclude discussion fluid dynamic physiology examine property motivate movement blood air body 4.1 characteristic fluid solid chapter 4.1 able predict gauge pressure equal fluid pressure column fluid relate weight density object recall common unit pressure equation gauge pressure absolute pressure fluid characterize ability flow conform shape container solid hand flow rigid retain shape independent container liquid gas fluid natural gas methane use cook flow pipe burner stove oven air breathe flow lung fill space respiratory tract alveoli fluid solid share certain characteristic exert force perpendicular surface solid withstand shear tangential force fluid impose large perpendicular force fall water significant height painful fall fluid solid characterize ratio mass volume know

density scalar quantity direction equation density ρ rho represent density m mass v volume si unit density find convenient use see mcat remember milliliter cubic centimeter volume word caution student assume ml cm3 equivalent liter m3 absolutely case fact 1000 liter cubic meter mcat important know density water weight volume give substance know density calculate multiply substance density volume acceleration gravity calculation appear frequently work buoyancy problem test day fg = ρvg density fluid compare pure water 1 atm 4 ° c variable call specific gravity combination pressure temperature water density exactly specific gravity unitless number usually express decimal specific gravity tool determine object sink float water describe later chapter object density give specific gravity simply density dimensionless number density water 1 example find specific gravity benzene give density solution ratio density benzene density water specific gravity numerator convert denominator density water give pressure ratio force unit area equation pressure p pressure f magnitude normal force vector area si unit pressure pascal pa equivalent newton

force vector area si unit pressure pascal pa equivalent newton square meter commonly unit pressure millimeter mercury mmhg torr atmosphere atm millimeter mercury torr identical unit unit atmosphere base average atmospheric pressure sea level conversion pa mmhg torr atm follow 1.013 × 105 pa = 760 mmhg  760 torr = 1 atm

forget unit variable derive equation know pressure equal force area know unit force n area m2 solve base unit pascal plug unit equation pressure scalar quantity magnitude direction easy assume pressure direction relate force vector note magnitude normal force matter position give surface pressure exert surface close container neglect gravity example place surface inside closed container fill gas individual molecule move randomly space exert pressure point container pressure point wall container space container pressure apply direction point scalar vector course pressure ratio force area unequal pressure exert object force act object add vector possibly result acceleration difference pressure cause air rush lung respiration window

burst outward tornado plastic cover break car window bubble outward car move note gravity present result pressure differential explore hydrostatic later chapter example window skyscraper measure 2.0 m 3.5 m. storm pass lower pressure outside window 0.997 atm pressure inside building remain 1 atm net force push window solution pressure different side window net force push direction low pressure outside window difference pressure determine net force moment countless trillion air molecule exert tremendous pressure body total force 2 × 105 n course actually feel pressure internal organ exert pressure perfectly balance atmospheric pressure change altitude resident denver 5280 foot sea level experience atmospheric pressure equal 632 mmhg 0.83 atm traveler make way death valley 282 foot sea level experience atmospheric pressure equal 767 mm hg 1.01 atm atmospheric pressure impact number process include hemoglobin affinity oxygen boiling liquid absolute hydrostatic pressure total pressure exert object submerge fluid remember fluid include liquid gas equation absolute pressure p = p0 + ρgz p absolute pressure p0 incident ambient pressure pressure surface ρ density fluid g acceleration gravity z depth object mistake assume p0 stand atmospheric pressure open air day day situation p0 equal 1 atm fluid system surface

day day situation p0 equal 1 atm fluid system surface pressure high low atmospheric pressure closed container pressure cooker pressure surface high atmospheric pressure fact exactly point pressure cooker allow food cook high temperature increase pressure raise boiling point water food reduce cooking time prevent loss moisture useful way remember part absolute pressure equation think dive swimming pool surface water absolute pressure usually equal atmospheric pressure p0 dive pool water exert extra pressure ρgz addition surface pressure feel extra pressure check pressure car bike tire device know gauge measure gauge pressure difference absolute pressure inside tire atmospheric pressure outside tire word gauge pressure pressure close space atmospheric pressure common pressure measurement absolute pressure equation

pgauge = p patm = p0 + ρgz patm note p0 = patm pgauge = p p0 = ρgz depth z. example diver ocean 20 m surface gauge pressure depth absolute pressure experience note density sea water solution pressure surface po equal atmospheric pressure patm solve gauge pressure equation solve absolute pressure absolute pressure p = patm + pgauge = 1.013 × 105 pa + 2.01 × 105 pa = 3.02 x 105 pa mcat concept check 4.1 assess understanding material 1 gauge pressure relate pressure exert column 2 relationship weight density 3 si unit pressure common unit 4 true false density scalar quantity chapter 4.2 able distinguish cohesion adhesion predict appearance meniscus fluid give knowledge

cohesive adhesive property calculate buoyant force act object apply concept specific gravity solve hydraulic lift problem pascal principle column fluid connect force cross sectional area distance label hydrostatic study fluid rest force pressure associate stand fluid proper understanding hydrostatic important mcat testmaker frequently include passage question hydraulic buoyancy fluid incompressible fluid volume reduce significant degree application pressure change pressure transmit undiminished portion fluid wall contain vessel pascal principle example unopened carton milk consider incompressible fluid close container squeeze container exert increase pressure side milk carton apply pressure transmit entire volume milk cap suddenly pop result geyser milk evidence increase pressure air pressure change large body water water level rise fall establish pressure equilibrium air water surface water body directly high pressure air pocket form small measurable valley water low pressure air system opposite effect create hill water application pascal principle see hydraulic system system advantage near incompressibility liquid generate mechanical advantage see discussion inclined plane pulley chapter 2 mcat physics math review allow accomplish certain work easily apply reduce force heavy machine use hydraulic include car brake bulldozer crane lift figure 4.1 show simple diagram hydraulic lift let determine lift allow auto mechanic raise heavy car far force weight car closed container fill incompressible liquid left lift piston cross sectional area a1 piston push column exert force magnitude equal f1 generate pressure equal

p1 piston displace volume liquid equal a1d1 cross- sectional area time distance give volume liquid inside incompressible volume fluid displace right hydraulic lift find second piston large surface area a2 pressure generate piston 1 transmit undiminished point system include a2 a2 large a1 factor magnitude force f2 exert a2 great f1 factor p1 = p2 accord

pascal principle column fluid connect force cross- sectional area distance label figure 4.1 hydraulic lift series equation show hydraulic machine generate output force magnify input force factor equal ratio cross sectional area large piston small piston violate law energy conservation analysis input output work frictionless system reveal conservation energy mention volume fluid displace piston 1 equal volume fluid displace piston 2 combine equation pressure volume generate equation work product constant pressure volume change isobaric process show familiar form work product magnitude force displacement times cosine angle 0 ° case factor d1 large d2 equal factor f2 large f1 additional work unaccounte great force f2 move small distance d2 auto mechanic need exert small force small area large distance generate large force large area small distance remember apply pascal principle large area large force force exert small example hydraulic press piston radius 5 cm push enclose fluid 50 kg weight rest piston piston contact system radius 20 cm take force need large piston press equilibrium solution use pascal principle probably hear version story

archimedes physicist ancient greece task king determine metallic composition certain crown give king gift archimedes know find crown volume mass allow find density compare density know metal weigh crown easy have trouble find way measure volume melt ruin workmanship day get bath water overflow tub give idea submerge crown water measure volume displace liquid principle derive story archimedes last contribution field physics archimedes principle deal buoyancy object place fluid help understand ship stay afloat feel light swim principle state body wholly partially immerse fluid buoy upwards force equal weight fluid displace archimedes body crown cause water level rise tub object place fluid cause volume fluid

displace equal volume object submerge fluid density volume fluid displace correspond certain mass fluid mass fluid displace exert force equal weight submerge object force direct upward call buoyant force magnitude fbuoy = ρfluidvfluid displacedg = ρfluidvsubmergedg common mistake student buoyancy equation use density object density fluid remember use density fluid object place fluid sink fluid point volume displace fluid exert force equal weight object object completely submerged volume displace fluid exert buoyant force equal weight object object accelerate downward sink case object dense fluid gold crown sink bathtub dense water hand object dense water block wood ice cube stop sink start float dense water object submerge volume displace volume water equal object object float average density average density fluid immerse sink average density great fluid way conceptualize buoyant force force liquid try return space displace try push object water important concept buoyant force liquid object object place fluid displace volume fluid experience magnitude buoyant force object different masse determine float object lie surface comparison density specific gravity remember object float matter matter mass average density equal density fluid place express object specific gravity percent directly indicate percent object volume submerge fluid pure water instance density

indicate percent object volume submerge fluid pure water instance density ice specific gravity 0.92 ice cube float glass water 92 percent volume submerge water 8 percent sit surface object specific gravity equal 1 float water object specific gravity great 1 sink water specific gravity exactly 1 indicate 100 percent object submerge sink strange cruise ship construct dense metal weigh thousand kilogram float water remember object float average density water steel hull ship sink air submerge beneath water level ship low deck lower ship average density water example wooden block float ocean half volume submerge find density wood ρb note density sea water solution magnitude weight block total volume vb fg b = mbg = ρbvbg weight displace seawater buoyant force give fbuoy = mwaterg = ρwatervwaterg vwater volume displace water volume block submerge block float buoyant force equal block weight dead sea

deep hypersaline lake world have salt content 35 percent time salty ocean dissolve salt make dense water surface earth specific gravity 1.24 human specific gravity 1.1 body water tendency sink dead sea unable float molecular force liquid water strider insect ability walk water water strider able glide water surface sink dense water special physical property liquid interface liquid gas surface tension cause liquid form thin strong layer like skin liquid surface surface tension result cohesion attractive force molecule liquid feel molecule liquid consider intermolecular force separate molecule liquid water molecule surface attractive intermolecular force come side force balance surface molecule strong attractive force molecule pull surface liquid center establish tension plane surface water indentation surface cause water strider foot cohesion lead net upward force remember cohesion occur molecule property container water oil water molecule cohesive water molecule oil cohesive oil molecule force liquid molecule experience adhesion attractive force molecule liquid feel molecule substance example adhesive force cause water

molecule liquid feel molecule substance example adhesive force cause water molecule form droplet windshield car gravity pull downward liquid place container meniscus curved surface liquid crawl container small form adhesive force great cohesive force backwards convex meniscus liquid level high middle edge occur cohesive force great adhesive force mercury metal liquid room temperature form backward meniscus place container type menisci show figure 4.2 fluid level high edge middle b fluid level high middle edge figure 4.2 type menisci concave meniscus common b convex backwards meniscus dotted line indicate measurement depth volume take type mcat concept check 4.2 assess understanding material 1 contrast cohesion adhesion 2 meniscus liquid experience equal cohesive adhesive force look like 3 block fully submerge inch surface fluid experience acceleration say displace volume fluid buoyant force 4 true false determine volume object fluid displacement specific gravity great 1

hydraulic lift operator usually apply force large cross sectional area small cross sectional area 4.3 fluid dynamic high yield chapter 4.3 able describe laminar flow turbulent flow dynamic static pressure pitot tube viscosity predict behavior fluid continuity equation bernoulli equation venturi effect recall variable involve flow rate term suggest fluid dynamic study fluid motion fascinating area physics application real life aspect world water delivery home blood flow artery vein analyze explain principle fluid dynamic mcat present relatively simplified version topic make important assumption rigid walled container uniform density fluid fluid flow easily barely flow resistance fluid flow call viscosity η increase viscosity fluid increase viscous drag nonconservative force analogous air resistance thin fluid like gas water dilute aqueous solution low viscosity flow easily object fluid low viscous drag blood vegetable oil honey cream molasse thick fluid flow slowly object fluid significantly viscous fluid superfluid test mcat viscous degree low viscosity say behave like ideal fluid viscosity describe inviscid viscosity measure fluid internal resistance flow viscous fluid lose energy flow indicate viscosity assume negligible test day allow bernoulli equation explain later chapter expression energy conservation flow fluid si unit viscosity pascal second low viscosity fluid low internal resistance flow behave like ideal fluid assume conservation energy low viscosity fluid laminar turbulent flow fluid move flow laminar turbulent laminar flow smooth orderly model layer fluid flow parallel show figure 4.3 smooth nearly parallel line object gravitational buoyant force label figure 4.3 laminar flow object fluid gravitational force large buoyant force object sink laminar flow characterize smooth flow line object layer necessarily linear speed example layer close wall pipe flow slowly interior layer fluid laminar flow pipe confine space possible calculate rate flow poiseuille law q flow rate volume flow time r radius tube δp pressure gradient η eta viscosity fluid l length

tube δp pressure gradient η eta viscosity fluid l length pipe equation rarely test mcat passage question focus relationship radius pressure gradient note relationship radius pressure gradient inverse exponential fourth power slight change radius tube significant effect

pressure gradient assume constant flow rate turbulence speed turbulent flow rough disorderly turbulence cause formation eddy swirl fluid vary size occur typically downstream obstacle show figure 4.4 parallel line pass object swirl figure 4.4 turbulent flow object fluid eddy formation downstream object obstruct laminar unobstructed fluid flow turbulence arise speed fluid exceed certain critical speed critical speed depend physical property fluid viscosity diameter tube critical speed fluid exceed fluid demonstrate complex flow pattern laminar flow occur thin layer fluid adjacent wall call boundary layer flow speed immediately wall zero increase uniformly layer boundary layer motion highly irregular turbulent significant energy dissipate system result increase frictional force calculation energy conservation bernoulli equation apply turbulent flow system luckily mcat assume laminar nonturbulent flow question fluid flow tube diameter d critical speed vc calculate vc critical speed nr dimensionless constant call reynolds number η viscosity fluid ρ density fluid reynolds number depend factor size shape surface roughness object fluid movement individual molecule fluid impossible track unaided eye helpful use representation molecular movement call streamline streamline

indicate pathway follow tiny fluid element call fluid particle velocity vector fluid particle tangential streamline point streamline cross streamline connect oval p oval q area p small q figure 4.5 streamline stream cross sectional area increase p q.

figure 4.5 show fluid invisible tube pass p q. streamline indicate pathway fluid wall tube notice tube get wide q indicate streamline spread increase cross sectional area lead consider relationship flow rate cross sectional area container fluid move assume fluid incompressible mean consider flow gas fluid incompressible rate give volume mass fluid pass point point closed system essentially expression conservation matter x liter fluid pass point give time x liter fluid pass point system time clearly state exception flow rate volume unit time constant close system independent change cross sectional area flow rate constant linear speed fluid change relative cross sectional area linear speed measure linear displacement fluid particle

give time notably product linear speed cross sectional area equal flow rate say volumetric rate flow fluid constant close system q = v1a1 = v2a2 q flow rate v1 v2 linear speed fluid point 1 2 respectively a1 a2 cross sectional area point equation know continuity equation tell fluid flow quickly narrow passage slowly wide one figure 4.5 early flow rate point p q linear speed fast point p flow rate constant tube regardless cross sectional area linear speed fluid increase decrease cross sectional area cover bernoulli equation let approach flow fluid perspective discuss continuity equation arise conservation mass fluid liquid essentially incompressible flow rate close space constant point continuity equation show constant flow rate inverse relationship linear speed fluid cross sectional area tube fluid high speed narrow tube second fluid low viscosity demonstrate laminar flow approximate conservative system total mechanical energy system constant discount small viscous drag force occur real liquid combine principle conservation arrive bernoulli p absolute pressure fluid ρ density fluid v linear speed g acceleration gravity h height fluid datum term bernoulli equation look vaguely familiar term call dynamic pressure pressure associate movement fluid term essentially kinetic

call dynamic pressure pressure associate movement fluid term essentially kinetic energy fluid divide volume term ρgh look like expression gravitational potential energy essentially pressure associate mass fluid sit position finally let consider absolute pressure fit conservation equation multiply unit pressure meter meter obtain pressure think ratio energy cubic meter energy density system high pressure high energy density system low pressure finally combination p + ρgh give static pressure equation absolute pressure h imply height certain point z early imply depth certain point bernoulli equation state sum static pressure dynamic pressure constant close container incompressible fluid experience viscous drag end bernoulli equation statement energy conservation energy dedicate fluid movement mean energy dedicate static fluid pressure inverse true movement mean static pressure example principle previously encounter shape airplane wing help generate lift show figure 4.6 airplane curved streamline wing straight streamline lift thrust label figure 4.6 aerodynamics airplane propeller

jet engine generate thrust push air backward case wing curved air stream travel far fast air pass underneath flat accord bernoulli equation slow air exert force wing fast air lift plane example bernoulli equation action use pitot tube specialize measurement device determine speed fluid flow determine difference static dynamic pressure fluid give point tube common application bernoulli equation mcat venturi flow meter show figure 4.7 tube wide 1 narrow portion 2 cross sectional area linear speed pressure label height column tube 2 low 1 figure 4.7 venturi flow meter tube narrow linear speed increase point 2 pressure exert wall decrease cause column tube low height point 2 consider bernoulli equation example start note average height tube remain constant ρgh term remain constant point 1 2 note h show figure 4.7 difference height column point 1 2 h bernoulli equation correspond average height tube datum cross sectional area decrease point 1 point 2 linear

datum cross sectional area decrease point 1 point 2 linear speed increase accord continuity equation dynamic pressure increase absolute pressure decrease point 2 low absolute pressure column fluid stick venturi tube low point 2 phenomenon call venturi effect example office building bathroom 40 m ground water supply enter building ground level pipe inner diameter 4 cm linear speed ground floor bathroom determine cross sectional area pipe bathroom pressure bathroom 3 × 105 pa require pressure ground level solution cross sectional area pipe bathroom calculate continuity equation point 1 ground level point 2 bathroom pressure find bernoulli equation mcat concept check 4.3 assess understanding material 1 define following term 2 following concept relate venturi effect bernoulli equation continuity equation relationship 3 effect increase follow flow rate radius tube pressure gradient viscosity length 4.4 fluid physiology chapter 4.4 able recall condition continuity equation apply describe total resistance airway change compare flow volume flow rate different area future student medicine feel abstract application physics math unimportant tedious discipline exceptionally important physiology movement blood lymph air body lung follow basic principle fluid dynamic pressure minor alteration focus primarily circulatory

system briefly discuss pressure flow relate gas exchange circulatory system close loop nonconstant flow rate nonconstant flow result valve gravity physical property vessel elasticity particular mechanic heart particular nonconstant flow feel measure pulse addition feature loss volume circulation result difference osmotic oncotic hydrostatic pressure fluid eventually return circulation result lymphatic flow problematic application continuity equation important point note despite difference blood volume enter heart equal blood volume leave heart single cycle blood flow away heart vessel progressively high resistance capillary total resistance system decrease increase number vessel parallel like parallel resistor circuit equivalent resistance low capillary parallel aorta return flow heart facilitate mechanical squeezing skeletal muscle increase pressure limb push blood heart expansion heart decrease

muscle increase pressure limb push blood heart expansion heart decrease pressure heart pull blood finally pressure gradient create thorax inhalation exhalation motivate blood flow venous circulation hold approximately time blood arterial circulation heart murmur result structural defect heart hear turbulent blood flow respiratory system mediate change pressure follow resistance relationship circulatory system inspiration negative pressure gradient move air lung expiration gradient reverse additional point note air reach alveoli essentially speed mcat concept check 4.4 assess understanding material 1 condition continuity equation apply 2 exhalation total resistance encounter airway change air leave alveoli escape nose mouth 3 flow venae cavae relate flow main behavior fluid impact moment life near ocean lake literally submerge vast expanse fluid mix gas know atmosphere exert force surface body bath submerge object water experience effect buoyant force exert displace fluid water garden shower ride car open window experience speed force pressure fluid world medicine consider fluid flow rest evaluate function respiratory circulatory system condition varied asthma heart murmur relate way body cause fluid flow balance hydrostatic oncotic pressure important maintain proper balance fluid peripheral tissue body basic concept hydrostatic fluid dynamic learn apply mcat passage question kaplan practice material intimidate complexity buoyant

force problem application bernoulli equation remember fluid liquid gas exert buoyant force object place function weight fluid displace remember incompressible fluid demonstrate inverse relationship dynamic pressure function speed static pressure chapter conclude section book focus mechanic chapter turn attention electrostatic electricity review content test knowledge critical thinking skill complete test like passage set online characteristics fluids solids fluids substance ability flow conform shape container fluid exert perpendicular force exert shear liquid gas phase matter fluid solid flow retain shape regardless density mass unit volume substance fluid solid pressure define measure force unit area exert fluid wall container object place fluid scalar quantity value magnitude

fluid wall container object place fluid scalar quantity value magnitude pressure exert gas wall container perpendicular normal container wall absolute pressure sum pressure certain point fluid equal pressure surface fluid usually atmospheric pressure plus pressure fluid gauge pressure difference absolute pressure atmospheric pressure liquid gauge pressure cause weight liquid point measurement pascal principle state pressure apply incompressible fluid distribute undiminished entire volume hydraulic machine operate base application pascal principle generate mechanical advantage archimedes principle govern buoyant force object place fluid fluid generate buoyant force object equal weight fluid displace object direction buoyant force opposite direction gravity maximum buoyant force large force gravity object object float true object dense fluid maximum buoyant force small force gravity object object sink true object dense fluid fluid experience cohesive force molecule fluid adhesive force material cohesive force rise surface tension fluid dynamic set principle actively flow fluid viscosity measurement fluid internal friction viscous drag nonconservative force generate viscosity fluid laminar flow turbulent flow rate laminar flow determine relationship mcat incompressible fluid assume laminar flow low viscosity flow allow assume conservation energy continuity equation statement conservation mass apply fluid dynamic bernoulli equation expression conservation energy flow fluid equation state sum static pressure dynamic

pressure constant point close system horizontal flow inverse relationship pressure speed close system direct relationship cross sectional area pressure exert wall tube know venturi effect fluid physiology circulatory system behave close system nonconstant resistance decrease total cross sectional area increase arterial circulation primarily motivate heart venous circulation time volume arterial circulation motivate skeletal musculature expansion heart inspiration expiration create pressure gradient respiratory system circulatory system air alveoli essentially zero speed answer concept check 1 gauge pressure equal pressure exert column fluid plus ambient pressure fluid minus atmospheric pressure atmospheric pressure pressure fluid column gauge pressure equal fluid pressure 2 weight density time

column gauge pressure equal fluid pressure 2 weight density time volume acceleration gravity 3 si unit pressure pascal common unit include mmhg torr atm 4 true density directionless scalar quantity 1 cohesion attractive force experience molecule fluid adhesion attractive force experience molecule fluid different material usually solid 2 adhesive cohesive force equal meniscus form liquid surface flat 3 displace volume equal volume block buoyant force equal weight block equal weight displace fluid extension block fluid immerse density 4 false fluid low specific gravity instead water determine volume object float water 5 operator usually apply force small cross- sectional area pressure side lift small force apply small surface area generate 1 dynamic pressure pressure associate flow static pressure pressure associate position static pressure sacrifice dynamic pressure flow pitot tube device measure static pressure flow calculate speed viscosity measure resistance liquid flow laminar flow flow eddy streamline roughly parallel turbulence presence backflow current eddy 2 continuity equation describe relationship flow cross- sectional area tube bernoulli equation describe relationship height pressure flow venturi effect direct relationship cross sectional area pressure result combine relationship bernoulli 3 flow rate increase increase radius tube pressure gradient decrease increase viscosity length tube 1 continuity equation apply human circulation presence pulse elasticity vessel nature pressure gradient preclude type analysis poiseuille law

instead isolate segment 2 total resistance increase air exit body despite increase diameter airway few airway parallel 3 theory equal flow venae cavae main pulmonary trunk reality flow venae cavae actually slightly pulmonary trunk blood enter right heart actually cardiac coronary circulation systemic circulation science mastery assessment explanation absolute gauge pressure depend density fluid object pressure surface equal atmospheric pressure gauge pressure give pgauge = ρgz ρ represent density fluid object object depth gauge tension chain difference anchor weight buoyant force object translational equilibrium t = fg

fbuoy object weight 833 n buoyant force find archimedes principle magnitude buoyant force equal weight seawater anchor displace fbuoy = ρwvwg anchor submerge entirely volume water displace equal volume anchor equal mass divide density give anchor mass value magnitude weight anchor divide g. put obtain buoyant lastly obtain tension initial equation t = fg t = 833 n  109 n = 724 n key quickly solve problem test day recognize answer choice contain outlier value slightly weight anchor b weight anchor c value slightly high weight anchor d buoyant force direction tension sum equal weight anchor b likely answer newton second law fnet = ma obtain following fbuoy  mg = ma ball experience buoyant force liquid volume fbuoy = ρvg ball small mass experience great acceleration ball volume ball small density small mass m = ρv ball a.

know water flow fast narrow pipe speed inversely proportional cross sectional area pipe volume water pass point time interval let 0.15 m pipe b 0.20 m pipe use νaaa = νbab ν speed cross sectional area pipe ν inversely proportional cross sectional area area proportional square diameter obtain question test understanding pascal principle state change pressure apply enclose fluid transmit undiminished portion fluid wall contain vessel tell work require lift bed patient double work need lift bed word force require double bed patient lift maintain pressure double cross sectional area platform hydraulic lever patient bed lift necessary calculation answer question open vertical pipe expose atmospheric pressure difference height

column water vertical pipe dependent difference hydrostatic pressure horizontal pipe horizontal pipe variable cross sectional area water flow fast hydrostatic pressure low value horizontal pipe narrow call venturi effect result pipe 2 low water level continuity equation state flow rate fluid remain constant cross section word ideal fluid flow pipe large cross sectional area narrow speed increase illustrate equation a1v1 = a2v2 blood flow slowly capillary infer cross sectional area large surprising glance give blood vessel divide thousand little capillary hard imagine add cross sectional area capillary entire capillary bed result area large cross sectional area aorta datum give c sufficient determine flow rate poiseuille law determine linear speed divide cross sectional area determine radius sufficient know flow rate segment pipe use continuity equation determine linear speed datum b determine critical speed turbulent flow begin indication turbulent flow datum d determine depth object fluid calculate total pressure use hydrostatic pressure formula ptot = patm + ρgz unit depth equation meter convert 25 cm 0.25 m. specific gravity equal density medium divide density water specific gravity 1.33 density dichloromethane 1,330 kg m3 finally plug value solve total pressure ptot = 101 kpa +

plug value solve total pressure ptot = 101 kpa + 1,330 kg m3)(0.25 m)(10 m s2 = 104 kpa match b basic restatement pascal principle force apply area transmit fluid result change fluid level system relationship state plug number give answer

16 n. buoyant force fbuoy equal weight water displace quantitatively express fbuoy = mfluid displacedg = ρfluidvfluid displacedg volume displace fluid equal volume ball density fluid remain constant ball large volume displace water experience large volume blood enter exit heart equal single cardiac cycle support c correct answer contrast flow rate blood circulatory system constant fluid exit circulation tissue later return lymphatic system eliminate furthermore contraction hear push blood arterial circulation create uneven flow rate observe pulse eliminate b finally diameter vessel decrease resistance increase artery significantly

resistance blood flow compare arteriole eliminate d question simple application definition pressure force area pressure decrease 1 percent area change force decrease 1 percent note measurement give play role calculation equation absolute hydrostatic pressure p = p0 + ρgz p0 pressure surface ρ density fluid g acceleration gravity z depth fluid density fluid b twice fluid depth fluid twice fluid b obtain absolute basic interpretation bernoulli equation state equal height speed pressure fluid inversely related venturi effect decrease speed water increase pressure increase pressure give area result increased force transmit piston consult online resource additional practice equation remember 4.2 weight volume fluid fg = ρvg 4.3 specific gravity 4.5 absolute pressure p = p0+ρgz 4.6 gauge pressure pgauge = p patm = p0 + ρgz patm 4.7 pascal principle

4.8 buoyant force fbuoy = ρfluidvfluiddisplacedg = ρfluidvsubmergedg 4.9 poiseuille law 4.10 critical speed 4.11 continuity equation q = v1a1 = v2a2 4.12 bernoulli equation biology chapter 6 respiratory system biology chapter 7 cardiovascular system biology chapter 8 immune system general chemistry chapter 8 gas phase physics math chapter 2 work energy physics math chapter 3 chapter 5 electrostatic magnetism chapter 5 electrostatic magnetism lightning science mastery assessment pre med know feeling content know mcat know important 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 get correct ensure thinking

match explanation review concept summary end chapter question 1–3 refer figure f represent electrostatic force exert charge particle s charge particle r. r left s right force s point left 1 figure magnitude electric force r s 2 distance center sphere halve magnitude force s r 3 assume direction f direction electric field r s. electron place midway r s resultant electric force electron 1 r. 2 s. 3

upward plane page 4 downward plane page 4 electric field distance r away charge q ratio electric field r 2r 3r 5 positive charge + q fix point r distance d away positive charge +2q fix point s. point locate midway charge point b distance +2q show direction positive charge place point point b respectively left right r + q point s +2q point b 1 + q charge 2 +2q charge 3 + q charge point right point b 4 +2q charge point right point 6 parallel conduct plate separate distance d. plate carry charge + q carry charge q. voltage plate 12 v. +2 μc charge release rest positive plate kinetic energy reach negative plate 1 2.4 × 10–6 j 2 4.8 × 10–6 j 3 2.4 × 10–5 j 4 4.8 × 10–5 j 7 negative charge figure 1 μc move y = 5 y = +5 follow dash line work require negative charge dash line negative charge move 10 unit pass equidistant positive charge left right 1 10 j 2 5 j 3 0 j 4 10 j 8 magnetic field distance r away current carry wire 10 t net magnetic field r wire place distance 2r original wire r middle current twice strong flow opposite direction 1 0 t 2 15 t 3 20 t 4 30 t 9 give electric dipole electric potential zero 1 midpoint dipole axis 2 perpendicular bisector dipole axis 3 dipole axis 4 point infinity 10 electron accelerate distance d electric potential v. electric potential apply electron increase factor 4 electron accelerate distance d. speed

electron end second trial large end trial factor 11 follow accurately depict field line create proton move right page arrow point radially positive charge arrow point positive charge angle arrow point positive charge angle arrow point radially outward positive charge 12 certain 9 v battery power source 2 c charge work battery 1 4.5 j 2 9 j 3 18 j 4 36 j 13 increase capacitance give capacitor dielectric insert plate dielectric material block flow charge following material

good dielectric 1 salt water 2 steel alloy primarily compose iron 3 glass oxide silica 14 move negative charge place external magnetic field circulate counterclockwise plane paper direction magnetic field point 1 page 2 page 3 center circle 4 tangent circle 15 kinase divalent cation cofactor stabilize interaction atp electric potential energy cation atp 3.3 × 10–19 j electric potential energy change distance cation atp double 1 increase factor 2 2 increase factor 4 3 decrease factor 2 4 decrease factor 4 answer key follow page 1 b ch 5.2 2 d ch 5.2 3 b ch 5.2 4 b ch 5.2 5 c ch 5.1 6 c ch 5.3 7 c ch 5.4 8 d ch 5.6 9 b ch 5.5 10 d ch 5.4 11 d ch 5.2 12 c ch 5.4 13 c ch 5.1 14 b ch 5.6 15 ch 5.3 chapter 5 electrostatic magnetism chapter 1 5.1 charge 2 insulator conductor 3 5.2 coulomb law 4 electric field 5 5.3 electric potential energy 6 5.4 electric potential 7 5.5 special case electrostatic 8 equipotential line 9 electric dipole 10 5.6 magnetism 11 magnetic field 12 magnetic force 13

concept summary pie chart indicate content chapter relevant percent question physics mcat content chapter relevant 7 question physics mcat chapter cover material following aamc content category 4c electrochemistry electrical circuit element electrostatic study stationary charge force create act charge electrical charge able activity enjoy consider essential basic living live electrical charge dangerous deadly magnify small shock receive doorknob walk carpet equivalent lightning bolt strong stop heart concept life save therapy cardioversion defibrillation create strong electrical current heart conduction system attempt resynchronize pulse chapter review basic concept essential understand charge electrostatic force include conductor insulator review coulomb law describe attraction repulsion charge object describe electric field charge create allow exert force charge discuss charge set field observe behavior charge place field particular note motional behavior test charge inside field relation electrical potential difference voltage point space determine change electric potential energy charge move position electric potential describe electric dipole solve problem involve molecular dipole important life planet water molecule finally explore topic magnetic field force chapter 5.1 able contrast behavior proton electron charge categorize material include glass copper

conductor recognize charge electron coulomb particle discuss electrostatic tiny forget mass use equation kinetic energy equation solve problem charge particle mcat require charge subatomic particle come variety proton positive charge electron negative charge opposite charge exert attractive force like charge sign exert repulsive force unlike force gravity attractive force electrostatic force repulsive attractive depend sign charge interact matter electrically neutral balance positive negative charge ensure relative degree stability charge balance system electrically unstable material normally electrically neutral acquire net charge result friction shuffle foot carpet negatively charge particle transfer carpet foot charge spread total surface body shock occur hand get close metal doorknob allow excess charge jump finger knob act ground means return charge earth static charge buildup static electricity significant dry air

charge earth static charge buildup static electricity significant dry air low humidity make easy charge remain separated si unit charge coulomb fundamental unit charge e = 1.60 × 1019 c

proton electron charge proton positively charge q = + e electron negatively charge q = e proton electron share magnitude charge share mass proton great mass electron fundamental unit charge e = 1.60 × 1019 c. proton electron charge proton positively charge q = + e electron negatively charge q = e

like mass energy electric charge govern law conservation charge law state charge create destroy insulator conductor insulator conductor vary ability hold transfer charge insulator easily distribute charge surface transfer charge neutral object especially insulator molecular level electron insulator tend closely link respective nucleus extension nonmetal insulator experimentally insulator serve dielectric material capacitor isolate electrostatic experiment environment prevent grounding contrast conductor give charge charge distribute approximately evenly surface conductor conductor able transfer transport charge circuit

electrochemical cell conductor conceptualize nucleus surround sea free electron able rapidly material loosely associate positive charge conductor generally metal ionic electrolyte solution effective conductor figure 5.1 demonstrate behavior insulator conductor negative charge place negative charge bunch insulator spread conductor figure 5.1 negatively charge insulator conductor insulator distribute charge surface mcat concept check 5.1 assess understanding material 1 place meter apart experience great acceleration coulomb electron coulomb 2 categorize following material conductor insulator blood hair copper glass iron sulfuric acid distil water 3 net charge object coulomb electron 3 mole neutron 5.2 coulomb law chapter 5.2 able calculate electric field charge generate electric force charge recall direction negative positive electrostatic force charge relative relate distance charge quantity electrostatic force electrostatic field magnitude apply direction convention draw electric field generate positive radially outward negative radially inward coulomb law quantify magnitude electrostatic force fe charge fe magnitude electrostatic force k coulomb constant q1 q2 magnitude charge r distance charge coulomb constant call electrostatic constant number depend unit equation si unit ε0 represent permittivity free space direction force obtain remember unlike charge attract like charge repel force point line connect center charge example positive charge attract negative charge certain distance away charge move separate twice distance force attraction change solution coulomb law state force charge vary inverse square distance distance double square distance quadruple force reduce fourth originally note necessary

double square distance quadruple force reduce fourth originally note necessary know distance unit close examination coulomb law reveal remarkably similar form equation gravitational force electrostatic force equation force magnitude proportional charge magnitude similar proportional relationship gravitational force mass equation force magnitude inversely proportional square distance separation similarity ought help remember equation test day notice coulomb law look similar gravitational force equation different constant charge mass fact remind equation deal electrostatic force charge gravitation

equation deal gravitational force body mass gravitation equation discuss chapter 1 mcat physics math example negatively charge electron electrostatically attract positively charge proton electron proton mass gravitationally attract ratio electrostatic force gravitational force electron proton note mp = 1.67 × 1027 kg = 9.11 × 1031 kg e = 1.60 × 1019 c solution coulomb law universal law gravitation state attractive force electron proton vary inverse square distance ratio force calculate divide magnitude value plug note electrostatic attraction electron proton strong gravitational attraction factor 1040 note set variable work math simplify process number variable cancel electric charge set surround electric field like mass create gravitational field electric field presence know exert force charge space field force exert electric field attractive repulsive depend stationary test charge q charge place electric field stationary source charge q actually create electric field opposite charge attractive like electric field produce source charge q test charge q place electric field e experience electrostatic force fe equal qe.

magnitude electric field calculate way see definitional equation electric field e electric field magnitude newton coulomb fe magnitude force feel test charge q k electrostatic constant q source charge magnitude r distance charge electric field vector quantity discuss process determine direction electric field vector moment look closely equation electric field magnitude derive simply divide side coulomb law calculate magnitude electric field particular point space method place test charge q point electric field measure force exert test charge define electric field point space ratio force magnitude test charge magnitude disadvantage method calculation test charge actually present order force generate measure test charge actually electric field need way measure magnitude divide coulomb law magnitude test charge arrive way determine magnitude electric field point space source charge second method calculate electric field magnitude point space require presence test charge need know magnitude source charge distance source charge point space want measure electric field method need know value source charge able calculate electric field convention direction electric field vector

give direction positive test charge presence source charge source charge positive test charge experience repulsive force accelerate away positive source charge hand source charge negative test charge experience attractive force accelerate negative source charge positive charge electric field vector radiate outward point away charge negative charge electric field vector radiate inward point charge electric field vector represent field line show figure 5.2 electric field line positive charge radially outward negative radially inward figure 5.2 field line positive negative neutral source charge field line imaginary line represent positive test charge presence source charge field line draw direction actual electric field vector indicate relative strength electric field give point space field draw sheet paper field line look like metal spoke bicycle wheel line close near source charge spread distance far charge field line close field strong line

spread distance far charge field line close field strong line far apart field weak charge exert electric field collection charge exert net electric field point space equal vector sum electric field field line represent electric field vector charge point away positive charge point negative charge dense field line strong electric field note field line single charge cross electric field electrostatic force vector quantity important remember convention direction test charge field positive force direction electric field vector source charge test charge negative force direction opposite field vector source mcat concept check 5.2 assess understanding material 1 electric field midway negative charge 2 direction negative electrostatic force point direction positive electrostatic force point negative electrostatic force positive electrostatic force 3 draw field line electric field generate alpha particle 4 distance charge relate electrostatic force electric 5.3 electric potential energy chapter 5.3 able describe change electric potential energy affect stability system calculate electric potential energy compare contrast electric potential energy electrostatic force conceptually mathematically predict change electric potential energy give change distance define potential energy store energy happen different type potential energy gravitational elastic chemical form need know test day fourth form electric potential energy

similar gravitational potential energy form potential energy dependent relative position charge respect charge collection charge electric potential energy give equation charge like charge positive negative potential energy positive charge unlike positive negative potential energy negative remember work energy unit joule define electric potential energy charge point space electric field work necessary bring charge infinitely far away point w = fd cos θ define d distance r separate charge assume force displacement vector parallel consider charge stationary negative source charge positive test charge move charge unlike exert attractive force close stable opposite charge negative potential energy energy increasingly negative charge bring close close increasingly negative number actually decrease value

charge bring close close increasingly negative number actually decrease value move far left 0 number line decrease energy represent increase stability electric potential energy work necessary test charge infinity point space electric field surround source charge let consider positive charge like charge exert repulsive force potential energy system positive like charge repel close stable remember unlike gravitational system force electrostatic attractive repulsive case like charge stable far apart magnitude electric potential energy small small positive number electric potential energy system increase like charge opposite charge apart conversely electric potential energy system decrease like charge apart opposite charge example charge +2e charge 3e separate distance 3 nm potential energy system note e fundamental unit charge equal 1.6 × 1019 c k

electrostatic constant equal solution equation potential energy question stem know charge +2e 3e r = 3 nm = 3 × 109 m. plug equation mcat concept check 5.3 assess understanding material 1 change electric potential energy 4 j 7 j reflect stability system 2 compare relationship electric potential energy coulomb law relationship gravitational potential energy universal law gravitation 3 electric potential energy change particle distance increase 4 factor electric potential energy change magnitude charge double distance halve 5.4 electric potential

chapter 5.4 able calculate electric potential distinguish electric potential voltage predict movement charge relative source charge give electric potential test charge location relate electric potential electric potential energy electric field electric potential discuss electric potential energy discuss previously sound like nearly thing closely relate fact electric potential define ratio magnitude charge electric potential energy magnitude charge express v electric potential measure volt v test charge q calculate electric potential point space electric field long know magnitude source charge distance source charge point space field divide q electric potential scalar quantity sign determine sign source charge q. positive source charge v positive negative source charge v negative collection charge total electric potential point space scalar sum electric potential charge essential equation test day know relate use memorize coulomb law able recreate table mathematical manipulation left right multiply r divide q. electric potential inversely proportional distance source charge potential difference exist point different distance source charge va vb electric potential point b respectively potential difference know voltage vb va. equation electric potential define potential difference wab work need test charge q electric field point point b. work depend potential point b independent actual pathway take b.

like gravitational force electrostatic force conservative plus end battery high potential end minus end battery low potential end positive charge move + definition current negative charge move + see charge allow spontaneously direction result decrease electric potential energy positive test charge mean move position high electric potential position low electric potential voltage δv = vb va negative case q positive positive test charge wab negative represent decrease electric electric potential ratio work test charge infinity point electric field surround source charge divide magnitude test charge let consider negative test charge negative test charge spontaneously position low electric potential position high electric potential voltage δv = vb va positive case q negative negative test charge wab negative represent decrease electric potential energy takeaway positive charge spontaneously

direction decrease electric potential negative voltage negative charge spontaneously direction increase electric potential positive voltage)—yet case electric potential energy decrease create analogy mechanic electrostatic familiarize concept electric field like gravitational field exert force charge like gravitational field exert force masse test charge particular electric potential energy give electric potential depend magnitude charge like mass particular gravitational potential energy depend magnitude mass mechanic concept discuss chapter 1 2 mcat physics math review mcat concept check 5.4 assess understanding material 1 difference electric potential voltage 2 charge place point zero electric potential relative source charge 3 true false unit electric potential energy electric potential different 5.5 special case electrostatic chapter 5.5 able describe equipotential line electric dipole recall electrical potential point bisector dipole predict voltage distinct point equipotential line predict behavior dipole expose external field section explore unique setup electrostatic common mcat equipotential line line potential point potential difference point equipotential line zero draw paper equipotential line look like concentric circle surround source charge dimensional space equipotential line actually sphere surround source charge equation electrical potential work

line actually sphere surround source charge equation electrical potential work move test charge q point equipotential line work move test charge q line work depend potential difference line pathway take entirely analogous displacement object horizontally level surface object height ground change gravitational potential energy unchanged furthermore change object gravitational potential energy depend pathway take height actual vertical displacement work charge equipotential line depend path know deal conservative force move charge conservative nonconservative force discuss chapter 2 mcat physics example diagram electron go point point b vicinity large positive charge electron follow path show path require work electron charge b charge move b different path solution state work depend potential difference path path show require work move electron b. note source charge positive point b low electrical potential point a. test charge negative electrical potential energy high point b

point a. sense electron gain energy move far away positive source charge reactivity organic compound base separation charge electric dipole result equal opposite charge separate small distance d transient case moment moment change electron distribution create london dispersion force permanent case molecular dipole water carbonyl functional group electric dipole visualize barbell equal weight end bar represent equal opposite charge separate small distance represent length bar analyze generic dipole figure 5.3 work specific example important electric dipole water molecule description give follow text figure 5.3 generic dipole dipole figure 5.3 charge + q q separate distance d. notice + q q source charge write lowercase give dipole want calculate electrical potential point p near dipole distance point space + q r1 distance point space q r2 distance point space midpoint dipole r.

know collection charge electrical potential p scalar sum potential charge point word point space relatively distant dipole compare d product r1 r2 approximately equal square r r1 r2 approximately equal d cos θ plug approximation equation product charge separation distance

define dipole moment p si unit c m p = qd dipole moment vector direction define differently physicist chemist physicist define vector line connect charge dipole axis vector point negative charge positive charge chemist usually reverse convention have p point positive charge negative charge chemist draw crosshatch tail end dipole vector indicate tail end positive charge example h2o molecule dipole moment 1.85 d. calculate electrical potential water molecule point 89 nm away axis dipole note 1 d debye = 3.34 × 1030 c m solution question ask potential axis dipole angle θ 0 ° substitute value equation dipole potential multiply 1.85 d 3.34 × 1030 convert c m important equipotential line aware plane lie halfway + q q call perpendicular bisector dipole angle plane dipole axis 90 ° cos 90 ° = 0 electrical potential point plane 0 magnitude electric field perpendicular bisector dipole approximate electric field vector point perpendicular bisector point direction opposite p define directionally physicist dipole classic example setup torque act absence electric field dipole axis assume random orientation

electric dipole place uniform external electric field equal opposite charge dipole experience force exert field charge equal opposite force act charge equal magnitude opposite direction result situation translational equilibrium net torque center dipole great example mcat test kinematic dynamic electrostatic setting dipole angle external electric field translational equilibrium rotational equilibrium force opposite direction left right figure 5.4 torque direction clockwise net torque dipole calculate equation τ = pe sin θ p magnitude dipole moment p = qd e magnitude uniform external electric field θ angle dipole moment make electric field torque cause dipole reorient dipole moment p align electric field e show figure 5.4 electrostatic force charge electric field point left right torque create clockwise direction charge figure 5.4 torque dipole external electric field electric dipole likely test

5.4 torque dipole external electric field electric dipole likely test qualitatively context passage reaction test day unlikely mathematical relation present test background mcat concept check 5.5 assess understanding material 1 define following term 2 voltage point equipotential line voltage cause charge line 3 electrical potential point perpendicular bisector dipole zero 4 behavior electric dipole expose external chapter 5.6 able recall requirement nonzero electric field nonzero magnetic field nonzero magnetic force predict impact magnetic field nearby object calculate magnitude magnetic field magnetic force exert field predict direction magnetic force right hand rule move charge create magnetic field magnetic field set movement individual charge electron move space mass movement charge form current conductive material copper wire permanent magnet si unit magnetic field strength tesla t size tesla unit large small magnetic field measure gauss 1 t = 104 gauss move charge single electron travel space current conductive material create magnetic field si unit magnetic field strength tesla t material classify diamagnetic paramagnetic ferromagnetic diamagnetic material atom

unpaired electron net magnetic field material slightly repel magnet call weakly antimagnetic

diamagnetic material include common material expect stick magnet wood plastic water glass skin atom paramagnetic ferromagnetic material unpaired electron atom net magnetic dipole moment atom material usually randomly orient material create net magnetic field paramagnetic material weakly magnetized presence external magnetic field align magnetic dipole material external field removal external field thermal energy individual atom cause individual magnetic dipole reorient randomly paramagnetic material include aluminum copper gold ferromagnetic material like paramagnetic material unpaired electron permanent atomic magnetic dipole normally orient randomly material net magnetic dipole unlike paramagnetic material ferromagnetic material strongly magnetized expose magnetic field certain temperature common ferromagnetic material include iron nickel cobalt bar magnet ferromagnetic material north south pole field line exit north pole enter south pole magnetic field line circular impossible monopole magnet bar magnet allow interact opposite pole attract like pole repel move charge create magnetic field certainly expect collection move charge form current conductive wire produce magnetic field vicinity configuration magnetic field line surround current carry wire depend shape wire special case commonly test mcat include long straight wire circular loop wire particular attention pay magnetic field center loop infinitely long straight current carry wire calculate magnitude magnetic field produce current wire perpendicular distance r wire b magnetic field distance r wire μ0 permeability free space current equation demonstrate inverse relationship magnitude magnetic field distance current straight wire create magnetic field shape concentric ring determine direction field vector use right hand rule right hand rule magnetism point thumb direction current wrap finger current carry wire finger mimic circular field line curl wire circular loop current carry wire radius r magnitude magnetic field center circular loop

give notice equation similar obvious difference equation magnetic field center circular loop wire include constant π obvious difference expression give magnitude magnetic field perpendicular distance r current carry wire second expression give magnitude magnetic field

center circular loop current carry wire radius r.

example suppose wire form loop carry current 0.25 clockwise direction show loop wire current flow clockwise direction determine direction magnetic field produce loop loop outside loop loop diameter 1 m magnitude magnetic field center loop solution use right hand rule determine direction magnetic field outside loop show right hand rule field inside loop page field outside loop page align right thumb current point loop encircle wire remain finger right hand finger point page loop page outside determine magnitude magnetic field center use equation loop wire review way magnetic field create let examine force exert magnetic field move charge magnetic field exert force move charge charge sense field sense field establish external charge collection charge discussion magnetic force move charge current carry wire assume presence fixed uniform external magnetic field note charge electrostatic magnetic force act time sum electrostatic magnetic force know lorentz force force move charge charge move magnetic field magnetic force exert magnitude calculate follow fb = qvb sin θ q charge v magnitude velocity b magnitude magnetic field θ small angle velocity vector v magnetic field vector b. notice magnetic force function sine angle mean charge perpendicular component velocity order experience magnetic force charge move parallel antiparallel magnetic field vector experience magnetic force remember sin 0 ° sin 180 ° equal zero mean charge move parallel antiparallel direction magnetic field experience force magnetic field introduce second right hand rule practice anticipation test day determine direction magnetic force move charge position right thumb direction velocity vector finger direction magnetic field line palm point direction force vector positive charge hand point direction force vector negative charge part right hand rule magnetic force thumb velocity indicate direction movement like hitchhiker finger field line finger parallel like uniform magnetic palm force positive charge high hand force negative charge backhand negative person example

charge high hand force negative charge backhand negative person example suppose proton

move velocity page uniform magnetic field 3.0 t direct page show proton move page magnetic field page magnitude direction magnetic force proton describe motion result setup note charge proton 1.60 × 1019 c mass 1.67 × 1027 kg solution start determine magnitude force determine direction use right hand rule thumb point page direction v. finger point page direction b.

proton positively charge force fb direction palm left note v fb perpendicular imply uniform circular motion occur field fb point radially inward center circle centripetal force magnetic force set equation equal proton circle radius 52 nm force current carry wire examine force create magnetic field point charge move field come surprise current carry wire place magnetic field experience magnetic force straight wire magnitude force create external magnetic field fb fb = ilb sinθ current l length wire field b magnitude magnetic field θ angle l b. right hand rule current carry wire field move point charge remember current consider flow example suppose wire length 2.0 m conduct current 5.0 page 30 gauss uniform magnetic field direct page magnitude direction magnetic force wire solution 1 t = 104 gauss 1 gauss = 104 t 30 gauss = 30 × 104 t = 3 × 103 t. wire conduct current page magnetic field point page current perpendicular magnetic field angle θ = 90 ° plug equation determine direction use right hand rule thumb point page direction l.

finger point page direction b. current flow positive charge force fb direction palm left mcat concept check 5.6 assess understanding material 1 requirement nonzero electric field nonzero magnetic field nonzero magnetic force nonzero electric field nonzero magnetic field nonzero magnetic force 2 experience large magnetic field object place meter left current carry wire object place center circle radius meter note assume current constant 3 following combination velocity magnetic field direction determine direction magnetic force give page page page proton page page left page right chapter review notion charge remind charge come variety positive negative explore fact charge travel differently insulator conductor learn charge

establish electric field exert force charge rely similarity electrical gravitational system well understand coulomb law nature force exist charge particle forget electrical force repulsive attractive difference electrical gravitational system charge contain electrical potential energy define energy position respect charge charge electric field position electrical potential spontaneously electrical potential difference voltage whichever direction result decrease charge electrical potential energy consider geometry electric dipole derive equation calculate electrical potential point space dipole finally consider magnetic field force chapter examine move charge interact circuit element complete understanding electricity review content test knowledge critical thinking skill complete test like passage set online si unit charge coulomb proton positive charge electron negative charge proton electron possess fundamental unit charge e = 1.60 × 10–19 c proton electron different masse opposite charge exert attractive force like charge exert conductor allow free uniform passage electron insulator resist movement charge localize area charge distribute surface material coulomb law give magnitude electrostatic force vector charge force vector point line connect center charge charge generate electric field exert force electric field ratio force exert test charge magnitude charge electric field vector represent field line radiate outward positive source charge radiate inward negative source charge positive test charge

source charge radiate inward negative source charge positive test charge direction field line negative test charge direction opposite electric potential energy electric potential energy work require bring test charge infinitely far away give position vicinity source charge electric potential energy system increase like charge opposite charge electric potential energy system decrease opposite charge like charge far apart electric potential electric potential energy unit charge different point space electric field surround source charge different electric potential value potential difference voltage change electric potential accompany movement test charge position potential difference path independent depend initial final position test charge unit electric potential voltage volt test charge spontaneously whichever direction result decrease

electric potential energy positive test charge spontaneously high potential low potential negative test charge spontaneously low potential high potential special case electrostatics equipotential line designate set point source charge multiple source charge electric potential equipotential line perpendicular electric field work charge move equipotential line work independent pathway take line work charge move point equipotential line point equipotential line charge opposite sign separate fix distance d generate electric dipole external electric field electric dipole experience net torque align electric field vector electric field induce translational motion dipole regardless orientation respect electric magnetic field create magnet move charge si unit magnetic field tesla t 1 t = 10,000 gauss diamagnetic material possess unpaired electron slightly repel magnet paramagnetic material possess unpaired electron weakly magnetic external magnetic field ferromagnetic material possess unpaired electron strongly magnetic external magnetic field magnet north south pole field line point north south pole current carry wire create magnetic field concentric circle surround wire external magnetic field exert force charge move direction parallel antiparallel field point charge undergo uniform circular motion uniform magnetic field centripetal force magnetic force act point charge direction magnetic force move charge current- carry wire determine

charge direction magnetic force move charge current- carry wire determine right hand rule lorentz force sum electrostatic magnetic force act body answer concept check 1 electron experience great acceleration subject force proton significantly 2 conductor blood copper iron sulfuric acid insulator hair glass 3 net charge 1 c neutron contribute charge 1 electric field 0 charge case field exert charge midpoint cancel electric field 2 pair charge negative electrostatic force point charge attractive positive electrostatic force point charge away repulsive 4 electrostatic force directly relate charge relate distance inverse square relationship electric field unrelated test charge relate distance inverse square relationship note source charge create electric field test charge use equation determine relationship 1 decrease potential energy indicate system stable mind negative number large absolute value negative

represent decrease value negative number small absolute value 4 > 7

|4| < |7| 2 electrical potential energy coulomb law multiply distance gravitational potential energy universal law gravitation multiply distance 3 particle charge electrical potential energy decrease distance increase particle opposite charge electrical potential energy increase distance 4 give equation electric potential energy increase factor charge double radius 1 electrical potential ratio charge electrical potential energy magnitude charge voltage potential difference measure change electrical potential point provide indication tendency movement direction 2 charge way minimize potential energy place charge point zero electrical potential indicate zero potential difference charge move away source charge depend sign source charge test charge 3 true electrical potential energy measure joule j electrical potential potential difference voltage measure 1 equipotential line set point space potential difference point zero well visualize concentric sphere surround source charge electric dipole separation charge molecule permanent temporary region equal opposite charge particular distance 2 voltage point equipotential line acceleration line potential difference different set equipotential line cause particle accelerate 3 perpendicular bisector electric dipole equipotential plane perpendicular axis dipole equation necessarily equal 0 cos 90 ° = 0 4 dipole rotate external electric field dipole moment align field 1 create electric field need charge create magnetic field need charge move create magnetic force need external electric field act charge move direction parallel antiparallel external 2 need determine actual value magnetic field case compare equation instead magnetic field create current carry wire give magnetic field create loop wire give μ0 r equation magnetic field center loop large denominator equation include π page electron page page page proton sin 180 ° = 0 page page page left electron page page right neutron q = 0 science mastery assessment explanation accord newton law r exert force s s exert force equal magnitude opposite direction r. magnitude force r s f. force

inversely proportional r2 cut distance half multiply force 22 make time electric field direction give point define direction force exert positive test charge position electron negatively charge particle feel force opposite direction electric field vector case force point left r electron feel force point right s e direction f. step answer question remember magnitude electric field inversely proportional square distance electric field radius r er electric field radius 2r similarly electric field radius 3r equal ratio er e2r e3r 36:9:4 positive charge place experience force force left +2q force right + q. point distance + q +2q force +2q large + q net force left + q point b force + q +2q point right net force right recall change potential energy δu change potential δv relate w = δu = qδv δu = 2 × 10 6 c × 12 v = 2.4 × 10–5 j. positive charge move positive negative plate decrease potential energy reflect fact voltage 12 v +12 v. potential energy lose convert kinetic energy charge gain 2.4 × 10–5 j kinetic energy work move negative charge initial position y = 0 move negative charge y = 0 final position work opposite sign force change direction electron cross y = 0 quantity work cancel argument depend crucially symmetry initial final position safe way answer question quickly draw diagram notice right away wire direction magnetic field page vector direction focus magnitude magnetic field know b1 = 10 t distance r.

consider relationship equation magnetic field current directly proportional magnetic field distance inversely proportional double current result double magnetic field wire 20 t. overall magnitude magnetic field 10 t + 20 t = 30 t page potential scalar quantity total potential sum potential positive negative charge r+ r represent distance positive negative charge respectively sum term zero point r+ = r–. point perpendicular bisector dipole axis infinity electric potential v equal work w divide test charge q mean potential directly proportional work equal energy gain particle overall energy increase factor 4 energy directly proportional square speed accord speed increase factor 2 know field line positively charge particle point away particle radial pattern regardless direction particle move field line point direction positive test charge field direction force exert positive test charge field voltage δv equal quotient work w divide charge particle work q accord equation voltage equal 9 v charge equal

2 c work equal 9 v × 2 c = 18 prevent flow charge plate dielectric insulative material insulative material contain atom tightly bind electron nonmetal glass compose nonmetal silicon oxygen good insulator support choice c hand pure water insulator presence ion

greatly increase conductivity salt water eliminate problem application right hand rule velocity vector v tangent circle magnetic force point radially center circle consider negative charge 12 o'clock position circle apply right hand rule thumb point left tangent circle point hand represent force negative charge point page radially center circle finger point page hand position direction magnetic field page potential energy easy think term common sense term rigorous mathematical formula opposite charge attract oppositely charge specie like atp cation move apart potential energy increase reflect fact oppositely charge specie like close distance furthermore formula electric potential energy u = kqq r. formula observe relationship u r give u  1 r mean r change factor 2 u change factor 2 factor 4 observation justify correct answer mathematically rigorous explanation consider opposite charge atp cation cause output formula u = kqq r negative distance charge double expression u = kqq/2r half large magnitude u negative oppositely charge specie small negative value actually mean u increase consider magnitude small temperature -5oc actually warm temperature 25oc.

similarly u small negative magnitude actually mean high energy short double radius mean energy double charge specie opposite consult online resource additional practice equation remember 5.1 coulomb law 5.2 electric field 5.3 electric potential energy 5.4 electric potential electric potential energy 5.5 electric potential source charge 5.7 electric potential near dipole 5.8 dipole moment p = qd 5.9 electric field perpendicular bisector dipole 5.10 torque dipole electric field τ = pe sin θ 5.11 magnetic field straight wire 5.12 magnetic field loop wire 5.13 magnetic force move point charge fb = qvb sin θ 5.14 magnetic force current carry wire fb = ilb sin θ general chemistry chapter 1 general chemistry chapter 3 bonding chemical interaction general chemistry chapter 12 physics math chapter 1 kinematic dynamic physics math chapter

2 work energy physics math chapter 6 chapter 6 circuit chapter 6 circuit circuit board background science mastery assessment pre med know feeling content know mcat know important 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 get correct ensure thinking match explanation review concept summary end chapter 1 defibrillator pass 15 current patient body 0.1 second charge go patient skin 1

current patient body 0.1 second charge go patient skin 1 0.15 c 2 1.5 c 3 15 c 4 150 c 2 student place ammeter negligible resistance parallel resistor determine current pass resistor student obtain accurate reading 1 yes ammeter negligible resistance 2 yes current go parallel path equal 3 ammeter infinite resistance 4 ammeter parallel change current 3 resistance conductor equal cross sectional area equal length compare find ratio 1:2 resistivity material construct ratio 4 voltaic cell provide current 0.5 circuit 3 ω resistor internal resistance cell 0.1 ω voltage terminal battery current 1 0.05 v 2 1.5 v 3 1.505 v 4 1.55 v 5 transformer device take input voltage produce output voltage large small input voltage depend transformer design voltage change transformer energy input power equal output power particular transformer produce output voltage 300 percent input voltage ratio output current input current 6 give r1 = 20 ω r2 = 4 ω r3 = r4 = 32 ω r5 = 15 ω r6 = 5 ω

total resistance setup show branch 1 r1 branch 2 r2 series r3 r4 parallel branch 3 r5 r6 series 1 0.15 ω 2 6.67 ω 3 16.7 ω 4 60 ω 7 mole electron pass circuit contain 100 v battery 2 ω resistor period 10 second note 1 5.18 × 10–3 mole 2 500 mole 3 5.18 × 103 mole 4 5.2 × 106 mole 8 circuit voltage drop resistor 10 v source 0.5 ohm resistor series 2 ohm 0.67- ohm resistor parallel 3 5 v 4 7.5 v 9 area capacitor plate double distance halve final capacitance cf compare original capacitance ci 1 cf = ci 3 cf = 2ci 4 cf = 4ci 10 energy store fully charge capacitor give typical cardiac defibrillator capacitor charge 7500 v store energy 400 j. base information charge capacitor cardiac defibrillator 1 1.1 × 105 c 2 5 × 102 c 3 1.1 × 101 c 4 3.1 × 106 c 11 10 ω resistor carry current vary function time show energy dissipate resistor 5 s current vs. time current 2 2 second zero second 2 2 second zero second 1 40 j 2 50 j 3 120 j 4 160 j 12 figure current meet point p. magnitude direction current point p x current p 2 3 8 current p 5 6 wire point x come p 1 2 x 2 2 p 3 10 x 4 10 p 13 following likely increase electric field plate parallel plate capacitor 1 add resistor connect capacitor series 2 add resistor connect capacitor parallel 3 increase distance plate 4 add extra battery system 14 resistor show carry individual resistance 4 ω.

assume negligible resistance wire overall resistance circuit branch 1 voltage source branch 2 resistor series branch 3 resistor 1 16 ω 2 8 ω 3 4 ω 4 3 ω 15 follow well characterize ideal voltmeter 1 ideal voltmeter ammeter infinite resistance 2 ideal voltmeter ammeter resistance 3 ideal voltmeter infinite resistance ideal ammeter 4 ideal voltmeter resistance ideal ammeter answer key

follow page 1 b ch 6.1 2 d ch 6.4 3 b ch 6.2 4 d ch 6.2 5 ch 6.1 6 b ch 6.2 7 ch 6.2 8 c ch 6.2 9 d ch 6.3 10 c ch 6.3 11 c ch 6.2 12 ch 6.1 13 d ch 6.3 14 d ch 6.2 15 c ch 6.4 chapter 6 circuit chapter 1 6.1 current 4 circuit law 5 6.2 resistance hy 6 property resistor 7 ohm law power 8 resistor series parallel 9 6.3 capacitance capacitor 10 property capacitor 11 dielectric material 12 capacitor series parallel 13 6.4 meter 17 concept summary content chapter relevant 16

question physics mcat chapter cover material following aamc content category 4c electrochemistry electrical circuit element battery electric circuit electrical equipment pervade everyday world think piece equipment tool toy battery power cord identify object depend movement electron delivery electric potential energy carry function turn light watch tv toast bread literally watch electron work emit light electricity restrict inorganic material world body find electricity serve key role number physiological function neuron brain conduction system heart rely electricity cell utilize mitochondrion carry oxidative phosphorylation chapter review essential circuit broad knowledge base draw specific topic circuit theory conductivity electromotive force emf resistance power kirchhoff law resistor capacitor meter series parallel arrangement circuit component encounter concept chapter equation associate remember mcat approach topic circuit great emphasis concept math expect calculate equivalent resistance resistor series parallel circuit encounter test day simple see college physic chapter 6.1 able recall definition current voltage electromotive force emf conductivity si unit compare conductivity solution give component describe relationship voltage source voltage drop use kirchhoff law describe flow electron chapter examine behavior charge case interested movement charge current historical convention current consider flow positive charge negative charge actually move conductive substance act medium

positive charge negative charge actually move conductive substance act medium current pass conductivity divide category metallic conductivity see solid metal molten form salt electrolytic conductivity see solution conductance reciprocal resistance property examine detail later si unit conductance siemens s give siemens meter material allow free flow electric charge material call electrical conductor metal atom easily lose outer electron free large collection metal atom make metal good electrical thermal conductor metallic bond visualize sea electron flow past rigid lattice metal cation model generally appropriate mcat metallic bonding accurately describe equal distribution charge density free electron neutral atom metallic mass remember metal find left periodic table atom low ionization energy easy atom lose electron

weak hold electron free metal conduct electrical charge periodic trend discuss chapter 2 mcat general chemistry review substantially different metallic conductivity important note electrolytic conductivity depend strength solution distilled deionize water low ion concentration consider insulator sea water orange juice excellent conductor conductivity electrolyte solution measure place solution resistor circuit measure change voltage solution concentration conductivity directly relate method determine ionic concentration solution blood caveat conductivity nonionic solution low ionic solution concentration total dissolve solid relate conductivity contribution nonionic solid important ion concentration chapter 5 mcat physics math review introduce concept electrical current flow charge point different electrical potential connect conductor copper wire magnitude current charge q pass conductor unit time t calculate si unit current ampère charge transmit flow electron conductor electron negatively charge point low electrical potential point high energy convention direction current direction positive charge flow high potential low potential direction current opposite direction actual electron flow pattern current flow direct current dc charge flow direction alternate current ac flow change direction periodically direct current produce household battery current supply long distance home building alternate current discussion circuit assume direct current test mcat exclusion alternate

current discussion circuit assume direct current test mcat exclusion alternate current potential difference voltage produce electrical generator galvanic voltaic cell group cell wire battery see classic science fair project potato charge move terminal cell different potential value voltage call electromotive force emf ε mislead term emf actually force potential difference voltage unit joules coulomb newton helpful think emf pressure result current way pressure difference point fluid fill tube cause fluid flow standard battery flashlight remote control example galvanic voltaic cell house spontaneous oxidation reduction reaction generate emf result difference reduction potential electrode electrochemistry discuss chapter 12 mcat general chemistry review current circuit general govern law conservation charge energy fully account

time create destroy electric circuit conduct path usually voltage source battery connect passive circuit element resistor kirchhoff law rule deal conservation charge energy kirchhoff junction rule point junction circuit sum current direct point equal sum current direct away point expression conservation electrical charge express iinto junction = ileaving junction kirchhoff junction rule like fork river certain number water molecule river junction number diverge direction water molecule spontaneously appear disappear hold true current example wire b c meet junction point p show current 5 flow p wire current 3 flow away p wire b. magnitude direction current wire c description give text solution sum current enter p equal sum current leave p.

assume ic flow p. find negative know current go direction current 2 flow p wire c. kirchhoff loop rule close circuit loop sum voltage source equal sum voltage potential drop consequence conservation energy electrical energy supply source get fully element loop excess energy appear energy disappear account course energy change form kinetic energy electron convert thermal energy light sound particular apparatus connect circuit remember kirchhoff loop rule consequence law conservation energy law term voltage joules coulomb energy joules express mathematically vsource = vdrop voltage loop circuit voltage build trip circuit impossible mcat concept check 6.1 assess understanding material 1 define follow term provide si unit electromotive force emf 2 likely high conductivity 1 m glucose 0.25 m nacl 3 true false circuit number electron enter point leave point 4 true false sum voltage source circuit equal sum voltage drop circuit 6.2 resistance high yield chapter 6.2 able recall physical property resistor determine apply formula connect power current voltage describe internal resistance battery impact circuit contrast effect resistor circuit series compare parallel calculate total resistance give circuit left image 4 resistor series right image 4 resistor parallel resistance opposition material movement flow charge electrical resistance think like friction air resistance viscous drag case motion oppose material offer resistance call conductor material offer high resistance call insulator conductive material offer amount resistance extreme property

resistor resistance resistor dependent certain characteristic resistor include resistivity length cross sectional area temperature summarize equation resistance ρ resistivity l length resistor cross- sectional area explore effect variable temperature section mcat common resistor outside generic unlabeled resistor light bulb appliance function resistor resistance apply atypically resistance air flow lung blood move circulatory system mathematical relationship useful circumstance material intrinsically well conductor electricity example copper conduct electricity well plastic electrical wire copper core surround layer plastic way number characterize

electrical wire copper core surround layer plastic way number characterize intrinsic resistance current flow material call resistivity ρ si unit ohm meter ω m

good practice able derive unit variable equation know solve resistivity ρ resistance equation end square meter r ohm l meter simplify meter time ohm unit accord resistance equation resistance resistor directly proportional length long resistor mean electron travel great distance resistant material factor scale linearly resistor double length double resistance equation resistance

demonstrate inverse proportionality resistance cross sectional area resistor resistor cross sectional area double resistance cut half increase cross sectional area increase number pathway resistor call conduction pathway wide resistor current flow analogous river wide river resistance water flow note electrical current follow continuity equation apply incompressible fluid a1v1 = a2v2 instead obey kirchhoff law evident resistance equation conductor great resistance high temperature increase thermal oscillation atom conductive material produce great resistance electron flow temperature intrinsic quality matter think resistivity function temperature material follow general rule include glass pure silicon semiconductor ohm law power cover voltage current resistance begin bring variable solve circuit electrical resistance

result energy loss reflect drop electrical potential voltage drop point circuit calculate accord ohm law v = ir v voltage drop current r magnitude resistance measure ohm ω ohm law basic law electricity state give magnitude resistance voltage drop resistor proportional magnitude current likewise give resistance magnitude current proportional magnitude emf voltage impress circuit equation apply single resistor circuit circuit entire circuit provide calculate equivalent resistance resistor circuit current move set resistor circuit voltage drop resistor current sum current divide circuit constant charge gain lose resistor resistor connect series current pass resistor conductive material copper wire act weak resistor offer magnitude resistance current cause drop electrical potential voltage source emf battery small measurable internal resistance rint result internal resistance voltage supply circuit reduce theoretical emf value small actual voltage supply cell circuit calculate v = ecell irint v voltage provide cell ecell emf cell current cell rint internal resistance battery mcat consider perfect battery account internal resistance cell actually drive current switch open position internal resistance zero voltage cell equal emf case current zero internal resistance negligible voltage emf superconductor special class material major exception rule internal resistance element compound cool low temperature usually 100 k

internal resistance element compound cool low temperature usually 100 k exact threshold vary material resistivity material ρ completely dissipate drop zero material break generally applicable law physic superconductor interesting cell discharge supply current current flow positive high potential end cell circuit negative low potential end certain type cell call secondary battery recharge battery recharge external voltage apply way drive current positive end secondary battery electrochemical term cell act galvanic voltaic cell discharge electrolytic cell recharge chapter 2 mcat physics math review briefly mention power rate energy transfer transform power measure ratio work energy expenditure time express follow electric circuit energy supply cell house spontaneous oxidation reduction reaction allow proceed closing switch example generate flow electron electron electrical potential energy convert energy

kinetic energy circuit drive emf cell mention emf force well think pressure exert cell electron current deliver energy resistor convert energy form depend particular configuration resistor particularly recognizable example resistor work coil inside toaster coil turn red hot toaster power dissipate thermal energy direct consequence resistance coil pose current run rate energy dissipate resistor power resistor calculate current resistor v voltage drop resistor r resistance resistor note different version power equation interconverte substitution ohm law v = ir equation calculate power resistor collection resistor extremely helpful mcat commit memory importantly understand effort reward point test day power equal voltage time current power company manipulate value keep power constant option increase current result decrease voltage option increase voltage decrease current power line high voltage line allow carry small current decrease energy lose system resistor series parallel resistors connect circuit way series current pass sequentially resistor connect linear arrangement parallel current divide pass resistor separately resistor series resistor connect series current choice travel resistor order return cell show figure 6.1 resistor series figure 6.1 resistor series r increase resistor add electron

series figure 6.1 resistor series r increase resistor add electron flow resistor energy dissipate voltage drop associate resistor voltage drop additive series resistor r1 r2 r3  rn total voltage drop v = v1 + v2 + v3 +  + vn v = ir resistance resistor series additive r = r1 + r2 + r3 +  + rn set resistor wire series treat single resistor resistance equal sum individual resistance term equivalent resultant resistance note r increase resistor add path current current point line include resistor know current circuit use v = ir solve voltage drop resistor assume know resistance example circuit wire cell supply 5 v series resistor 3 ω 5 ω 7 ω wire series show result voltage current resistor circuit entire circuit 5 volt battery connect resistor series 3 5 7 ohm point b c d label start resistor resistor respectively solution total resistance resistor r = r1 + r2 + r3 = 3 ω + 5 ω + 7 ω = 15 ω use ohm law current entire circuit series current circuit element use ohm law resistor turn b voltage drop r1 ir1 = 0.33 a)(3 ω = 1.0 v b c voltage drop

r2 ir2 = 0.33 a)(5 ω = 1.67 v c d voltage drop r3 ir3 = 0.33 a)(7 ω = 2.33 v resistor

parallel resistor parallel figure 6.2 resistor parallel rp decrease resistor add resistor connect parallel wire common high potential terminal common low potential terminal show figure 6.2 configuration allow charge follow different parallel path high potential terminal low potential terminal arrangement electron choice path choose pathway choose different pathway matter path take voltage drop experience division current pathway originate common point end common point circuit analogous river split multiple stream plunge different waterfall come re-form river low height water start common height end low common height matter step water fall fall change height stream circuit parallel arrangement resistor express mathematically vp = v1 = v2 = v3 =  = vn remember kirchhoff loop rule resistor parallel voltage drop pathway equal voltage voltage parallel pathway resistance pathway differ case electron prefer path resistance word current large pathway low resistance fact inverse relationship portion current travel particular pathway resistance offer pathway resistance equation previously discuss show inverse relationship cross sectional area resistor resistance resistor like open rush hour lane reduce traffic congestion perform cardiac bypass perfuse hypoxic heart tissue configuration resistor parallel allow great total number conduction path effect connect resistor parallel reduction equivalent resistance effect replace resistor parallel single resistor resistance resistance small resistor circuit equivalent resistance resistor parallel calculate note rp decrease resistor add voltage drop circuit branch voltage drop parallel branch magnitude current branch inversely proportional resistance offer branch come directly ohm law circuit divide branch branch twice resistance twice resistance half magnitude current compare remember sum current go division accord kirchhoff junction rule equal total current go point current example consider equal resistor wire parallel equivalent resistance setup solution equation sum resistor parallel find common denominator right inverse special case r1 = r2 substitute example total resistance halve wire identical resistor parallel generally n identical resistor wire

halve wire identical resistor parallel generally n identical resistor wire parallel total resistance give note voltage parallel resistor equal equal resistance current flow resistor equal current run example consider resistor wire parallel r1 = 5 ω r2 = 10 ω.

voltage 10 v current resistor solution current flow circuit find equivalent resistance calculate ohm law calculate current flow circuit give amp flow combination r1 r2 resistor parallel vp = v1 = v2 = 10 v.

apply ohm law check note ip = 3 = i1 + i2 current flow small resistor particular note r1 half resistance r2 twice current ip find 3 problem solve note ratio resistance branch approach circuit problem thing need find total circuit value total voltage give voltage battery total equivalent resistance total current find total current find total resistance circuit mcat concept check 6.2 assess understanding material 1 add remove resistor change total resistance circuit resistor series parallel 2 physical quantity determine resistance resistor 3 power relate current voltage resistance 4 true false internal resistance battery lower current provide 5 circuit set resistor circuit branch r1 split r2 r3 set parallel r1 = 3 ω r2 = 2 ω r3 = 6 ω proportion total current travel resistor total resistance circuit 6.3 capacitance capacitor chapter 6.3 able predict behavior capacitor charge discharge describe impact dielectric capacitance voltage charge recognize physical property impact capacitance contrast effect capacitor circuit series compare circuit parallel left image capacitor series right image 4 capacitor aside battery resistor major circuit element test mcat capacitor capacitor characterize ability hold charge particular voltage excellent real world example capacitor important capacitor encounter clinic defibrillator defibrillator charge high pitched electronic tone sound electron build capacitor defibrillator fully charge charge release surge power operator yell clear cloud ground lightning storm act capacitor charge build eventually discharge bolt lightning mcat focus particular type capacitor call parallel plate capacitor discussion center capacitor type property

capacitor electrically neutral metal plate connect voltage source positive charge build plate connect positive high potential terminal negative charge build plate connect negative low potential terminal plate system capacitor store particular charge particular voltage capacitance capacitor define ratio magnitude charge store plate potential difference voltage capacitor voltage v apply plate capacitor charge q collect + q positive plate q negative

capacitor charge q collect + q positive plate q negative plate capacitance give si unit capacitance farad coulomb large quantity charge farad large capacitance capacitance usually give microfarad 1 μf = 1 × 10–6 f picofarad 1 pf = 1 × 10–12 f

careful confuse farad faraday

constant electrochemistry f charge mole capacitance parallel plate capacitor dependent geometry conduction surface simple case parallel plate capacitor capacitance give ε0 permittivity free space area overlap plate d separation plate separation charge set uniform electric field plate parallel field vector magnitude calculate look equation discuss chapter 5 mcat physics math review equation e derive fundamental electrostatic equation v = e × r. r setup distance plate d rewrite v = ed direction electric field point plate positive plate negative plate imagine place positively charge particle oppositely charge plate expect particle accelerate direction surprising electric field line point direction indicate direction force exert positive charge regardless particular geometry capacitor parallel plate function capacitor store energy form charge separation particular voltage akin function dam purpose store gravitational potential energy hold mass water give height potential energy store capacitor term dielectric material way say insulation dielectric material air glass plastic ceramic certain metal oxide introduce plate capacitor increase capacitance factor call dielectric constant κ dielectric constant material measure insulate ability vacuum dielectric constant 1 definition reference dielectric constant air slightly 1 glass 4.7 rubber 7 number need memorize relevant

dielectric constant give test day capacitance dielectric material c′ = κc c′ new capacitance dielectric present c incorporate dielectric constant equation 6.14 reveal capacitor cακεd charge c = aκε0 d dielectric material decrease capacitance κ 1 dielectric isolate capacitor dielectric material place isolate charge capacitor charge capacitor disconnect circuit voltage capacitor decrease result dielectric material shield opposite charge lower voltage charge capacitor dielectric increase capacitance capacitor factor dielectric constant dielectric material introduce isolate capacitor increase capacitance arise decrease voltage dielectric circuit capacitor dielectric material place charge capacitor circuit connect voltage source charge capacitor increase voltage remain constant equal voltage source increase charge store capacitor dielectric increase capacitance capacitor factor dielectric constant dielectric material introduce

dielectric increase capacitance capacitor factor dielectric constant dielectric material introduce circuit capacitor increase capacitance arise increase store charge store energy capacitor useful allow discharge charge release plate discharge plate conductive material plate contact example capacitor discharge wire cause current pass wire way battery cause current circuit paddle defibrillator machine charge place patient heart go life threaten arrhythmia ventricular fibrillation reason doctor yell clear discharge paddle current need travel patient heart people touch patient create parallel pathway large scale lightning occur large charge exceed capacitance earth surface underside cloud serve approximately parallel plate capacitor large rapid discharge plate capacitor term failure capacitor create current attach wire normal function capacitor example voltage terminal isolate 3 μf capacitor 4 v. piece ceramic have dielectric constant κ = 2 place plate find new charge capacitance voltage capacitor solution introduction dielectric effect charge store isolate capacitor new charge charge charge store give q′ = q = cv = 3 μf)(4 v = 12 μc introduce dielectric dielectric constant 2 capacitance capacitor multiply 2 c′ = κc new capacitance new voltage capacitor determine example 3 μf capacitor connect 4 v battery piece ceramic have dielectric constant κ = 2 place plate find new charge capacitance voltage capacitor solution question similar previous voltage hold constant

battery new voltage 4 v. introduce dielectric dielectric constant 2 capacitance capacitor multiply 2 c′ = κc new capacitance new charge capacitor determine q′ = c′v′ = 6 μf)(4 v = 24 μc capacitor series parallel like resistor capacitor arrange circuit parallel series arrange resistor scope mcat case capacitor series capacitor connect series total capacitance decrease similar fashion decrease resistance see parallel resistor show figure 6.3 capacitor series figure 6.3 capacitor series cs decrease capacitor add capacitor share voltage drop loop store charge functionally group capacitor series act like equivalent capacitor large

charge functionally group capacitor series act like equivalent capacitor large distance plate fact distance equal series capacitor add increase distance see early mean small capacitance memorize follow equation independently understand conceptual basis mathematic resistor series parallel simply reverse mathematical approach capacitor equation calculate equivalent capacitance capacitor show cs decrease capacitor add note capacitor series total voltage sum individual voltage like resistor series capacitor parallel capacitors wire parallel show figure 6.4 produce resultant capacitance equal sum individual capacitance capacitor parallel figure 6.4 capacitor parallel cp increase capacitor add cp increase capacitor add cp = c1 + c2 + c3 +  + cn see resistor parallel voltage parallel capacitor equal voltage source mcat concept check 6.3 assess understanding material 1 assume plate attach conduct material capacitor behave voltage source remove 2 dielectric material impact capacitance voltage charge 3 add remove capacitor change total capacitance circuit capacitor series parallel 4 physical quality contribute capacitance capacitor chapter 6.4 able recall key detail ammeter voltmeter ohmmeter include measure place circuit ideal resistance determine multiple meter place focus calculation hypothetical circuit far important spend time consider real one analyze complex circuit important familiar meter device measure circuit quantity ammeters measure current point circuit ammeter require circuit current 0 a. ammeter insert series current measure use magnetic property current carry wire cause visible needle movement calibrate display current particularly high current overwhelm ammeter special low resistance shunt parallel ammeter

allow reading ideally ammeter change circuit mathematic insert circuit extremely low resistance ideal ammeter zero resistance voltage drop voltmeter like ammeter require circuit active voltmeter use magnetic property current carry wire voltmeter measure voltage drop point circuit wire parallel point goal meter minimize impact rest circuit voltmeter wire parallel ideal voltmeter infinite resistance unlike voltmeter ammeter ohmmeter require circuit active fact ohmmeter false reading damage active circuit

require circuit active fact ohmmeter false reading damage active circuit ohmmeter battery know voltage function ammeter point circuit circuit element analyze ohm law calculate resistance know ohmmeter voltage current create point circuit mcat concept check 6.4 assess understanding material 1 following type meter measure place circuit ideal resistance meter type measure placement ideal resistance 2 true false voltmeter ammeter place chapter cover lot material begin review current take special note conventional definition current movement positive charge fact negatively charge electron actually move consider basic law electricity circuit kirchhoff law expression conservation charge energy ohm law relate voltage current resistance define resistance analyze relationship resistance resistivity directly proportional resistance length directly proportional resistance cross sectional area inversely proportional define capacitance ability store charge voltage store energy stress importance conceptual mathematical treatment resistor capacitor series parallel major testing topic mcat finally cover different meter measure circuit quantity electricity challenge concept mcat student unlike kinematic thermodynamic fluid tangible electricity well understand schematic model time review chapter assuredly pay point test day chapter turn attention completely different topic tangible far audible review content test knowledge critical thinking skill complete test like passage set online current movement charge occur point different electrical potential convention current define movement positive charge high potential end voltage source low-reality negatively charge particle electron circuit low potential high potential current flow conductive material metallic conduction rely uniform movement free electron metallic bond

electrolytic conduction rely ion concentration insulator material conduct current kirchhoff law express conservation charge energy kirchhoff junction rule state sum current direct point circuit equal sum current direct away point kirchhoff loop rule state close loop sum voltage source equal sum voltage drop resistance opposition movement electron resistor conductive material moderate resistance slow electron stop resistance calculate resistivity length cross-sectional area material question ohm law state

resistivity length cross- sectional area material question ohm law state give resistance magnitude current resistor proportional voltage drop resistors circuit combine calculate equivalent resistance partial circuit resistor series additive sum create total resistance circuit resistor parallel cause decrease equivalent resistance resistor circuit certain power dissipate dependent current resistor voltage drop resistor capacitance capacitor capacitor ability store discharge electrical potential capacitance parallel plate capacitor determine area plate distance plate capacitor series cause decrease equivalent capacitance capacitor parallel sum create large equivalent dielectric material insulator place plate capacitor increase capacitance factor equal material dielectric constant κ ammeter insert series circuit measure current negligible resistance voltmeter insert parallel circuit measure voltage drop large resistance ohmmeter insert resistive element measure resistance self power negligible resistance answer concept check 1 current movement positive charge conductive material time give ampère voltage potential difference point give volt electromotive force emf refer potential difference voltage source circuit usually battery give volt conductivity reciprocal resistance measure permissiveness current flow measure siemens s 2 sodium chloride solution likely high conductivity salt increase ion content water glucose dissociate near zero impact conductivity 3 true restatement kirchhoff junction rule 4 false voltage source voltage drop equal close loop necessarily true entire circuit example 9 v battery power 10 light bulb parallel 9 v voltage source 9 v drop light bulb total 90 v drop light bulb combine 1 add resistor series increase total resistance circuit remove series decrease total resistance circuit relationship reverse

parallel add resistor decrease resistance remove increase 2 resistivity length cross sectional area temperature contribute resistance resistor 3 power relate current voltage resistance 4 true internal resistance lower available voltage circuit lower available voltage lower current 5 current travel resistor regardless resistance ratio resistance r2 r3 1:3 ratio current pass 3:1 word current pass r2 current pass r3 calculate

pass 3:1 word current pass r2 current pass r3 calculate total resistance calculate resistance resistor parallel add resistance r1 total resistance 4.5 ω.

1 capacitor discharge provide current opposite direction initial current 2 dielectric material increase capacitance capacitor isolate voltage decrease dielectric material introduce circuit voltage constant dictate voltage source capacitor isolate store charge remain constant additional source charge circuit store charge increase 3 add capacitor series decrease total capacitance circuit remove series increase total capacitance circuit relationship reverse parallel add capacitor increase capacitance remove decrease 4 surface area distance dielectric constant contribute capacitance capacitor series point parallel circuit element point series circuit element interest 2 false voltmeter ammeter design minimum impact circuit science mastery assessment explanations electrical current define charge flow mathematical term charge transfer time 15 current act 0.1 s transfer 15 × 0.1 s = 1.5 c charge measure current point circuit ammeter place series place parallel new path current create measure value reflective actual current circuit observation match d note ideal ammeter zero resistance effect current circuit resistance resistor give formula direct proportionality resistance resistivity variable equal resistor determine r1 r2 1:2 ratio ρ1 ρ2 1:2 ratio question test understanding battery circuit voltage terminal battery current flow refer electromotive force emf ε battery current flow circuit voltage terminal battery decrease equal current multiply internal resistance battery mathematically give equation v = ε irint determine emf battery calculate voltage battery current flow use ohm know internal resistance battery current voltage

calculate emf answer make sense context real battery internal resistance suppose small voltage provide circuit close possible emf cell current run tell transformer conserve energy output power equal input power pout = pin ioutvout = iinvin inverse proportionality current voltage output voltage

300 input voltage 3 time output current input voltage represent 1:3 ratio fast way tackle kind question simplify circuit bit bit example notice r3 r4 parallel series r2 similarly r5 r6 series determine total resistance branch leave branch parallel start find total resistance middle branch look total resistance branch r5 + 6 = r5 + r6 = 15 ω + 5 ω = 20 ω circuit view resistor parallel provide resistance 20 ω. total resistance circuit determine mole charge pass circuit period 10 s calculate charge run circuit charge simply current multiply time current calculate ohm law calculate number mole charge represent faraday constant approximate f close determine voltage drop resistor start calculate total resistance circuit resistor parallel equivalent resistance total resistance circuit sum remain resistor equivalent resistance know equivalent resistance calculate total current ohm law finally determine voltage drop parallel resistor voltage drop resistor 5 v drop resistor 2 ω resistor accord kirchhoff loop rule resistor form complete loop combination resistor 10 v voltage source net potential difference closed loop 0 v. question bring mind equation ε0 permittivity free space area plate d distance plate equation infer double area double capacitance halve distance double capacitance new capacitance time large initial capacitance question ask calculate charge capacitor use formula q = cv give v = 7500 v calculate c formula energy charge close 0.1 c close c power energy dissipate unit time energy dissipate e = pδt second interval resistor active 2 current second power dissipate resistor r carry current p = i2r.

energy dissipate e = i2rδt = 2 a)2(10 ω)(3 s = 4 × 10 × 3 = 120 j kirchhoff junction rule state sum current direct point equal sum current direct point current direct point p 8 2 3 sum 13 a. current direct point p 5 6 total 11 a. number equal additional current 2 direct away point p

point x. electric field plate parallel plate capacitor relate potential difference plate capacitor distance plate show formula addition battery increase total voltage apply circuit consequently increase electric field addition resistor series increase resistance decrease voltage apply capacitor eliminate add resistor parallel change voltage drop capacitor change electric field eliminate b increase distance plate c decrease electric field resistance resistor wire series equal sum individual resistance 12 ω mean circuit functionally contain 12 ω resistor 4 ω resistor parallel determine overall resistance system use formula primarily recall question intuitive voltmeter attempt determine change potential point provide alternate route charge flow infinite resistance ammeter attempt determine flow charge single point contribute resistance series circuit resistance consult online resource additional practice equation remember 6.2 kirchhoff junction rule iinto junction = ileaving junction 6.3 kirchhoff loop rule vsource = vdrop 6.4 definition resistance 6.5 ohm law v = ir 6.6 voltage cell emf v = ecell irint 6.7 definition power 6.8 electric power 6.9 voltage drop circuit element series v = v1 + v2 + v3 + + vn 6.10

equivalent resistance series r = r1 + r2 + r3 + + rn 6.11 voltage drop circuit element parallel vp = v1 = v2 = v3 = = vn 6.12 equivalent resistance parallel 6.13 definition capacitance 6.14 capacitance base parallel plate geometry 6.15 electric field capacitor 6.16 potential energy capacitor 6.17 capacitance dielectric material c′ = κc 6.18 equivalent capacitance series 6.19 equivalent capacitance parallel cp = c1 + c2 + c3 + + cn biology chapter 6 respiratory system biology chapter 7 cardiovascular system general chemistry chapter 12 physics math chapter 2 work energy physics math chapter 4 physics math chapter 5 electrostatic magnetism chapter 7 wave sound chapter 7 wave sound violin background science mastery assessment pre med know feeling content know mcat know important 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 get correct ensure thinking match explanation review concept summary end chapter 1 opera singer precisely identical glass singer produce pure tone possible shatter glass frequency 808 hz sing frequency 838 hz presence second glass second glass likely 1 shatter long time apply frequency high 2 shatter short time apply frequency high 3

frequency high 2 shatter short time apply frequency high 3 shatter apply frequency equal natural frequency glass 4 shatter high frequency sound associate 2 child practice overtone flute brother cover end flute brief second sound change assume new pitch represent overtone 1 pitch sound 2 pitch sound 3 pitch sound change 4 change pitch depend start pitch 3 follow necessarily true frequency angular frequency period give wave 1 magnitude angular frequency large magnitude period 2 product frequency period equal angular 3 magnitude angular frequency large magnitude frequency 4 product angular frequency period 1 4 ultrasound machine calculate distance base 1 intensity reflect sound 2 travel time reflect sound 3 angle incidence sound 4 detect frequency sound 5 period certain wave 34 m doppler shift double perceive frequency following true 1 detector move source velocity equal speed sound 2 source move detector velocity equal half speed sound 3 perceive period 17 m 4 perceive period 68 m 1 iii 2 iv 3 ii iii 4 ii iv 6 speed wave wavelength 10 cm 1 0.01 s 2 0.03 s 3 0.1 s 4 0.3 s

7 angular frequency harmonic pipe length 1.5 m close end note speed sound 1 170 radian

second 2 170π radian second 3 340 radian second 4 340π radian second 8 certain sound level increase 20 db. factor 4 log 2 9 form otosclerosis stapedial foot plate transmit vibration bone middle ear fluid cochlea fix position limit displacement stapedial foot plate vibration base mechanism following symptom likely see individual otosclerosis 1 increase perceive volume sound 2 decrease perceive volume sound 3 increase perceive pitch sound 4 decrease perceive pitch sound 10 wave frequency 180 ° phase amplitude resultant wave amplitude original wave 5 cm 3 cm 1 2 cm 2 3 cm 3 5 cm 4 8 cm 11 student measure sound frequency road walk east following situation student determine difference perceive frequency actual emit frequency zero 1 plane fly directly east west 2

police car pass student siren 3 person play piano house street 4 dog bark car move east 12 following medium sound travel fast 13 shock wave great impact source travel 1 speed sound 2 exactly speed sound 3 speed sound 4 speed sound 14 officer approach student study radio play loudly experience doppler effect follow statement remain true officer move close student 1 apparent frequency music increase 2 apparent frequency produce officer stationary student approach 3 apparent velocity wave decrease 1 2 ii 3 iii 4 ii iii 15 ignore attenuation intensity sound change distance source double 1 time intense 2 twice intense 3 half intense 4 quarter intense 1 c ch 7.1 2 b ch 7.2 3 c ch 7.1 4 b ch 7.2 5 ch 7.2 6 b ch 7.1 7 d ch 7.2 8 c ch 7.2 9 b ch 7.2 10 ch 7.1 11 d ch 7.2 12 d ch 7.2 13 b ch 7.2 14 ch 7.2 15 d ch 7.2 wave sound chapter 7.1 general wave characteristic transverse longitudinal wave principle superposition traveling stand wave production sound frequency pitch intensity loudness sound content chapter relevant 11 question physics mcat chapter cover material following aamc content category 4a translational motion force work energy equilibrium live system 4d

light sound interact matter species interaction sound amazingly complex e human ear develop means detect longitudinal wave carry air likely serve evolutionary purpose rustle leave indicate potential meal potential predator brain highly attuned analyze sound discuss

chapter 2 mcat behavioral sciences review is include normal auditory pathway pinna tympanic membrane ossicle cochlea vestibulocochlear nerve temporal lobe secondary structure superior olive help localize sound inferior colliculus involve startle reflex language inextricably link sound rough change pitch timbre imply evoke dozen complex feeling rough music relationship sound profound e.t.a. hoffman musicologist pedagogue write vivid description radiant beam shoot region deep night aware gigantic shadow rock forth close destroy pain endless longing longing pleasure rise jubilant tone sink succumb pain consume destroy love hope joy try burst breast voiced harmony passion live captivate beholder spirit sound create entire world explore is chapter aim lay foundation understand wave phenomenon e general property wave introduce include discussion wavelength frequency wave speed amplitude resonance review interaction wave meet point space constructive destructive interference examine mathematic stand wave mean musical instrument produce characteristic sound e subject sound review specific example longitudinal waveform focus wave phenomenon doppler effect finally provide brief discussion use ultrasound shock wave medicine 7.1 general wave characteristic chapter 7.1 able define key term apply wave sound frequency pitch distinguish common example transverse longitudinal wave predict impact apply force natural frequency give system predict relative amplitude resultant wave create interfere wave important use common language describe wave establish terminology associate wave phenomenon spend rest chapter look application wave principle sound chapter shi focus electromagnetic wave transverse longitudinal waves e mcat primarily concern sinusoidal wave wave transverse longitudinal individual particle oscillate forth displacement follow sinusoidal pattern transverse wave direction particle oscillation perpendicular propagation movement wave visualize consider e wave stadium e wave move stadium individual stand

consider e wave stadium e wave move stadium individual stand run stadium perpendicular direction e wave”—by stand sit common example mcat include electromagnetic wave visible

light microwave x ray form transverse wave attach string fixed point move hand demonstrate figure 7.1a waveform energy deliver direction wave travel transverse wave particle oscillate perpendicular direction energy transfer longitudinal wave one particle wave oscillate parallel direction propagation wave particle oscillate direction energy transfer sound wave classic example longitudinal wave sound waveform little difficult picture figure 7.1b help visualize longitudinal waveform travel air look like case longitudinal wave create person move piston forth cause air molecule oscillate cycle compression rarefaction decompression direction motion wave form longitudinal wave lay slinky flat table tap end figure 7.1 wave type transverse particle oscillate perpendicular direction propagation b longitudinal particle oscillate parallel direction propagation transverse wave particle oscillation perpendicular direction propagation energy transfer longitudinal wave particle oscillation parallel direction propagation energy transfer wave describe mathematically graphically first assign meaning physical quantity wave represent e distance maximum crest wave call wavelength λ e frequency f number wavelength pass fixed point second measure hertz hz cycle second cp value calculate propagation speed ν ν = fλ frequency define number cycle second inverse period t)—is number second cycle frequency relate angular frequency ω measure radian second oen consideration simple harmonic motion spring pendula wave oscillate central point call equilibrium position e displacement x wave describe far particular point wave equilibrium position express vector quantity e maximum magnitude displacement wave call amplitude careful terminology note amplitude define maximum displacement equilibrium position crest trough total displacement crest trough double amplitude ese quantity show figure 7.2 figure 7.2 anatomy wave simple harmonic motion spring string pendula formal content list mcat important familiar jargon wave motion sound light electromagnetic radiation content list analyze wave pass

motion sound light electromagnetic radiation content list analyze wave pass space describe step step wave calculate phase difference consider wave frequency wavelength amplitude

pass space time phase respective crest trough coincide line wave perfectly phase phase difference zero wave travel space way crest wave coincide trough phase phase difference half wave is express give angle 180 ° cycle = wavelength = 360 ° course wave phase fraction cycle principle superposition e principle superposition state wave interact displacement resultant wave point sum displacement interact wave wave perfectly phase displacement add amplitude resultant equal sum amplitude wave is call constructive interference wave perfectly phase displacement counteract amplitude resultant wave difference amplitude interact wave is call destructive interference wave perfectly phase resultant wave amplitude equal sum amplitude wave equal wave exactly 180 degree phase resultant wave zero amplitude wave perfectly phase phase partially constructive partially destructive interference occur show figure 7.3a wave nearly phase add displacement resultant simply sum displacement wave wave perfectly add phase erefore amplitude resultant wave sum wave amplitude contrast figure 7.3b

show wave perfectly phase e wave cancel resultant wave amplitude clearly small wave figure 7.3 phase difference phase difference zero b phase difference 180 degree noise cancel headphone pressure wave noise cancel destructive interference speaker create wave 180 degree phase similar amplitude frequency usually present noise difficult perfect noise cancel headphone operate principle superposition ey simply muffle sound actually capture environmental noise computer technology produce sound wave approximately 180 degree phase e combination wave inside headset result destructive interference cancel nearly cancel ambient noise travel stand wave string fixe end move wave form travel propagate fixed end wave move call travel wave wave reach fixed boundary reflecte invert show figure 7.4 free end string continuously move wave original wave move string fixed end reflected wave move away fixed end ese wave interfere figure 7.4 travel wave consider case end string fixe travel wave excite string certain wave frequency cause interference travel wave reflected wave form waveform appear stationary case apparent movement string fluctuation amplitude fixed point length string ese wave know stand wave point wave remain rest amplitude constantly zero

know node point midway node fluctuate maximum amplitude know antinode addition string fixe end pipe open end support stand wave mathematic relate stand wave wavelength length string open pipe similar pipe open end close support stand wave closed end contain node open end contain antinode mathematic different stand wave string pipe discuss detail later context sound stand wave formation integral formation sound certain context clarinet piano half-filled wine glass consider musical instrument pencil chair paper is discrepancy natural resonant frequency object solid object hit strike rub disturb way begin vibrate tap pencil surface cause vibrate hit chair crumple piece paper blow air pressure clarinet reed mouthpiece strike taut piano string create friction wine glass surface cause vibration natural frequency frequency

create friction wine glass surface cause vibration natural frequency frequency detection range human ear sound audible e quality sound call timbre determine natural frequency frequency object object vibrate single frequency produce pure tone object vibrate multiple frequency relation ese object produce sound find particularly musical tap pencil hit chair crumple paper ese sound call noise scientifically object vibrate multiple natural frequency fundamental pitch multiple overtone relate number ratio produce rich tone e

human brain perceive sound musical nonpercussion instrument produce overtone note mcat frequency 20 hz 20,000 hz generally audible healthy young adult high frequency hearing generally decline age e

natural frequency object change change aspect object example set identical glass fille different level water vibrate different natural frequency produce note diatonic musical scale string infinite number natural frequency depend length linear density tension string periodically vary force apply system system drive frequency equal frequency force is know force oscillation frequency apply force close natural frequency system amplitude oscillation

large is easily demonstrate child swing push parent parent push child frequency nearly equal frequency child swing parent arc swinge child large large amplitude increase force frequency nearly identical swing natural frequency periodic force equal natural resonant frequency system system say resonate amplitude oscillation maximum oscillate system frictionless periodically vary force continually add energy system amplitude increase indefinitely system completely frictionless damping result finite amplitude oscillation general damping attenuation decrease amplitude wave cause applied nonconservative force furthermore object withstand large amplitude oscillation break crumble dramatic demonstration resonance shattering wine glass loudly singe natural frequency glass is actually possible steady loud tone glass resonate oscillate maximum amplitude eventually shatter mcat concept check 7.1 assess understanding material question 1 define following term 2 wave phase interval 180 degree amplitude resultant wave compare amplitude interfere 3 true false sound wave prime example transverse wave 4 apply force natural frequency system change system chapter 7.2 able explain sound produce transmit connect amplitude frequency correspond property sound wave predict change apparent frequency base movement object relation calculate key value sound include intensity frequency apparent frequency wavelength doppler pipe system sound longitudinal wave transmit oscillation particle deformable medium sound travel solid liquid gas travel vacuum e speed sound give b bulk modulus measure medium resistance compression b increase gas liquid solid ρ density medium bulk modulus increase disproportionately density go gas liquid solid sound travel fast solid slow gas e speed sound air 20 ° c speed

slow gas e speed sound air 20 ° c speed sound fast solid low density slow dense gas production sound sound produce mechanical disturbance particle material sound wave direction propagation particle travel wave vibrate oscillate equilibrium position cause small region compression alternate small region rarefaction decompression ese alternate region increase decrease particle density travel material allow sound wave propagate sound involve

vibration material particle source sound ultimately mechanical vibration frequency ey produce vibration solid object vibration fluid include gas solid object vibrate produce musical sound include string piano violin guitar metal bell wood bar xylophone marimba vibration air certain object include woodwind brass instrument pipe organ soda bottle create musical sound e pitch frequency air column instrument vibrate determine length air column change cover hole instrument directly change length e human voice musical instrument list sound create pass air vocal cord pair thin membrane stretch larynx air move past cord vibrate like double reed oboe bassoon cause air vibrate frequency e pitch sound control vary tension cord adult male vocal cord large thick adult female male voice typically low frequency pitch discuss frequency rate particle wave complete cycle perception frequency sound call pitch lower- frequency sound low pitch high frequency sound high pitch mcat sound frequency usually normal range human hearing 20 hz 20,000 hz sound wave frequency 20 hz call infrasonic wave frequency 20,000 hz call ultrasonic wave dog whistle emit frequency 20 22 khz medical ultrasound machine emit frequency excess 2 ghz example witness doppler effect ambulance fire truck siren blare quickly approach lane pass hear distinct drop pitch siren is phenomenon affecte frequency call doppler effect describe difference actual frequency sound perceive frequency source sound sound detector move relative source detector move perceive frequency f′ great actual frequency f. source detector move away perceive frequency actual frequency

frequency f. source detector move away perceive frequency actual frequency is see doppler effect equation f′ perceive frequency f actual emit frequency ν speed sound medium νd speed detector νs speed source note unusual sign equation memorize form upper sign detector source move object e low sign detector source move away object doppler effect apply wave include light mean source light move detector observed frequency increase call blue shift blue high frequency end visible spectrum source move away detector observed frequency decrease cause red shift light electromagnetic wave discuss chapter 8 mcat physics math review sign

convention doppler equation sign sign away is sign convention usually confusing doppler effect equation let close look imagine situation present early drive street hear ambulance approach scenario detector ambulance sound source time drive away ambulance ambulance move fast get close direction drive away ambulance logic low sign numerator relate detector e driver ambulance hand drive logic sign denominator relate source case doppler effect equation look like νs > νd know f′ > f. imagine ambulance pass continue speed road point drive ambulance sign numerator + go fast e ambulance driver drive away sign denominator + correspond doppler effect equation νs > νd f′ < f. is change f′ great f f

perceive drop pitch e doppler effect visualize consider sound wave move object compress sound wave object stretch show figure 7.5 object move right le wave front object compress object stretch apart figure 7.5 doppler effect black arrow indicate direction motion car car crest sound wave compress increase frequency pitch car crest sound wave stretch apart decrease frequency e doppler effect animal process echolocation echolocation animal emit sound usually dolphin bat serve source detector sound e sound bounce off surface reflecte animal long take sound return change frequency sound determine position object environment speed move example train travel south sound whistle pass stationary observer whistle emit sound frequency 1400 hz frequency hear stationary observer train move observer train pass observer note speed sound air approximately solution solve problem speed train vs convert train move stationary observer sign denominator numerator simply v vd = 0 give train move away observer sign denominator change numerator remain unchanged observer stationary special case doppler effect object produce sound travel speed sound allow wave front build object is create large amplitude point amplitude sound wave relate degree compression medium create large pressure differential pressure gradient is highly condense wave call shock wave cause physical disturbance pass object e passing shock wave create high pressure follow low pressure responsible phenomenon know sonic boom unlike depiction movie television sonic boom hear time object travel fast speed sound pass detector

point speed sound exceed mach 1 object move fast speed sound effect shock wave mitigate wave front trail object destructively interfere intensity loudness sound e loudness volume sound way perceive intensity perception loudness subjective depend brain function physical factor obstruction ear canal stiffening ossicle damage cochlear hair cell exposure loud noise age sound intensity hand objectively measurable intensity average rate energy transfer area surface perpendicular wave word intensity power

rate energy transfer area surface perpendicular wave word intensity power transport unit area e si unit intensity watt square meter intensity calculate equation p power area rearrange equation consider power deliver surface tympanic membrane eardrum equal product intensity surface area assume intensity uniformly distribute e amplitude sound wave intensity relate intensity proportional square amplitude erefore double amplitude produce sound wave time intensity relate distance source sound wave sound wave emanate outward source wave push interior wall expand spherical balloon surface area sphere increase function square radius = 4πr2

sound wave transmit power large large area far source travel intensity inversely proportional square distance source example sound wave travel 2 meter source spread energy surface area time large identical sound wave travel 1 meter e soest sound average human ear hear intensity equal e mechanical disturbance associate threshold hearing remarkably small displacement air particle order billionth centimeter end spectrum intensity sound threshold pain intensity cause instant perforation eardrum approximately is huge range unmanageable express linear scale range easy work use logarithmic scale call sound level β measure decibel db intensity sound wave i0 threshold hearing reference intensity intensity sound change factor calculate new sound level ratio final intensity initial intensity use logarithm scale extremely large range mcat deal base logarithm common logarithm example log 1000 = 3 103 = 1000 example log 1 = 0 100 = 1 logarithm discuss chapter 10 mcat physics

math review e sound level relative intensity sound source threshold show table 7.1 table 7.1 sound level intensity sound source important threshold sound level db sound level db threshold hearing 1 × 1012 1 × 1011 1 × 1010 quiet room night 1 × 109 1 × 108 1 × 107 conversational speech 1 m 1 × 106 vacuum cleaner 1 m 1 × 105 1 × 104 lawn mower 1 m 1 × 103 jackhammer 1 m 1 × 102 loud rock concert 1 × 101 1 × 100 threshold pain 1 × 101 rifle 1 m 1 × 102 jet engine 30 m 1 × 103 1 × 104 example detector surface area 1 square meter place 1 meter blender measure average power blender sound 103 w. find intensity sound level blender ratio intensity blender jet engine note assume βjet = 150 db.

solution intensity define power area sound level calculate intensity finally ratio sound intensity find difference sound jet engine sound 1,000,000 time intense blender sound sound transmit undiminished aer decrease intensity associate distance real world measurement sound low expect calculation is result damping attenuation oscillation form repeat linear motion sound subject nonconservative force system include friction air resistance viscous drag like nonconservative force attenuation generally negligible test day important answer question mcat clear consider effect damping attenuation oscillate system e presence nonconservative force cause system decrease amplitude oscillation amplitude intensity sound level loudness relate correspond gradual loss sound note damping effect frequency wave pitch change is phenomenon reflection explain difficult hear confined cluttered space room friction surface object room actually decrease sound wave amplitude small distance attenuation sound volume vary periodically interference effect sound slightly different frequency produce proximity tune pair instrument volume vary rate base difference pitch produce e frequency periodic increase volume calculate f1 f2 represent frequency close pitch fbeat represent result beat frequency remember stand wave produce constructive destructive interference travel wave reflected wave broadly stand wave form wave frequency travel opposite direction interfere travel medium stand wave appear stand propagate interference wave reflected wave produce resultant fluctuate amplitude wave opposite direction interfere produce new wave

pattern characterize alternate point maximum displacement amplitude point displacement e point stand wave fluctuation displacement call node e point maximum fluctuation call antinode node place displacement frequency travel wave result stand wave formation e length medium dictate wavelength extension frequency travel wave establish stand wave object support stand wave boundary end close boundary allow oscillation correspond node e closed end pipe secure end string consider closed boundary open boundary allow maximal oscillation correspond antinode e open end pipe free end flag open boundary consider string guitar violin string piano wire fixe rigidly

boundary consider string guitar violin string piano wire fixe rigidly end string secure end immobile point consider node stand wave set antinode node end length string correspond half wavelength stand wave show figure 7.6a is sine wave distance node node

half wavelength stand wave set antinode end node locate antinode show figure 7.6b case length string correspond wavelength stand wave distance sine wave node second consecutive node exactly wavelength is pattern suggest length l string equal multiple half- wavelength e equation relate wavelength λ stand wave length l string support n positive nonzero integer n = 1 2 3 call harmonic e harmonic correspond number half wavelength support string relationship ν wave speed possible frequency e low frequency long wavelength stand wave support give length string know fundamental frequency first harmonic e frequency stand wave give n = 2 know first overtone second harmonic is stand wave half wavelength twice frequency first harmonic e frequency stand wave give n = 3 know second overtone harmonic show figure 7.6c possible frequency string support form harmonic series string first second harmonic first harmonic lambda equal 2l second lambda equal l lambda equal third l figure 7.6 second harmonic string harmonic give number half wavelength support string n = node = antinode shortcut string attach end number antinode present tell harmonic pipe support stand wave produce sound musical instrument straight curved tube air oscillate particular

frequency set stand wave e end pipe open close end pipe open support antinode close support node end pipe open slightly allow entry air opening small cover musician mouth case function close end pipe open end call open pipe close end open call closed pipe e flute function open pipe instrument clarinet brass instrument closed pipe instrument musician counterintuitive e distal end flute open proximal end closed mouthpiece flute close closed end function open end similarly air pass mouthpiece reed brass instrument opening

sufficiently small function closed end open pipe open end antinode end stand wave set node antinode end length pipe correspond half wavelength stand wave show figure 7.7a is analogous string end antinode instead node e analogy continue second harmonic first overtone wavelength equal length pipe show figure 7.7b e harmonic second overtone wavelength equal third length pipe show figure 7.7c open pipe contain multiple half wavelength number half wavelength correspond harmonic wave e relationship wavelength λ stand wave length l open pipe support possible frequency harmonic series like string open pipe first second harmonic first harmonic l half lambda second l equal lambda l three- half lambda figure 7.7 second harmonic open pipe harmonic give number half wavelength support shortcut open pipe number node present tell harmonic worthwhile note figure 7.7 symbolic representation first harmonic open pipe use term symbolic conventional way diagram stand wave represent sound wave transverse longitudinal wave hard case closed pipe closed end correspond node open end correspond antinode e first harmonic closed pipe consist node closed end antinode open end show figure 7.8a sinusoidal wave distance node following antinode quarter wavelength unlike string open pipe harmonic closed pipe equal number quarter wavelength support pipe closed end node open end antinode odd harmonic is number quarter- wavelength integer number half wavelength necessarily node antinode end e first harmonic wavelength time length close pipe e harmonic first overtone wavelength third length close pipe show figure 7.8b e fih harmonic second overtone wavelength four-fihs length close pipe show figure 7.8c e equation relate wavelength λ stand wave

length l close pipe support n odd integer n = 1 3 5 e frequency stand wave

close pipe v wave speed closed pipe first fih harmonic first harmonic l equal lambda l quarter lambda fih l five quarter lambda figure 7.8

fifth harmonic close pipe harmonic give number quarter wavelength support unlike string open pipe simply count number node antinode determine harmonic wave close pipe present close pipe sure actually count number quarter wavelength contain pipe determine harmonic point focus sound audible range medicine use sound wave visualize organ anatomy pathology is imaging modality prenatal screening diagnose gallstone breast thyroid masse needle guidance biopsy ultrasound use high frequency sound wave outside range human hearing compare relative density tissue body ultrasound machine consist transmitter generate pressure gradient function receiver process reflected sound see figure 7.9 speed wave travel time know machine generate graphical representation border edge body calculate traverse distance note ultrasound ultimately rely reflection interface object necessary visualize reflection discuss chapter description give caption figure 7.9 ultrasound transmitter sender generate wave reflect object return transmitter function receiver ultrasound transmitter receiver package single unit e transmitter receiver function simultaneously objective system reduce interference addition standard ultrasound modern ultrasound machine doppler mode doppler ultrasound determine flow blood body detect frequency shi associate movement away receiver ultrasound therapeutically ultrasound wave create friction heat act tissue increase blood flow site injury deep tissue promote fast healing focused ultrasound range application focus sound wave parabolic mirror cause constructive interference focal point mirror is create high energy wave exactly point noninvasively break kidney stone lithotripsy ablate destroy small tumor ultrasound dental cleaning destruction cataract phacoemulsification case ultrasound wave apply sufficient time period achieve desire effect mcat concept check 7.2 assess understanding material question 1 sound produce transmit 2

property sound wave amplitude frequency correspond 3 object travel apparent frequency differ original frequency object travel away object follow away object follow 4 phenomenon detect treat ultrasound 5 follow diagram label type pipe string represent node antinode relevant equation relate λ l pipe open end wavelength inside second pipe

relate λ l pipe open end wavelength inside second pipe open end quarter wavelength inside string chapter review general characteristic wave include phenomenon interference resonance analyze characteristic behavior sound example longitudinal waveform sound mechanical disturbance particle create oscillate region compression rarefaction parallel direction wave movement e intensity sound wave perceive sound level loudness sound measure decibel e decibel scale logarithmic scale describe ratio sound intensity reference intensity threshold human hearing review doppler effect special case shock wave review mathematic govern formation stand wave important formation musical sound string open pipe closed pipe finally discuss medical application sound incorporate topic ultrasound continue review mcat topic easy think sound listen music study turn 40 smooth jazz rococo fugue principle sound production propagation key enjoyment harmonious sound sound course waveform test mcat light wave electromagnetic radiation general heavily test topic test day review chapter review content test knowledge critical thinking skill complete test like passage set online resource general wave characteristics transverse wave oscillation wave particle perpendicular direction wave propagation e.g. e wave electromagnetic wave longitudinal wave oscillation wave particle parallel direction wave propagation e.g. sound wave displacement x wave refer far point equilibrium position express vector quantity e amplitude wave magnitude maximal displacement e maximum point wave point positive displacement call crest e minimum point wave point negative displacement call trough e wavelength λ wave distance crest e frequency f wave number cycle make second express hertz hz e angular frequency ω way express frequency express radian second e period t wave number second take complete cycle inverse frequency interference describe way wave

interact space form constructive interference occur wave exactly phase e amplitude resultant wave equal sum amplitude interfere wave destructive interference occur wave exactly phase e amplitude resultant wave equal difference amplitude interfere wave partially constructive partially destructive interference occur

difference amplitude interfere wave partially constructive partially destructive interference occur wave perfectly phase e displacement resultant wave equal sum displacement interfere wave travel wave continuously shie point maximum stand wave produce constructive destructive interference wave frequency travel opposite direction space antinode point maximum oscillation node point oscillation resonance increase amplitude occur periodic force apply natural resonant frequency object damping decrease amplitude cause apply sound produce mechanical disturbance material create oscillation molecule material sound propagate form matter vacuum sound propagate fast solid follow liquid slow medium density increase speed sound decrease e pitch sound relate frequency e doppler effect shi perceive frequency sound compare actual frequency emit sound source sound detector move relative e apparent frequency high emit frequency source detector move e apparent frequency low emit frequency source detector move away e apparent frequency high low equal emit frequency object move direction depend relative speed source move speed sound shock wave sonic boom form loudness volume sound sound level relate intensity intensity relate wave amplitude intensity decrease distance energy lose attenuation damping frictional force string open pipe open end support stand wave length string pipe equal multiple half wavelength closed pipe close end support stand wave length pipe equal odd multiple quarter wavelength sound medically ultrasound machine imaging diagnostic treatment therapeutic purpose answer concept check wave speed rate wave transmit energy matter carry wave speed product frequency wavelength frequency measure oen waveform pass give point space measure hz angular frequency frequency measure radian second period time necessary complete wave cycle e equilibrium position point zero displacement oscillate system

amplitude maximal displacement wave equilibrium position travel wave node antinode wave propagation stand wave defined node antinode wave propagation wave perfectly phase amplitude result wave equal sum amplitude interfere wave wave perfectly phase amplitude result wave difference amplitude interfere wave erefore wave

phase amplitude result wave difference amplitude interfere wave erefore wave extreme amplitude result wave sum difference amplitude false sound wave common example longitudinal wave e object resonate force frequency equal natural resonant frequency e amplitude oscillation increase sound produce mechanical vibration

ese usually generate solid object like bell vocal cord occasionally generate fluid sound propagate longitudinal wave matter propagate vacuum e amplitude wave relate sound level volume e frequency wave relate pitch object travel apparent frequency high original frequency object travel away apparent frequency low object follow apparent frequency high low equal original frequency depend relative speed detector source ultrasound prenatal screening diagnose gallstone breast thyroid masse blood clot needle guidance biopsy dental cleaning treat deep tissue injury kidney stone certain small tumor cataract first open pipe antinode end middle node point lambda 2l n second close pipe antinode end one- pipe node closed end third pipe lambda 4l n string node end middle antinode point lambda 2l n science mastery assessment glass perfectly identical fact first glass shatter 808 hz tell close identical natural resonant frequency glass produce frequency equal close natural frequency apply frequency cause glass resonate increase wave amplitude associate resonate object attenuation increase increase frequency motion nonconservative force damp sound wave sound level match shatter first glass account attenuation glass shatter reason describe eliminate d is question test understanding pipe open end begin remember high frequency sound high pitch low frequency sound low pitch e pipe example begin open end end close off. task determine frequency second harmonic differ pipe open end equal length open end

pipe length l open end wavelength second harmonic first overtone equal l contrast pipe open end close wavelength equal mind first overtone close pipe correspond harmonic second us brother cover end flute wavelength increase give wavelength frequency sound inversely proportional increase wavelength correspond decrease frequency erefore brother cover end flute sound produce instrument slightly low pitch original sound e angular frequency relate frequency equation ω = 2πf

erefore magnitude angular frequency large magnitude frequency e magnitude angular frequency large magnitude period variable inversely proportional eliminate e product frequency period 1 inverse eliminate b finally product angular frequency period 2π eliminate d intensity measure distance time travel easy indication commonly ultrasound machine apparent frequency d doppler ultrasound calculate distance angle incidence c position structure screen ultrasound period inversely relate frequency perceive frequency double perceive period halve 34 m 17 m condition ii cause doubling perceive frequency condition necessarily true opposite is question test understanding travel wave know frequency wavelength relate equation ν = fλ frequency period inverse equation rearrange solve period e angular frequency relate frequency wave formula ω = 2πf us initial task calculate frequency wave know speed determine frequency wave first calculate wavelength ν = fλ harmonic stand wave pipe close end wavelength e frequency wave finally obtain angular frequency multiply frequency wave 2π ω = 2πf = 340π radian second let ii intensity increase intensity aer increase equation relate sound level intensity obtain ratio ii say stapedial footplate limited displacement vibration way state amplitude vibration decrease amplitude relate intensity intensity relate sound level perceive sound level volume decrease pitch describe c d

relate frequency sound wave phase 180 ° resultant amplitude difference wave amplitude case result wave amplitude 5 cm 3 cm = 2 cm is question test understanding doppler effect

difference zero perceive emit frequency imply source sound move relative student car d move speed student relative motion 0 case student sound source necessarily move relative sound mechanical disturbance propagate deformable medium transmit oscillation particle parallel direction sound wave propagation sound need matter travel eliminate e speed propagation fast solid material follow liquid slow gas shock wave buildup wave front distance wave front decrease is occur maximally object travel exactly speed wave travel speed sound object move fast speed sound effect shock wave mitigate wave front trail object destructively interfere observer move close stationary source e applicable version doppler effect equation ν speed sound numerator great denominator f′ great f statement true e scenario describe statement ii produce similar identical frequency officer frequency formula e apparent frequency increase increase exactly officer move statement iii false know frequency increase officer decrease velocity associate decrease intensity equal power divide area case area refer surface area concentric sphere emanate source sound is surface area give 4πr2 distance r double intensity decrease factor consult online resource additional equation remember 7.1 wave speed ν = fλ 7.3 angular frequency 7.4 speed sound 7.5 doppler effect 7.7 sound level 7.8 change sound level 7.9 beat frequency 7.10 wavelength stand wave string open pipe 7.11 frequency stand wave string open pipe 7.12 wavelength stand wave closed pipe 7.13 frequency stand wave closed pipe behavioral sciences chapter 2 sensation perception general chemistry chapter 8 e gas phase physics math chapter 1 kinematic dynamic physics math chapter 2 work energy physics math chapter 8 light optic physics math chapter 10 light optic pre med know feeling content know mcat know

light optic pre med know feeling content know mcat know first important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal is 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 get correct ensure thinking match explanation review concept summary end chapter light ray frequency 5.0 × 1014 hz region electromagnetic spectrum locate fall leave change color green red chlorophyll break leave secondary anthocyanin pigment follow well describe light reflect anthocyanin wavelength 700 m wavelength 580 nm frequency 4.2 × 106 hz frequency 4.2 × 1013 hz object place center curvature concave mirror following true image real inverted virtual inverted real upright virtual upright double slit experiment wavelength light second dark fringe angle 30 ° give distance slit 0.3 mm 1 × 10–5 m 6 × 10–5 m 3.6 × 10–2 m 6 × 10–2 m

ray light f = 5 × 1014 hz travel air crystal chromium index refraction air crystal chromium 1 2 3 respectively incident angle 30 ° follow describe frequency angle refraction 5 × 1014 hz 9.6 ° 5 × 1014 hz 57 ° 1.0 × 1010 hz 9.6 ° 1.0 × 1010 hz 57 ° source light f = 6.0 × 1014 hz pass plane polarizer polarizer direction rotate 90 ° respect second polarizer frequency light come polarizer 3.0 × 1014 hz 6.0 × 1014 hz 9.0 × 1014 hz light pass polarizer organic chemistry lab student determine specific rotation chiral product use plane polarizer accidentally insert second polarizer 90 ° angle true result light pass polarizer circularly polarize twice plane polarize light pass single polarizer follow describe image form object place convex lens distance small focal length virtual invert virtual upright real upright real inverted submarine inspect surface water laser point submarine surface water air angle laser penetrate surface water reflect entirely water assume nwater = 1.33 nair = 1 student analyze behavior light ray pass small opening lens allow project screen distance away happen central maximum bright spot screen slit narrow central maximum remain central maximum narrow central maximum

wide central maximum divide small light fringe follow able produce virtual image convex lens concave lens plane mirror iii ii iii ii iii monochromatic red light allow pass different medium incident angle medium 1 30 ° incident angle medium 2 45 ° relationship speed light medium 2 compare medium 1 scientist look microscope thin lense m1 = 10 m2 = 40 overall magnification microscope imagine beam monochromatic light originate air allow shine flat surface piece glass angle 60 ° normal reflect refract beam perpendicular index refraction follow result splitting white light component color dispersion prism diffraction grating refraction thin film

light component color dispersion prism diffraction grating refraction thin film reflection ideal convex mirror c ch 8.1 d ch 8.1 ch 8.2 b ch 8.3 ch 8.2 d ch 8.4 c ch 8.4 b ch 8.2 d ch 8.2 c ch 8.3 d ch 8.2 ch 8.2 d ch 8.2 d ch 8.2 d ch 8.2 chapter 8 light optic chapter 1 8.1 electromagnetic spectrum hy 2 electromagnetic wave 3 color visible spectrum 4 8.2 geometrical optic hy 9

8.3 diffraction 10 single slit 11 slit lens system 12 multiple slit 13 x ray diffraction 14 8.4 polarization 15 plane polarized light 16 circular polarization 17 concept summary pie chart indicate content chapter relevant eighteen percent question physics mcat content chapter relevant 14 question physics mcat chapter cover material following aamc content category 4d light sound interact matter time browse local convenience store look security mirror one bulge wall usually eye level look mirror notice image world distort distort image right small expect curve mirror introduce slope present reality additionally wide field vision mirror simple plane mirror security mirror useful convenient low tech solution allow cashier survey entire store glance feature result fact security mirror convex diverge optical system parallel light ray hit mirror reflect multiple direction allow observer large field vision image somewhat distort object image close appear passenger mirror car bear message convex mirror allow driver wide view car chapter complete topic chapter 7 mcat physics math review analyze transverse waveform visible light electromagnetic em wave consider detail rule optic describe behavior electromagnetic wave bounce travel shape composition matter optical system cover test mcat

concave convex mirror produce image reflection concave convex lense produce image refraction finish discuss phenomenon thin slit experiment diffraction light 8.1 electromagnetic spectrum high yield chapter 8.1 able order type electromagnetic radiation x ray microwave visible light low high energy describe property electromagnetic wave compare visible spectrum electromagnetic spectrum electromagnetic spectrum include radio wave end long wavelength low frequency low energy gamma ray short wavelength high frequency high energy extreme find order low energy high energy microwave infrared visible light ultraviolet x ray chapter focus primarily range wavelength correspond visible spectrum light 400 nm 700 nm change magnetic field cause change electric field change electric field cause change magnetic field reciprocate nature field

change electric field cause change magnetic field reciprocate nature field electromagnetic wave occur nature oscillate field cause oscillation field completely independent matter electromagnetic wave travel vacuum electromagnetic wave transverse wave oscillate electric magnetic field vector perpendicular direction propagation electric field magnetic field perpendicular illustrate figure 8.1 wave perpendicular reach amplitude equilibrium position time propagation path figure 8.1 electromagnetic wave electric field e oscillate page magnetic field b oscillate page electromagnetic spectrum describe range frequency wavelength electromagnetic wave wavelength give following unit mm 10–3 m μm 10–6 m nm 10–9 m å ångström 10–10 m spectrum break region descend order wavelength radio 109–1 m microwave 1 m–1 mm infrared 1 mm–700 nm visible light 700–400 nm ultraviolet 400–50 nm x ray 50–10–2 nm γ ray 10–2 nm electromagnetic spectrum depict figure 8.2 high frequency low wavelength gamma ray x ray uv visible light violet blue green yellow orange red infrared microwave fm radio long radio wave figure 8.2 electromagnetic spectrum electromagnetic wave vary frequency wavelength vacuum electromagnetic wave travel speed call speed light constant represent c approximately approximation purpose mcat relate equation electromagnetic wave travel air speed reference electromagnetic wave familiar equation ν = fλ

c = fλ c speed light vacuum approximation air f frequency λ wavelength recall order color visible spectrum remember grade school rainbow roy g. bv red orange yellow green blue color visible spectrum spectrum perceive light human eye visible region region different wavelength perceive different color violet end visible spectrum 400 nm red 700 nm wavelength visible range common mcat remember boundary visible spectrum 400–700 nm save time energy test day light contain color equal intensity perceive white color object emit light dependent color light reflect object appear red absorb color light red imply red object green illumination appear black absorb green light light reflect term

green illumination appear black absorb green light light reflect term blackbody refer ideal absorber wavelength light appear completely black low temperature surrounding mcat concept check 8.1 assess understanding material 1 order type electromagnetic radiation high energy low energy property light follow trend follow trend 2 true false light wave longitudinal direction propagation perpendicular direction oscillation 3 boundary visible spectrum range visible spectrum compare range 8.2 geometrical optic high yield chapter 8.2 able apply sign convention mirror lense optic system describe bending light move medium different explain impact dispersion effect aberration behavior light recall snell law key optic equation solve optic snell law problem light travel homogeneous medium travel straight line know rectilinear propagation behavior light boundary medium interface medium describe theory geometrical optic geometrical optics explain reflection refraction application mirror lense reflection rebounding incident light wave boundary medium light wave reflect absorb second medium bounce boundary travel medium figure 8.3 illustrate reflection plane mirror light bounce surface return angle normal figure 8.3 reflection accord law reflection θ1 = θ2 law reflection θ1 = θ2 θ1 incident angle θ2 reflect angle measure normal normal line draw perpendicular boundary medium angle optic measure normal surface medium general image create mirror real virtual image say real light actually converge position image image virtual light appear come position image actually converge distinguish feature real image ability image project

screen parallel incident light ray remain parallel reflection plane mirror plane mirror flat reflective surface cause convergence divergence reflect light ray light converge plane mirror create virtual image plane mirror image appear distance mirror object show figure 8.4 word plane mirror create appearance light ray originate mirror surface reflect light remain mirror image appear mirror image virtual plane mirror include common mirror find home assist discussion spherical mirror plane mirror conceptualize spherical mirror infinite radius curvature

spherical mirror plane mirror conceptualize spherical mirror infinite radius curvature light ray bounce plane mirror point theoretical convergence show figure 8.4 reflection plane mirror o object virtual image incident angle θ equal respective reflect angle θ′

spherical mirror come variety concave convex word spherical imply mirror consider spherical cap dome take large spherically shape mirror spherical mirror associate center curvature c radius curvature r center curvature point optical axis locate distance equal radius curvature vertex mirror word center curvature center spherically shape mirror complete sphere passenger mirror car example convex mirror appear small far away small circular mirror apply makeup example concave mirror appear big close look inside sphere surface concave surface hand look outside sphere convex surface concave surface center curvature radius curvature locate mirror convex surface center curvature radius curvature mirror concave mirror call converge mirror convex mirror call diverge mirror cause parallel incident light ray converge diverge reflect respectively concave like look cave concave mirror converge mirror convex mirror diverge mirror reverse true lense important length associate mirror show figure 8.5 focal length f distance focal point f mirror note spherical mirror radius curvature r distance c mirror distance object mirror o distance image mirror i. label object object distance image image distance focal point focal length center curvature radius curvature principal axis figure 8.5 key variable geometrical optic mirror picture concave mirror light ray simple relationship

distance important unit distance equation important value unit mcat use equation calculate image distance type mirror lense image positive distance > 0 real image imply image mirror image negative distance < 0 virtual locate mirror plane mirror think spherical mirror infinitely large focal distance plane mirror r = f =  equation = o.

interpret say virtual image distance mirror equal distance object mirror magnification m dimensionless value ratio image distance object distance extension magnification give ratio size image size object follow sign convention give later table 8.1 orientation image upright inverted determine negative magnification signify inverted image positive value signify upright image |m| < 1 image small object reduce |m| > 1 image large object enlarge |m| = 1 image size object figure 8.6 show ray diagram concave spherical mirror object different point ray diagram useful get approximation image test day ray diagram helpful quick determination type image produce object distance mirror real vs. virtual inverted vs. upright magnify vs. reduce ray diagram caution pressure test day easy draw incorrectly important practice draw ray diagram avoid careless error test day important familiar solve optic question mathematically draw ray diagram important ray draw concave mirror ray strike mirror parallel axis normal passing center mirror reflect focal point green line figure 8.6 8.7 ray pass focal point reach mirror reflect parallel axis red line ray strike mirror point intersection axis reflect angle measure normal blue line figure 8.6a object place f image produce real invert magnify figure 8.6b object place f image form reflect light ray parallel term mirror equation image distance =  scenario figure 8.6c object place f mirror image produce virtual upright green red ray draw image invert magnify b green blue ray draw image c

green red ray draw extend image upright magnify figure 8.6 ray diagram concave converging mirror object place f b object place f c object place f mirror time object focal point converge mirror reflect ray parallel image infinity single diverge mirror form virtual upright reduced image regardless position object far away object small image quickly remember rule recall

convenience store security mirror mention beginning chapter ray diagram diverge mirror show figure 8.7 red green blue line draw image upright reduce figure 8.7 ray diagram convex diverge mirror find image mirror draw follow ray find point intersect point intersection mark tip image ray draw appear intersect extend mirror create virtual image ray parallel axis reflect focal point ray focal point reflect parallel axis ray center mirror reflect angle relative sign conventions mirrors table 8.1 provide sign convention single mirror note mcat problem involve mirror object place mirror object distance o positive table 8.1 sign convention single mirror object mirror object mirror extremely image mirror image mirror virtual mirror concave mirror convex diverging mirror concave mirror convex diverging image upright erect image inverted focal length converge mirror converge lense positive focal length diverge mirror diverge lense negative image type single lens mirror assume o positive uv upright image virtual image form object focal length away inverted image real example object place 6 cm concave mirror 10 cm radius curvature determine image distance magnification image real virtual inverted upright solution use optic equation positive value signify image mirror real single lens mirror o > 0

real image invert determine magnification m calculate negative sign magnification confirm image invert fact |m| > 1 indicate image enlarge refraction bending light pass medium change speed speed light medium speed vacuum remember speed light vacuum c equal speed light air slightly low value mcat appropriate use speed light pencil straight object dip glass water angle look impossibly bent intersect surface water light reflect portion pencil water light medium vacuum speed c. give medium c speed light vacuum ν speed light medium n dimensionless quantity call index refraction medium index refraction vacuum 1 definition material index refraction great 1 air n essentially equal 1 speed light air extremely close c. index refraction number common medium show table 8.2 value provide reference need table 8.2 index refraction common index refraction n 1 definition index refraction n glass type 1.48–1.93 refract ray light obey snell law pass medium n1 sin θ1 = n2 sin θ2 n1 θ1 refer

medium light come n2 θ2 refer medium light enter note θ measure respect normal show figure 8.8 incident ray leave water enter air refract ray bend normal figure 8.8 snell law snell law light enter medium high index refraction n2 > n1 bend normal sin θ2 < sin θ1 θ2 < θ1 show figure 8.9 conversely light travel medium index refraction small n2 < n1 light bend away normal sin θ2 > sin θ1 θ2 > θ1

pencil water appear bent water high refractive index light travel medium low refractive index high refractive index bend nornal figure 8.9 refraction light air water remember light enter medium high index refraction bend normal light enter medium low index refraction bend away normal example penny sit pool water n = 1.33 depth 3.0 m. observer 1.8 m tall stand 30 cm away edge close penny visible solution draw picture situation description give precede text note light come water n1 = 1.33 go air n2  1 light bend away normal θ2 > θ1 need find angle light ray normal water snell law solve θ1 find x trigonometry x = 3 m × tan θ1 = 3 tan 7.1 ° = 3 × 0.124 = 0.37 m = 37 cm note expect calculate precise value trigonometric function inverse trigonometric function test day question provide mainly opportunity application total internal reflection light travel medium high index refraction water medium low index refraction air refract angle large incident angle θ2 > θ1 refract light ray bend away normal incident angle increase refract angle increase eventually special incident angle call critical angle θc reach refract angle θ2 equal 90 degree critical angle refract light ray pass interface medium critical angle derive snell law θ2 = 90 ° total internal reflection phenomenon light incident boundary reflect original material result angle incidence great critical angle θc show figure increase incident angle lead increase refract angle critical angle reach refract angle 90 degree total internal reflection occur figure 8.10 total internal reflection incident angle θc refract angle equal 90 ° incident angle 90 ° total internal reflection occur total internal reflection occur light move medium high refractive index medium low example previous example

suppose penny 3 m away edge light ray go penny edge pool emerge water solution angle

second penny light ray find critical angle expect mcat know inverse sin 0.75 know sin θc great 0.71 critical angle great 45 ° θc > θ1

light ray emerge pool important difference lense mirror aside fact lense refract light mirror reflect work lense surface affect light path example person wear glass see light travel object air glass lens surface light travel glass reach travel glass air second surface light refract twice pass air lens lens air thin spherical lense mcat lense generally negligible thickness light travel lens lens focal point focal length measure direction center thin spherical lense focal length equal speak focal length lens converge lense read glass need people farsighted diverge lense standard glass need people figure 8.11a illustrate converge lens thick center figure 8.11b illustrate diverge lens thin center basic formula find image distance magnification spherical mirror apply lense object distance o image distance focal length f magnification m relate convex lens cause parallel light ray refract second focal point light focal point refract parallel light ray b concave lens cause parallel light ray refract focal point light travel second focal point refract parallel light ray figure 8.11 ray diagram single lense convex converge lense b concave diverge lense lense thickness neglect focal length relate curvature lens surface index refraction lens lensmaker equation n index refraction lens material r1 radius curvature lens surface r2 radius curvature second lens surface eye complex refractive instrument use real lense cornea act primary source refractive power change refractive index air significant light pass adaptive lens change focal length reach vitreous humor diffuse layer retinal tissue reach rod cone point image focus minimize significantly relatively blurry nervous system process remain error provide crisp view world find image lens draw follow ray find point intersect point intersection mark tip image ray draw appear intersect extend lens light come create virtual ray parallel axis  refract focal point face ray focal point reach lens  refract parallel axis ray center

focal point reach lens  refract parallel axis ray center lens  continue straight refraction sign

conventions lenses note sign convention change slightly lense lense mirror positive magnification represent upright image negative magnification mean inverted image lense mirror positive image distance mean image real locate real r negative image distance mean image virtual locate virtual v table 8.3 summarize sign convention

single lense table 8.3 sign convention single lens object lens light source object opposite lens light source extremely rare image opposite lens light source real image lens light source virtual lens convex converging lens concave diverging lens convex converging lens concave diverging image upright erect image inverted important realize concave mirror convex lense converge similar property convex mirror concave lense diverge similar property designation real virtual point confusion student opposite side compare mirror lense identify real r remember real light actually go interact lens mirror mirror light reflect stay mirror mirror real mirror virtual mirror lense convention different light travel lens come real opposite lens original light source virtual lens original light source object single lens virtual object virtual object real positive object distance place certain multiple lens system image lens object scenario rarely encounter mcat focal length radius curvature simple sign convention mirror lense converge specie positive focal length radius curvature diverge specie negative focal length radius curvature remember lense focal length radius curvature surface thin lens thickness negligible sign focal length radius curvature give base surface light pass optometrist describe lens term power p measure diopter f focal length meter give equation p sign f positive converge lens negative diverge lens people nearsighted near object clearly need diverge lense people farsighted distant object clearly need converge lense bifocal lense corrective lense distinct region cause convergence light correct farsightedness hyperopia second cause divergence light correct nearsightedness myopia lens mcat expect student understand myopia hyperopia correspond ray diagram correction strategy multiple lens systems lenses contact series lense negligible distance system behave single lens equivalent focal length power reciprocal focal length equivalent power p = p1 + p2 + p3 + + pn eye optical

power 60 diopter contact lens wearer prescription 0.25 8 diopter positive negative bad human eye maintain

prescription 0.25 8 diopter positive negative bad human eye maintain optical power 87 maximum good example lense contact corrective contact lens wear directly eye case cornea eye converge lens contact contact lens converge diverge depend necessary correction power add lense contact image lens object lens image lens consider image system microscope telescope good example system magnification system m = m1 × m2 × m3 × × mn mcat time test give massive multiple lens system expect calculation test multiple lens system conceptually example object 15 cm left thin diverge lens 45 cm focal length show find image form upright invert real virtual radius curvature assume lens symmetrical glass non negligible thickness index refraction 1.50 concave lens radius curvature label object object solution image distance find equation lens diverge focal length negative sign f = 45 cm object like object

single lens system positive sign o = +15 cm solve negative sign indicate image light source virtual remember single lens mirror virtual image upright thickness lens usually negligible tell question determine radius curvature use lensmaker equation lens symmetrical radius equal opposite sign light progress left right surface lens concave r1 < 0 second surface lens convex r2 >

spherical mirror lense imperfect subject specific type error aberration spherical aberration blurring periphery image result inadequate reflection parallel beam edge mirror inadequate refraction parallel beam edge lens create area multiple image slightly different image distance edge image appear blurry phenomenon see figure 8.12 parallel light ray converge focal point imperfect refraction ray meet focal point figure 8.12 spherical aberration parallel ray perfectly reflect refract focal point lead blurriness periphery image remember conic section precalculus

class surprise spherical mirror lense focus light perfectly parabola perfect reflector mean parallel light ray reflect perfectly focal point extracorporeal shock wave lithotripsy parabolic mirror position kidney stone focal point sound wave reflect mirror create vibration kidney stone shatter chromatic aberration discuss predominantly see spherical discuss early speed light vacuum wavelength light travel medium different wavelength travel different speed fact imply index refraction medium affect wavelength light pass medium index refraction relate speed wave imply index refraction actually vary wavelength wavelength light separate call dispersion common example dispersion splitting white light component color prism source white light incident face prism light emerge prism spread fan shaped beam show figure 8.13 occur violet light small wavelength red light bend great extent red experience refraction spectrum violet having experience great refraction spectrum note light enter medium different index refraction wavelength change frequency light white light disperse component color prism figure 8.13 dispersion prism different speed inside prism wavelength light refract different degree chromatic aberration show figure 8.14 dispersive effect spherical lens depend thickness curvature lens significant splitting white light result rainbow halo image phenomenon correct visual lense like eyeglass car window special coating different dispersive quality lens parallel light ray refract different degree depend color light figure 8.14 chromatic aberration light dispersion glass lens lead formation rainbow halo edge image mcat concept check 8.2 assess understanding material 1

edge image mcat concept check 8.2 assess understanding material 1 populate following table accord sign convention mirror lense symbol positive negative symbol positive negative 2 true false incident angle measure respect 3 describe bending light move medium low refractive index high refractive index medium high refractive index low refractive index low n high n high n low n 4 define following term 5 mathematical relationship image distance object distance chapter 8.3 able distinguish diffraction pattern single slit double slit slit len system recall wave phenomenon lead diffraction fringe describe young double slit experiment light

pass lens double slit form alternate bright dark fringe diffraction refer spreading light pass narrow opening obstacle interference diffract light ray lead characteristic fringe slit len double slit system diffraction interference significant evidence wave theory usually safe assume nonrefracted light travel straight line situation light actually travel straight line path light pass narrow opening opening size order light wavelength light wave spread diffract show figure 8.15 slit narrow light spread incident wave pass narrow slit emanate figure 8.15 diffraction light emerge narrow slit wide arc narrow lens place narrow slit screen pattern observe consist bright central fringe alternate dark bright fringe show figure 8.16 central bright fringe maximum twice wide bright fringe side slit narrow central maximum wide location dark fringe minima give formula sin θ = nλ width slit θ angle line draw center lens dark fringe axis lens n integer indicate number fringe λ wavelength incident wave note bright fringe halfway dark fringe incident wave pass slit width lens form bright central fringe n = 0 dark fringe n = 1 figure 8.16 single slit diffraction lens wave interact displacement wave add process call interference describe chapter 7 mcat physics math review famous double slit experiment thomas young show diffract ray light emerge parallel

slit experiment thomas young show diffract ray light emerge parallel slit interfere landmark finding contribute understanding light wave figure 8.17 show typical setup young double slit experiment monochromatic light light wavelength pass slit interference pattern observe screen place slit region constructive interference light wave appear bright fringe maximum screen conversely region light wave interfere destructively dark fringe minimum appear light similar waveform affect constructive destructive interference light pass slit lens light pass multiple slit interference occur sound wave discuss chapter 7 mcat physics math light pass lens double slit separate distance d form alternate bright dark fringe screen distance d slit bright fringe angle theta distance y axis figure 8.17 young double slit experiment setup experiment b interference pattern cause position dark fringe minimum screen find d distance slit θ angle line draw midpoint slit dark fringe normal n integer indicate number fringe λ

wavelength incident wave note bright fringe halfway dark fringe example double slit experiment linear distance y sixth eighth minimum screen note wavelength λ 550 nm slit separate distance 0.14 mm screen 70 cm slit solution position dark fringe minimum give know value small angle sin θ  tan θ length hypotenuse close length adjacent know value substitute equation close correct answer diffraction grating consist multiple slit arrange pattern diffraction grating create colorful pattern similar prism different wavelength interfere characteristic pattern example organization groove cd dvd act like diffraction grating create iridescent rainbow pattern surface disc thin film cause interference pattern light wave reflect external surface film interfere light wave reflect internal surface film show figure 8.18 common example thin film soap bubble oil puddle wet parking lot note interference diffract ray reflect ray wave bounce internal external surface film respectively partially constructively interfere figure 8.18 thin film interference interference pattern c occur light wave reflect external

film interference interference pattern c occur light wave reflect external surface film b interfere light wave reflect internal surface film a.

note small degree refraction show image x ray diffraction use bending light ray create model molecule x ray diffraction combine protein crystallography protein analysis dark light fringe linear appearance complex dimensional image example x ray diffraction pattern show figure 8.19 concentric ring blue light intensity figure 8.19 x ray diffraction pattern x ray diffraction protein crystallography commonly analyze structure protein technique number protein assay discuss chapter 3 mcat biochemistry mcat concept check 8.3 assess understanding material 1 diffraction pattern single slit differ slit thin lens 2 wave phenomenon diffraction fringe result 3 double slit diffraction interference differ single- 4 true false maximum diffraction pattern equidistant minimum chapter 8.4 able compare contrast plane polarize circularly polarize light describe polarize filter impact wavelength and/or frequency light pass filter plane polarize

linearly polarize light light electric field wave orient direction electric field vector parallel follow magnetic field vector parallel convention dictate plane electric field identify plane polarization unpolarized light random orientation electric field vector sunlight light emit light bulb prime example common application plane polarized light mcat classification stereoisomer discuss chapter 2 mcat organic chemistry review optical activity compound presence chiral center cause plane polarized light rotate clockwise counterclockwise give number degree relative concentration specific rotation remember enantiomer nonsuperimposable mirror image opposite specific rotation plane polarized light diagnose number disease amyloidosis cause buildup form misfolded protein diagnose biopsy stain tissue congo red stain bright apple green color see plane polarized light gout precipitation monosodium urate crystal pseudogout precipitation calcium pyrophosphate crystal differentiate precipitate color polarize light monosodium urate appear yellow calcium pyrophosphate appear blue axis crystal align polarizer filter call polarizer camera sunglass allow light electric field point particular direction pass pass beam light polarizer let portion light parallel axis polarizer second polarizer hold angle polarizer axis determine light pass polarizer align light

hold angle polarizer axis determine light pass polarizer align light pass polarizer pass second second polarizer turn axis perpendicular light get electric field unpolarized light wave exist dimension direction wave propagation surround electric field plane perpendicular direction polarize light limit electric field oscillation dimension circular polarization rarely see natural phenomenon result interaction light certain pigment highly specialized filter circularly polarize light uniform amplitude continuously change direction cause helical orientation propagate wave show figure 8.20 helix average electrical field vector magnetic field vector lie perpendicular like wave maximum fall outer border helix helical shaped electric field figure 8.20 circularly polarized light mcat concept check 8.4 assess understanding material 1 contrast plane polarize circularly polarize light 2 application polarize filter impact wavelength light pass filter chapter illuminate key behavior characteristic light optical system describe nature

electromagnetic em wave note perceive light visible range 400 nm 700 nm focus geometrical optic consider reflective refractive behavior light note way mirror reflect light produce image lense refract light produce image acknowledge fact light travel straight line pathway bend spread diffraction examine pattern interference occur light pass double slit demonstrate young double slit experiment finally wrap discussion plane polarize circularly polarize light chapter consider property support wave theory light chapter explore photon property support particle theory light atomic nuclear review content test knowledge critical thinking skill complete test like passage set online electromagnetic wave transverse wave consist oscillate electric field oscillate magnetic field field perpendicular direction propagation wave electromagnetic spectrum range frequency wavelength find em wave em spectrum include low high energy radio wave microwave infrared visible light ultraviolet x ray visible spectrum run approximately 400 nm violet 700 reflection rebounding incident light wave boundary medium law reflection state incident angle equal angle reflection measure normal spherical mirror center radius curvature concave mirror converge system produce

spherical mirror center radius curvature concave mirror converge system produce real inverted image virtual upright image depend placement object relative focal point convex mirror diverge system produce virtual upright image plane mirror produce virtual upright image image size object think spherical mirror infinite radius curvature refraction bending light pass medium speed light change depend index refraction medium speed change cause refraction refraction depend wavelength light involve behavior cause dispersion light prism snell law law refraction state inverse relationship index refraction sine angle refraction measure normal total internal reflection occur light refract medium instead reflect inside medium happen light move medium high index refraction medium low index refraction high incident angle minimum incident angle total internal reflection occur call critical angle lense refract light form image object thin symmetrical lense focal point convex lense converge system produce real inverted image virtual upright image concave lense diverge system

produce virtual upright image lense non negligible thickness require use following table summarize image creation converge diverge system mirror lense o > 2f o = 2f 2f > o > f o = f o

< f diffraction bending spreading

light wave pass narrow slit diffraction produce large central light fringe surround alternate light dark fringe addition lens interference support wave theory light young double slit experiment show constructive destructive interference wave occur light pass parallel slit result minimum dark fringe maximum bright fringe intensity plane polarize light light ray electric field plane polarize light create pass unpolarized light circularly polarize light light ray electric field equal intensity constantly rotate direction circularly polarize light create expose unpolarized light special pigment filter answer concept check 1 γ ray > x ray > ultraviolet > visible light > infrared > microwave > radio frequency follow trend energy wavelength follow opposite trend 2 false light wave transverse direction propagation perpendicular direction oscillation 3 visible light range wavelength 400 nm 700 nm comparison entire em spectrum range wavelength nearly 0 109 m. object mirror object mirror image mirror image mirror virtual mirror concave mirror convex diverging mirror concave mirror convex diverging image upright erect image inverted object lens light source object opposite lens light source extremely image opposite lens light source image lens light source virtual lens convex lens concave diverging lens convex lens concave diverging image upright erect image inverted 2 true optic incident angle measure relative 3 light bend normal go medium low n high n. light bend away normal go medium high n low n incident angle large critical angle θc total internal reflection occur 4 dispersion tendency different wavelength light experience different degree refraction medium lead separation light visible spectrum rainbow aberration spherical chromatic alteration distortion image result imperfection optical system 1 diffraction single slit create characteristic fringe project screen light spread lens introduce system additional refraction light cause constructive destructive interference create fringe 2 fringe result

constructive destructive interference 3 image form double slit diffraction contain fringe light ray

3 image form double slit diffraction contain fringe light ray constructively destructively interfere single slit form image wide band light spread 4 true maxima minimum alternate diffraction pattern maximum equidistant minimum minimum equidistant maximum 1 plane polarize light contain light wave parallel electric field vector circularly polarize light select give amplitude continuously rotate electric field direction 2 plane polarization effect wavelength frequency speed light polarization affect light pass medium light intensity science mastery assessment explanation unnecessary memorize entire electromagnetic spectrum test day important know visible spectrum run 400–700 nm calculate wavelength light wavelength fall visible spectrum yellow- color object determine wavelength light reflect object anthocyanin pigment appear red reflect red light frequency light calculate equation c = fλ red light wavelength 700 nm convert 700 × 10 9 m.

plug value yield f = 3 × 108 700 × 10 9 = 4.2 × 1013 hz match d note close eye unit enable immediate elimination solve question ray diagram wary ray diagram test day easy small mistake cause light ray intersect solve question sign convention object center curvature distance 2f plug optic equation positive image real single mirror lense real image inverted calculate wavelength use formula d sin(θ = n + 1/2)λ rearrange formula solve wavlength λ = d sin θ n + 1/2 distance give millimeter convert meter d = 3 × 10–4 m.

question ask second dark fringe n = 2 plug give value yield λ = 3 × 10–4)sin 30o 2 + 1/2 = 6 × 10–5 m match choice b question contain part determine frequency angle refraction light ray straightforward frequency light ray travel medium change frequency 5 × 1014 hz eliminate c d angle refraction calculate determine logic light ray go air crystal low index refraction high accord snell law angle refraction small incident angle close normal light ray move crystal

chromium go low index refraction high make angle refraction small eliminate b question answer calculation snell law calculation time consume plane polarized light light electric field wave orient direction light pass polarizer contain ray electric field vector direction reach polarizer light able pass light ray orient direction dictate second plane polarizer allow specific orientation electric field light pass plane polarizer perpendicular light pass second polarizer support c correct answer note polarizer align light pass pass second twice plane polarize eliminate image produce convex lens real virtual real object place distance great focal point virtual object place distance focal point focal point lens remember single mirror lens image real invert virtual upright question object place focal point image virtual upright determine optic equation f > o negative negative virtual question test understanding total internal reflection laser beam travel water air high low index refraction angle refraction increase critical angle θc angle refraction 90 ° point refract ray parallel surface water incident angle great critical angle light reflect water question ask critical angle inverse sine 0.75 slightly high 48.59 ° exact answer question test understanding diffraction light pass narrow opening light wave spread slit narrow light wave spread lens place narrow slit screen pattern consist alternate bright dark fringe observe screen slit narrow central maximum bright central fringe wide see equation

slit narrow central maximum bright central fringe wide see equation position dark fringe slit len setup sin θ = nλ width slit decrease sin θ increase nλ constant give fringe sin θ increase θ necessarily increase imply fringe spread far apart image produce plane mirror virtual statement iii true go diverge specie convex mirror concave lense statement ii true converge specie concave mirror convex lense produce real virtual image depend far object species statement color light irrelevant ratio specific color mention second recall snell law n1 sin θ1 = n2 sin θ2 know value n medium know simple relationship replace n snell law cancel c side overall magnification system multiple lense simply product lens magnification case 10 × 40 = draw diagram good angle give respect normal know incident angle equal 60 ° know reflect

beam angle 60 ° relative normal reflect beam angle 30 ° plane glass reflect refract beam perpendicular refract beam 60 ° angle plane glass θrefracte 30 ° relative normal n1 sin θ1 = n2 sin θ2

light split component

color dispersion prism eliminate diffraction diffraction grating separate color wavelength eliminate b refraction light thin film lead light dispersion different color refract slightly different angle film eliminate c mirror significant aberration lead separation light component color tell ideal mirror d correct answer consult online resource additional practice equation remember 8.1 speed light frequency wavelength c = fλ 8.2 law reflection θ1 = θ2 8.3 optic equation 8.5 index refraction 8.6 snell law n1 sin θ1 = n2 sin θ2 8.7 critical angle 8.8 lensmaker equation 8.10 focal length multiple lens system 8.11 power multiple lens system p = p1 + p2 + p3 + + pn 8.12 magnification multiple lens system m = m1 × m2 × m3 × × 8.13 position dark fringe slit len setup sin θ = nλ 8.14 position dark fringe double slit setup behavioral sciences chapter 2 sensation perception biochemistry chapter 3 nonenzymatic protein function protein analysis organic chemistry chapter 2 organic chemistry chapter 11 physics math chapter 7 wave sound physics math chapter 9 atomic nuclear phenomena atomic nuclear pre med know feeling content know mcat know first important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal is 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

question quiz miss include quick read correspond subchapter relevant content subchapter question review question get correct ensure thinking match explanation review concept summary end chapter work function metal 6.622 × 10–20 j ray electromagnetic radiation frequency 1.0 × 1014 hz incident metal speed electron eject metal note h = 6.626 × 1034 j· me = 9.1 × 1031 kg wavelength photon cause electron emit metal kinetic energy 50 j note work function metal 16 j h = 6.626 × 1.0 × 1034 m 3.0 × 1027 m 3.0 × 1026 m 1.0 × 1035 m follow statement inconsistent bohr model atom energy level electron stable discrete electron emit absorb radiation make transition energy level jump low energy high energy orbit electron absorb photon precisely right frequency photon energy equal energy difference orbit jump high energy low energy orbit electron absorb photon frequency photon energy exactly energy difference hydrogen atom electron fall ground state n = 2 state 10.2 ev energy emit wavelength radiation note 1 ev = 1.60 × 1019 j h = 6.626 × 1034 j· 5.76 × 109 m 1.22 × 107 m 3.45 × 107 m 2.5 × 1015 m figure illustrate electron initial energy 10 ev move point point b. change accompany movement electron absorption photon emission photon decrease atom work function increase atom total energy follow fundamental force primary responsible hold bind energy strong nuclear force electrostatic force gravitational force following statement photoelectric effect true intensity light beam affect photocurrent kinetic energy emit electron depend light intensity weak beam light frequency great threshold frequency yield current intense beam light frequency low threshold frequency light give frequency kinetic energy emit electron increase value work function decrease bind energy argon-40 isotope mev note mproton = 1.0073 amu mneutron = 1.0087 amu mar-40 nucleus = 39.9132 amu 0.4096

mneutron = 1.0087 amu mar-40 nucleus = 39.9132 amu 0.4096 mev 40.3228 mev 381.7 mev 643.8 mev

follow correctly identify follow process β decay β+ decay e capture γ decay consider follow fission reaction masse specie involve give atomic mass unit species 1 amu create 932 mev energy energy liberate transformation mass energy reaction 0.003 mev 1.4 mev 2.8 mev 5.6 mev element x radioactive decay α decay half life day 12.5 percent original sample element x remain n day value n graph exponential decay process create y axis natural logarithm ratio number intact nucleus give time number intact nucleus time t = 0 x axis time slope graph represent λ certain carbon nucleus dissociate completely α particle particle half life carbon-14 approximately 5,730 year half life carbon-12 essentially infinite ratio carbon-14 carbon-12 certain sample 25 normal ratio nature old sample 5,730 year approximately 5,730 year significantly great 5,730 year 11,460 year approximately 11,460 year nuclide undergo alpha decay positron decay gamma decay difference atomic number parent nuclide atomic number daughter nuclide c ch 9.1 b ch 9.1 d ch 9.2 b ch 9.2 b ch 9.2 b ch 9.3 ch 9.1 c ch 9.3 c ch 9.4 c ch 9.4 c ch 9.4 b ch 9.4 c ch 9.4 ch 9.4 d ch 9.4 atomic nuclear chapter 9.1 photoelectric effect kinetic energy eject electron 9.2 absorption emission light 9.3 nuclear binding energy mass defect 9.4 nuclear reaction pie chart indicate content chapter relevant fourteen percent question physics mcat content chapter relevant 16 question physics mcat chapter cover material following aamc content category 4d light sound interact matter 4e atom nuclear decay electronic structure atomic chemical behavior life depend photoelectric effect photon light

enter chloroplast plant cell react chlorophyll cause ejection electron certain magnesium contain dye is electron feed synthetic pathway ultimately result glucose production mcat include photosynthesis content list principle primary example photoelectric effect albert einstein describe effect win nobel prize theory relativity use photoelectric effect industrial application solar panel aer discuss photoelectric effect examine nuclear radiation nuclear radiation curiously opposite cause life threaten disease cancer treatment cancer safely mass power generation cause untold devastation meltdown weapon mass destruction addition

nuclear radiation examine strong nuclear force equation mass defect quote equation science end chapter cover physics content test mcat ready mathematic skill base 9.1 photoelectric effect chapter 9.1 able relate work function energy need emit electron metal recall factor(s threshold frequency depend recognize phenomenon result application photoelectric effect high intensity blue light behave wave photon light sufficiently high frequency typically blue ultraviolet light incident metal vacuum metal atom emit electron is phenomenon discover heinrich hertz 1887 call photoelectric effect mention early albert einstein 1905 explanation photoelectric effect win nobel prize electron liberate metal photoelectric effect produce net charge flow unit time current provide light beam frequency threshold frequency metal light beam great intensity produce large current way e high intensity light beam great number photon unit time fall electrode produce great number electron unit time liberate metal light frequency threshold frequency magnitude result current directly proportional intensity amplitude light beam e minimum frequency light cause ejection electron know threshold frequency ft. e threshold frequency depend type metal expose radiation e photoelectric effect intent purpose response frequency incident photon threshold frequency f < ft electron eject photon sufficient energy dislodge electron atom frequency incident photon great threshold frequency f > ft electron eject maximum kinetic energy eject electron equal difference hf hft call work function einstein explanation result light beam consist integral number

work function einstein explanation result light beam consist integral number light quanta call photon e energy photon proportional frequency light e = hf e energy photon light h planck constant 6.626 × 1034 j· f frequency light know frequency easily find wavelength λ accord equation c = fλ describe chapter 8 mcat physics math review accord equation wave high frequency short wavelength high energy blue ultraviolet end spectrum wave low frequency long wavelength low energy red infrared end spectrum nuclear physics wavelength commonly measure nanometer 1 nm = 109 m ångström 1 å = energy photon increase increase

frequency reason discuss electron eject metal proton neutron weak hold metal valence electron low ionization energy kinetic energy eject electron frequency photon light incident metal threshold frequency metal electron barely escape metal frequency incident photon threshold frequency metal photon energy eject single electron excess energy convert kinetic energy eject electron calculate maximum kinetic energy eject electron formula kmax = hf  w w work function metal question e work function minimum energy require eject electron relate threshold frequency metal w = hft ese formula solve maximum kinetic energy electron exact kinetic energy actual energy 0 kmax depend specific subatomic interaction photon metal atom kmax achieve possible energy photon transfer eject electron photoelectric effect frequently test mcat underlie principle simple simply example energy transfer light energy cause increase electrical potential energy atom allow electron escape energy leave destroy transfer kinetic energy eject electron think work function like activation energy sense match exceed cause reaction escape electron occur activation energy discuss chapter 5 mcat general chemistry review example blue light frequency 6.00 × 1014 hz incident rubidium w = 2.26 ev photoejection electron maximum kinetic energy eject electron carry away note h = 6.626 × 1034 j· = 4.14 × 1015 ev s solution

× 1034 j· = 4.14 × 1015 ev s solution photon frequency 6.00 × 1014 hz photon e = hf = 4.14 × 1015 ev s)(6.00 × 1014 hz = 2.48 ev

clearly give photon energy allow electron metal overcome 2.26 ev barrier fact maximum excess kinetic energy carry away electron turn k = hf  w = 2.48  2.26 = 0.22 ev general photoelectric effect strong support particle theory light state light continuous wave act discrete bundle energy call photon show figure 9.1 intensity incident increase number eject electron increase frequency increase speed eject electron increase figure 9.1 photoelectric effect mcat concept check 9.1 assess understanding material question 1 work function relate energy necessary emit electron 2 threshold frequency depend 3 electrical phenomenon result

application photoelectric effect 9.2 absorption emission light chapter 9.2 able describe absorption spectrum single atom determine recall photon emission common electronic transition explain phenomenon fluorescence chapter 1 mcat general chemistry review explore bohr model atom reminder bohr model state electron energy level stable discrete correspond specific orbit electron jump low energy high energy orbit absorb photon light precisely right frequency match energy difference orbit e = hf photon carry energy electron jump high energy level electron fall high energy level low energy level photon light emit energy equal energy difference orbit ese process atomic absorption emission show figure 9.2 photon absorb ground state hydrogen atom push electron high energy orbit electron fall original orbit photon release figure 9.2 bohr model light absorption emission information single electron great foundation test day real world oen handle complex structure organic chemistry use infrared ir spectroscopy determine chemical structure different bond absorb different wavelength light uv vis spectroscopy take step look absorption light visible ultraviolet range absorption spectrum represent color bar peak area absorption represent black line show graph absolute absorption function wavelength is show figure 9.3

show absorption spectrum atmosphere entire electromagnetic spectroscopy discuss great detail chapter 11 mcat organic chemistry gamma ray x ray uv ir long radio wave absorb atmosphere visible light pass radio wave figure 9.3 absorption spectrum atmosphere sky blue blue light absorb atmospheric gas change molecular structure cause dramatic shi absorption pattern substance consider indicator like phenolphthalein is indicator clear appearance acidic state absorb visible light basic state bright pink absorb long wavelength visible light remember color absorb indicator contain large organic compound strikingly different absorption pattern base solely protonation state compound ese compound oen conjugate double bond aromatic ring system permit absorption light photon visible range phenomenon relate absorption emission visible light fluorescence excite fluorescent substance ruby emerald phosphor find fluorescent light ultraviolet radiation begin glow visible light photon

ultraviolet light relatively high frequency short wavelength aer excite high energy state ultraviolet radiation electron fluorescent substance return original state step return step step involve energy step photon emit low frequency long wavelength absorb ultraviolet photon wavelength emit photon visible range electromagnetic spectrum see light particular color correspond wavelength e wide range color fluorescent light whitish green office lighting glaring color neon sign result distinct multi step emission spectra different fluorescent material mcat concept check 9.2 assess understanding material question 1 determine absorption spectrum single atom 2 true false small change chemical structure minimally impact light absorption emission pattern 3 electronic transition photon emission common 4 cause fluorescence 9.3 nuclear binding energy mass defect chapter 9.3 able describe key concept nuclear bind energy include strong nuclear force mass defect bind energy recall fundamental force nature apply equation e = mc2 point examine relationship electromagnetic radiation matter particularly electron shi energy store nucleus emit specific circumstance assume mass nucleus simply sum masse proton neutron actual mass nucleus hydrogen slightly small is difference

proton neutron actual mass nucleus hydrogen slightly small is difference call mass defect scientist difficulty explain mass defect occur einstein characterize equivalence matter energy embody equation e = mc2 e energy m mass c speed light e mass defect result matter convert energy large exponent speed light square equation small mass yield huge energy example conversion gram mass energy produce 89.9 terajoule 1 tj = 1012 joule 21.5 billion kilocalorie proton neutron nucleon come form nucleus attract strong nuclear force strong compensate repulsive electromagnetic force proton strong nuclear force strong fundamental force act extremely short distance time diameter proton neutron e nucleon close order strong nuclear force hold e bond system low energy level unbonded constituent difference energy radiate away form heat light electromagnetic radiation mass defect apparent is energy call binding energy allow nucleon bind nucleus give strength strong nuclear force mass transform

dissipate energy measurable fraction initial total mass e bind energy nucleon peak element iron imply iron contain stable nucleus general intermediate sized nucleus stable large small nucleus e weak nuclear force contribute stability nucleus millionth strong strong nuclear force e strong weak nuclear force constitute fundamental force nature e electrostatic force gravitation example measurement atomic mass neutron proton yield contain proton neutron theoretically helium nucleus mass 2 × 1.00728 + 2 × 1.00867 = 4.03190 amu true mass helium nucleus 4.00260 amu mass defect bind energy nucleus note solution difference 4.03190 4.00260 = 0.02930 amu

mass defect helium nucleus mass contribute bind energy nucleus mcat concept check 9.3 assess understanding material question 1 define following term strong nuclear force 2 fundamental force nature 3 mass defect relate bind energy 9.4 nuclear reaction chapter 9.4 able compare contrast nuclear fission nuclear fusion reaction recall emission δz δa different radioactive process recall type decay detect atomic absorption spectrum predict number half life necessary decay portion radioactive percentage radioactive nucleus remain vs. number half life half- life half number nucleus previous half life exist nuclear reaction fusion fission radioactive decay involve combine split nucleus atom bind energy nucleon great intermediate sized atom intermediate sized atom stable small atom combine large atom split great energy release write isotopic notation element precede atomic number subscript mass number superscript e atomic number z correspond number proton nucleus mass number correspond number proton plus neutron balance nuclear equation important balance number nucleon side balance atomic number mass fusion occur small nucleus combine form large nucleus example star include sun power fuse hydrogen nucleus helium nucleus show figure 9.4 method sun produce 3.85 × 1026 joule second 385 yottawatt account

mass defect arise formation helium nucleus hydrogen nucleus earth fusion power plant far common fission power plant generate energy deuterium lithium nucleus hydrogen nucleus

come give off gamma ray neutrino positron proton step form figure 9.4 hydrogen fusion sun create helium nuclei fission process large nucleus split small nucleus spontaneous fission rarely occur absorption low energy neutron fission induce certain nucleus special interest fission reaction release neutron neutron cause chain reaction nearby atom undergo fission is turn release neutron continue chain reaction induce fission reaction power commercial nuclear example fission reaction occur uranium-235 u-235 absorb low energy neutron briefly form excite state u-236 split xenon-140 strontium-94 neutron isotopic notation form unbalanced reaction balance neutron produce reaction solution treat arrow equal sign problem simply ask balance equation mass number arrow equal application nucleon number conservation say total number neutron plus proton remain neutron convert proton vice versa decay 235 + 1 = 236 arrow balance look atomic number number proton balance 92 + 0 = 92 = 54 + 38 + 0 find number neutron determine nucleon remain account xenon-140 strontium-236 140 + 94 = 236 234 = 2 nucleon proton balance remain nucleon neutron neutron produce reaction neutron free absorb u-235 cause fission reaction note actually necessary know intermediate high energy state form radioactive decay naturally occur spontaneous decay certain nucleus accompany emission specific particle mcat prepare answer general type radioactive decay e integer arithmetic particle isotope specie radioactive half life problem e use exponential decay curve decay constant isotope decay arithmetic nucleon conservation let letter x y represent nuclear isotope parent nucleus x undergo nuclear decay form daughter nucleus y balanced balance nuclear reaction sum atomic number side equation sum mass number side approach radioactive decay problem mcat start balance number proton atomic number wrong answer

problem mcat start balance number proton atomic number wrong answer choice simply error number proton eliminate check mass alpha decay emission α particle nucleus consist proton neutron zero electron e alpha particle massive compare beta particle carry double charge alpha particle interact matter easily penetrate shielding lead sheet extensively alpha particle

electron carry charge +2 e emission α particle mean atomic number daughter nucleus parent nucleus mass number is express balanced example suppose parent nucleus x alpha decay follow mass number atomic number daughter isotope y solution solve question simply need balance atomic number necessary identify element answer question answer

mcat usually give element symbol y thorium th atomic number 90 daughter nucleus beta decay emission β particle electron give symbol e β.

electron reside nucleus emit nucleus neutron decay proton β particle antineutrino electron singly charge 1836 time light proton beta radiation radioactive decay penetrate alpha radiation case induce decay positron emission positron release mass electron carry positive charge e positron give symbol e+ β+ neutrino ν emit positron decay note neutrino antineutrino test mcat omit type beta decay need conservation charge negative charge β produce neutron convert proton maintain charge conversely positive charge β+ produce proton convert neutron maintain charge remember negative beta decay produce negative β particle positive beta decay produce positive β particle β decay neutron convert proton β-particle z = 1 = 0 emit atomic number daughter nucleus high parent nucleus mass number change is express balanced equation β+ decay proton convert neutron β+-particle z = +1 = 0 emit atomic number daughter nucleus low parent nucleus mass number change is express balanced equation example suppose promethium-146 nucleus beta decay follow mass number atomic number daughter isotope y solution balance atomic number mass number y samarium sm atomic number 62 daughter nucleus gamma decay emission γ ray high energy high- frequency photon ey carry charge simply lower energy parent nucleus change mass number atomic number e high energy state parent nucleus represent gamma decay question easy mcat change occur mass number atomic number γ ray emit is express balanced equation example suppose excited parent isotope gamma decay undergo positron emission form turn alpha decay z americium- 241 solution final daughter nucleus give

necessary work backwards reaction reaction follow alpha decay atomic number parent nucleus 97 mass number 245 berkelium-245 precede reaction follow positron emission atomic number parent nucleus 98 mass number 245 californium-245 finally precede reaction follow gamma decay atomic number parent nucleus 98 mass number 245 high energy form californium-245 certain unstable radionuclide capable capture inner electron

energy form californium-245 certain unstable radionuclide capable capture inner electron combine proton form neutron release neutrino e atomic number

original mass number remain electron capture rare process well think reverse β decay sample radioactive particle half life sample time take half sample decay subsequent half life half remain sample decay remain asymptotically half life problem common mcat sure write easy lose example half life certain isotope 4 year fraction sample isotope remain 12 year solution 4 year half life 12 year 3 half life half life 4 year half sample decay second half life year 4 8) half remain half decay leave fourth original final half life year 8 12 half remain fourth decay leave eighth original sample fraction remain 3 half life let n number radioactive nucleus decay sample turn rate nucleus decay proportional number remain n is suggest equation λ know decay constant e solution equation tell number radioactive nucleus change time is know exponential decay $n = n0e\lambda t$ n0 number undecayed nucleus time $t = 0$ e decay constant relate half life typical exponential decay curve show figure 9.5 graph exponential decay figure 9.5 exponential decay example time $t = 0$ 2 mole sample radioactive isotope nucleus remain 45 minute assume decay constant 2 hr1 hint = 0.22 solution question ask application exponential decay equation raise euler number e exponent especially fractional exponent scope math mcat value 0.22 22 original 2 mole sample remain constitute 0.44 mol multiply avogadro number give number nucleus remain mcat concept check 9.4 assess understanding material question 1 true false nuclear fission nuclear fusion release energy 2

compare contrast nuclear fission nuclear fusion reaction size reactant change nuclear mass reaction increase decrease 3 complete following chart 4 half life necessary complete decay radioactive sample 5 type nuclear decay detect atomic absorption spectrum congratulation finishe physics material need test day topic interaction energy matter atomic level begin examine photoelectric effect take look bohr model hydrogen ion generalization electronic structure permissible state regard absorption emission light energy note molecular level small change structure lead significant shi absorption study interaction nucleus energy include prototypical nuclear reaction fusion fission finishe discussion nuclear reaction examine common form nuclear decay mathematic determine half- life sample remain chapter focus build test day skill include mcat math shortcut concept rewarding review content test knowledge critical thinking skill complete test like passage set online resource photoelectric effect e photoelectric effect ejection electron

surface metal response light e threshold frequency minimum light frequency necessary eject electron give metal e work function minimum energy necessary eject electron give metal value depend metal calculate multiply threshold frequency planck constant e great energy incident photon work function kinetic energy eject electron possess e eject electron create current magnitude current proportional intensity incident beam light absorption emission light e bohr model atom state electron energy level stable discrete correspond specific orbit electron jump low energy high energy orbit absorb photon light frequency energy difference orbit electron fall high energy low energy orbit emit photon light frequency energy difference orbit absorption spectrum impact small change molecular fluorescence occur species absorb high frequency light return ground state multiple step step energy absorb light visible range electromagnetic nuclear binding energy mass defect nuclear bind energy energy release nucleon proton neutron bind e bind energy nucleon release stable nucleus e fundamental force nature strong weak nuclear force contribute stability nucleus electrostatic force e mass defect difference mass unbonded nucleon mass bond nucleon nucleus e unbonded

constituent energy mass bond constituent e mass defect mass convert energy nuclear fusion occur small nucleus combine large nucleus fission occur large nucleus split small nucleus energy release fusion fission nucleus form process stable start nucleus radioactive decay loss small particle nucleus alpha α decay emission alpha particle helium beta negative β decay decay neutron proton emission electron e β antineutrino beta positive β+ decay call positron emission decay proton neutron emission positron e+ β+ neutrino gamma γ decay emission gamma ray convert high- energy nucleus stable nucleus electron capture absorption electron inner shell combine proton nucleus form neutron half life time require half sample radioactive nucleus decay exponential decay rate radioactive nucleus decay proportional number nucleus remain answer concept check e work function describe minimum

nucleus remain answer concept check e work function describe minimum energy necessary emit electron additional energy photon convert excess kinetic energy photoelectric effect e threshold frequency depend chemical composition material identity metal e accumulation

move electron create current e energy difference ground state electron high level electron orbit determine frequency light particular material absorb absorption spectrum false small change protonation deprotonation change oxidation state bond order cause dramatic change light absorption material electron transition high energy state low energy state experience photon emission fluorescence special stepwise photon emission excited electron return ground state intermediate excited state energy transition release photon light small energy transition initial energy absorb material release photon light visible range e strong nuclear force primary force provide adhesive force nucleon proton neutron nucleus mass defect apparent loss mass nucleon come mass convert energy at energy call bind energy e fundamental force nature strong weak nuclear force electrostatic force gravitation mass defect relate bind energy transformation nuclear matter energy resultant loss matter ey relate equation e = mc2 true like inverse nuclear fusion nuclear fission reaction release energy

size reactant particle change nuclear mass reaction increase decrease large actinide lanthanide small hydrogen helium electron e β antineutrino positron e+ β+ neutrino ν gamma ray γ absorb electron remain cut half aer half life portion remain reach zero is theoretical consideration sample consider decay aer 7 8 gamma radiation produce electromagnetic radiation nuclear fragment detect atomic absorption spectrum science mastery assessment determine speed electron eject first calculate value kinetic energy calculate speed notice wide range exponent answer choice math question complex allow round determine wavelength light ray first calculate frequency photoelectric effect equation case estimation planck constant make calculation simple lead nonviable answer worth attempt determine wavelength incident ray light relate frequency speed light e bohr model base set postulate originally forward discuss behavior electron hydrogen summary postulate state energy level electron stable discrete correspond specific orbit eliminate ey state electron emit absorb radiation make transition energy level eliminate b specifically electron jump

radiation make transition energy level eliminate b specifically electron jump low energy orbit high energy absorb photon light precisely right frequency photon energy equal energy difference orbit eliminate c fall high energy orbit low energy electron emit photon light frequency correspond energy difference orbit is opposite d make right solve question correctly careful unit convert 10.2 ev joule determine wavelength radiation combine formula e = hf c = f λ e electron move high energy level low energy level occur extra energy dissipate emission photon electron move b absorb photon increase atom total energy opposite occur d eliminate e work function energy require eject electron material move b electrical potential energy atom decrease mean energy require free electron atom eliminate c e strong nuclear force attractive force hold proton neutron nucleus support choice b is force great electrostatic repulsion proton note bind energy fundamental force e great intensity great number incident photon great number electron eject metal surface provide frequency light

remain threshold is mean large current remember frequency light assume threshold frequency determine kinetic energy eject electron intensity light determine number electron eject time current determine bind energy first determine mass defect e mass defect simply masse proton neutron unbound state add minus mass form argon-40 nucleus contain 18 proton 40  18 = 22 neutron is math difficult calculator round value proton value neutron similar amount end near actual value calculate 18 × 7 = 126 22 × 9 = 198 decimal value manageable exact number spacing answer choice allow estimation e bind energy determine mass defect e close answer c is

process describe electron capture certain unstable radionuclide capable capture inner electron combine proton form neutron e atomic number original mass number remain electron capture relatively rare process think reverse β decay notice equation similar β+ decay identical particle absorb emit is problem present reaction ask energy liberate transformation mass energy convert mass energy tell 1 amu convert 932 mev energy need calculate mass amu convert reaction give atomic mass element reaction simply matter balance equation give small magnitude value small difference answer choice good round point calculation is mass convert energy obtain energy mass multiply conversion factor 1 amu = 932 e = 0.003 × 932  0.003 × 900 = 2.7 mev point able round easy calculation keep near correct answer choice half life element x day 50 percent original sample remain aer day 25 remain aer day 12.5 remain aer 12 day erefore n = 12 day approach set x number half life elapse solve x give x = 3 us 3 half life elapse half life day know n = 12 day e expression n = n0eλt equivalent take natural logarithm side expression clear plot vs. t straight line slope λ typical carbon nucleus contain 6 proton 6 neutron α particle contain 2 proton 2 neutron erefore carbon nucleus half life carbon-12 essentially infinite 25 decrease ratio carbon-14 carbon-12 mean 25 decrease carbon-14

half carbon-14 deteriorate half life elapse erefore sample 5,730 year old careful wording

question state ratio 25 ratio nature 25 ratio nature correspond d alpha decay element lose proton positron decay proton convert neutron gamma decay impact atomic number nuclide erefore alpha decay positron decay yield daughter nuclide few proton parent nuclide consult online resource additional equation remember 9.1 energy photon light e = hf 9.2 maximum kinetic energy electron photoelectric effect kmax = hf  w 9.3 work function w = hft 9.4 mass defect energy e = mc2 9.5 nuclear decay general form emit decay particle 9.6 alpha decay 9.7 beta negative decay 9.8 beta positive decay positron emission 9.9 gamma decay 9.10 electron capture 9.11 rate nuclear decay 9.12 exponential decay n = n0eλt 9.13 decay constant general chemistry chapter 1 general chemistry chapter 2 e periodic table organic chemistry chapter 11 physics math chapter 1 kinematic dynamic physics math chapter 2 work energy physics math chapter 8 light optic chapter 10 mathematics animate number background pre med know feeling content know mcat know first important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal is 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 get correct ensure thinking match explanation review concept summary end chapter number 17,060 write scientific notation 1706 × 101 1.706 × 104 1.7060 × 104 0.17060 × 105 number significant digit differ 14,320,010 3.618000 14,320,010 significant digit 3.618000 14,320,010 few significant digit 3.618000 14,320,010 number significant digit 3.618000 comparison

number scientific notation appropriate number significant digit answer follow math problem note assume number result measurement 3.060 × 4.10 + 200 = follow appropriate setup estimate value 3.6 × 4.85 question answer choice differ small margin 3.5 × 5 3.5 × 4.5 4 × 4 4 × 5 value 2000.25 close following equation incorrect a3 × b3 = ab)3 a5 ÷ a7 = a2 a0.5)4 + a2 = 2a2 a3)2 = a9 value natural logarithm convert value common logarithm natural logarithm divide constant constant add subtract natural logarithm natural logarithm raise exponent inverse natural logarithm take minimum value 2 cos θ 1 following relationship incorrect |sin θ × cos θ| < |sin θ| + |cos θ| sin θ ÷ cos θ = tan θ tan 90 ° undefined sin θ = sin 90 ° θ approximate ph solution pka 3.6 ha = 100 mm a = 0.1 m

note temperature fahrenheit celsius scale equal value 0 k 233 k 313 k 273 k certain rigid container pressure temperature directly proportional pressure change 540 torr 180 torr temperature change factor temperature change 150 pound man give drug dose approximately milligram drug administer dose note 1 lb = 4.45 n 33 mg 67 mg 100 mg 225 mg rate reaction calculate change concentration time unit rate constant k reaction second order overall respect species note second order reaction type rate law form rate = k[a]2 concentration species middle aged man require base level 900 calorie day plus additional 12 calorie kilogram body mass day young adult woman require base level 500 calorie day plus 15 calorie kilogram body mass day mass middle aged man young adult woman caloric need 26 kg 67 kg 133 kg 266 kg b ch 10.1 c ch 10.1 b ch 10.1 ch 10.1 ch 10.2 d ch 10.2 ch 10.2 ch 10.3 d ch 10.3 b ch 10.2 b ch 10.4 d ch 10.4 c ch 10.4 c ch 10.4 c ch 10.4 chapter 10.1 arithmetic significant figure 10.2 exponent logarithm rule logarithm common vs. natural logarithm definition relationship use relationship go grocery store different solve mcat multiple choice question begin process determine item need near future know need check order determine quantity need buy reach goal store compare container shelf will match exactly example need total 16 ounce pea recipe home need 11 package pea come 10- 16 ounce package point choose good need 16 ounce package well little extra run short note

chapter chapter follow contain typical chapter profile directly relate physics aamc content category chapter cover fundamental math content require calculation science test section chapter 10 consider review shop international grocery store process elaborate packaging size currency match unit familiar take time consider intensive critical thinking efficiently navigate grocery store recognize process need use test day figure want question look information passage question stem outside knowledge need calculation critical thinking decision match answer eliminate wrong answer choice guess strategically chapter focus calculation critical thinking mathematic math require mcat level precalculus will need derivative integral test day rapid application arithmetic exponent logarithm rule trigonometry statistic graphical analysis necessary navigate mcat efficiently chapter will new content consider opportunity hone mathematic skill 10.1 arithmetic significant figure chapter 10.1 able convert value scientific notation determine significant digit number 1,547,200 apply rounding technique multiplication division problem mcat use number particularly nice look especially consider calculator test testmaker know calculator allow complex math solvable reasonable time reconcile oppose concept test day trick scientific notation help narrow exponent answer choice give answer directly judicious estimation differentiate similar answer significant figure will lead answer way mcat skill testable topic mcat essential use judicious rounding math strategy test day mcat efficiently particularly true chemical physical foundations biological systems section try solve exact answer need able choose right answer choice scientific notation method write number take advantage power scientific notation number write significand exponent easy conceptualize example consider number 217 math number somewhat cumbersome transform scientific notation 2.17 × 102 number easy manipulate power 10 pull case 2.17 significand call coefficient mantissa 2 102 exponent significand number absolute value range 1,10 mean real number 10 1 include 10 1 10 include 10 extension significand begin 0

begin digit decimal point exponent hand number positive negative 0 time calculation scientific notation consider adjust small time investment convert scientific notation time save subsequent calculation usually make exceed time investment especially true question answer differ power exception maintain scientific notation calculation square root discuss later chapter significant figure provide indication certainty measurement help avoid exceed certainty perform calculation significant figure determine precision instrument measurement example imagine measure width block wood ruler ruler marking centimeter millimeter state confidence width block millimeter 55 millimeter ruler marking small millimeter force estimate interval millimeter marking block reach 55.2 millimeter 100 percent confident decimal information well write let know confident digit significant figure important indication accuracy measurement inaccurate measurement bias research lead faulty conclusion present datum look accuracy measurement way identify number significant digit number look error margin statistical significance graph topic discuss chapter 12 mcat physics math review situation describe digit consider significant know measure accurately hold digit calculation time reach final answer need reduce answer appropriate number significant figure determine number significant figure number count number nonzero digit left nonzero digit right digit marker include 0 significant zero left nonzero digit consider leading zero significant zero right nonzero digit decimal point number zero significant figure decimal point significant example 3,490 significant figure 3,490.0 measurement digit usually estimation consider significant example scientific notation clarify significant figure contain decimal point convert standard number scientific notation sure maintain number significant figure 100.0 write scientific notation 1.000 × 102 100 write 1 × 102 trail zero example significant second example math significant figure significant figure estimation important laboratory science particularly analytical chemistry multiplication division maintain digit possible calculation little rounding error round number significant digit number significant digit factor divisor dividend addition subtraction decimal point maintain maintain significant figure convention decimal point significant figure answer decimal

maintain significant figure convention decimal point significant figure answer decimal digit initial number few decimal test day math extension kaplan mcat review series neglect significant figure answer choice calculation necessary

specify question stem passage example determine volume cylinder radius measure 7.45 m height 8.323 m. note use 3.14159 π round answer correct number significant digit factor multiply answer number significant digit factor few number significant digit case radius significant digit remember case measurement digit estimate consider significant correct answer 1,500 1.5 × 103 test day math determine answer choice provide answer choice close minimal opportunity rounding far apart rough estimation necessary estimation addition subtraction relatively simple rounding choice review trick multiplication division consider following multiplication problem 3.17 × 104 × 4.53 × 105 significant digit answer multiplication problem 1.44 × 1010 precise calculation scope mental math answer choice close generally acceptable round decimal place 3.2 × 104 × 4.5 × 105 round number multiplication mind round number large small original number number round good round number slightly compensate rounding answer come 1.44 × 1010 answer choice far apart differ power adjust number contain significant digit simplify math example calculation adjust 3 × 104 × 4.5 × 105 1.35 × 1010 represent error 6.25 close choose correct answer question test day let consider division avenue estimation multiplication example adjust number opposite direction division attempt proportional adjustment direction consider following example example estimate value 15.4 ÷ 3.80 solution estimation division shift number direction easy adjust divisor

simplify calculation round divisor 4 round dividend accordingly case make sense round dividend 16 number multiple 4 estimate 16 ÷ 4 = 4 note despite rough adjustment close true value 4.05 round number multiply round number number compensate round number divide round number direction compensate mcat concept check 10.1 1 describe process convert

number scientific notation value possible significand 2 highlight circle significant digit following number 3 round number contain decimal direction( number multiplication division 10.2 exponent logarithm chapter 10.2 able estimate square root give value like estimate log value give number simplify expression + 2b)3 student exponent logarithm topic file away depth memory exponential logarithmic function uncommon everyday life number science topic equation regularly test mcat require use concept show table 10.1 common exponential logarithmic equations mcat location kaplan mcat review series chapter 7 mcat physics math location kaplan mcat review series n = n0eλt chapter 9 mcat physics math arrhenius equation chapter 5 mcat gibbs free energy chapter 7 mcat p scale ph poh pka pkb ph = log h+ chapter 10 mcat chapter 10 mcat addition exponential equation exponent appear frequently mcat context scientific notation discuss early look rule arithmetic exponent basic understanding exponent necessary mcat helpful know value basic rule number zeroth power equal 1 x0 = 1 add subtract number exponent true value calculate addition subtraction perform example 32 + 32  62 32 + 32 = 9 + 9 = 18 base exponent add coefficient 32 + 32 = 1 + 1 × 32 = 2 × 32 = 18 case multiplication division exponent manipulate directly long base number multiply number base exponent add determine new xa × xb = x(a + b add subtract multiply divide number exponent base division subtract exponent denominator exponent numerator find exponent quotient long basis number raise exponent

exponent numerator find exponent quotient long basis number raise exponent raise exponent exponent multiply xa)b = x(a × b fraction raise exponent exponent distribute numerator denominator negative exponent represent inverse function fractional exponent numerator treat exponent denominator represent root number estimate square root test day expect calculate approximate square root useful familiar value table 10.2 table 10.2 square value integers 1 20 ask calculate square root number 400 approximate value determine perfect square fall alternative method divide number give know square attempt reduce estimate value consider square root 2 3 22 = 4 32 = 9 close 2 3 estimate 2.2 congruent

knowledge square root 180 13 14 true value estimation square root logarithm generally sufficient decimal place struggle precise will necessary test day number scientific notation adjust decimal place necessary exponent easily divisible finally useful know value rules logarithms logarithms follow rule exponent inverse function logarithmic rule describe equation 10.9 10.14 useful know p shorthand log ph = log h+ pka = log ka example derive henderson hasselbalch equation expression ka common vs. natural logarithms logarithm use base common base decimal system base e euler number 2.718 base logarithm log10 call common logarithm base euler number loge ln call natural logarithm common natural logarithm obey rule discuss easy estimate common logarithm familiarity decimal number system useful able convert natural logarithm common logarithm e euler number 2.718281828459045 base natural estimate logarithm number use scientific notation exact logarithmic calculation number integer power 10 unnecessary mcat testmaker interested test ability apply mathematical concept appropriately solve certain problem fortunately simple method approximation test day value write proper scientific notation form n × 10 m n number 1 10 fact use logarithm rule approximate value n number 1 10 logarithm decimal 0 1 log 1 = 0 log 10 = 1 close n 1

1 = 0 log 10 = 1 close n 1 close log n 0 close n 10 close log n 1 reasonable approximation log n × 10 m  m + 0.n 0.n

represent slide decimal point n position left divide n example log 9.2 × 108  8 + 0.92 = 8.92 actual = similar concept estimate logarithm calculation ph describe chapter 10 mcat general chemistry review shortcut slightly different work negative logarithm negative exponent case ph log n × 10m  m  0.n mcat concept check 10.2 assess understanding material question
1 simplify following expression + b)2 = loga = log a3  log = 3 estimate log 7,426,135,420 chapter 10.3 able explain appropriate way orient vector vector addition calculate value sine cosine tangent give right triangle recall sine cosine tangent value key angle little trigonometry

require mcat basic understanding definition strong knowledge special right triangle essential strong performance especially physics material definition relationship give right triangle angle characteristic value sine cosine tangent depend length leg triangle hypotenuse show figure 10.1 opposite angle b adjacent c hypotenuse figure 10.1 right triangle side sine calculate ratio opposite angle interest hypotenuse cosine calculate ratio adjacent angle interest hypotenuse tangent calculate ratio opposite angle interest adjacent angle interest trigonometric ratio soh cah toa sine = opposite ÷ hypotenuse cosine = adjacent ÷ hypotenuse tangent = opposite ÷ adjacent value sine cosine range 1 1 value tangent range . trigonometric function inverse function inverse sine sin1 arcsin inverse cosine cos1 arccos inverse tangent tan1 arctan function use calculate value sine cosine tangent yield numerical value angle interest triangle figure 10.1

inverse trigonometric function likely appear question ask direction resultant vector addition trigonometric function useful split vector component inverse trigonometric function useful determine direction resultant test day know value sine cosine tangent angle 306090 454590 special right triangle memorization draw triangle triangle show figure 10.2 30 60 90 length 1 30 square root 3 60 2 hypotenuse 45 45 90 length 1 square root 2 hypotenuse figure 10.2 special right triangle 306090 b 454590 important value trigonometric ratio angle show table 10.3 common trigonometric ratio mcat mcat concept check 10.3 assess understanding material question 1 vector addition angle resultant calculate 2 sine cosine tangent calculate give dimension right 3 true false angle right triangle characteristic value 4 angle 0 ° 180 ° trigonometric function value chapter 10.4 able distinguish direct inverse relationship convert metric prefix solve system equation substitution set equation equal elimination 3x + 4y = 17 5x  2y = 11

examine individual mathematical skill let explore common problem solve strategy attack mcat question use relationship proportionality especially important passage base question unit

analysis help determine formula appropriate give question use conversion factor ubiquitous mcat answer choice give different unit information present algebraic system require underlie passage interpretation approach question use relationships relationships generally indicate mcat passage formula use proportionality constant case imply require bit work calculate ratio calculation type base multiplication division explain relationship word math challenging decode connection variable direct relationship increase variable proportionately increase decrease decrease proportion inverse relationship increase variable associate proportional decrease accord boyle law pressure volume inverse relationship double cut half keep constant hand accord gay lussac law pressure temperature direct relationship double keep constant mcat routinely increase difficulty question require use conversion factor equation require variable certain format answer choice differ unit give question stem case necessary convert unit simple conversion perform maintain base unit example conversion gram kilogram milligram require multiplication appropriate power metric prefix associate power find table 10.4 table 10.4 metric prefix addition conversion necessary change prefix convert unit particularly british system si unit table 10.5 show important conversion factor recognize test day conversion factor time memorize mcat provide necessary table 10.5 common conversion factor mcat 5280 foot ft 12 inch 1 inch 1 calorie cal 1 calorie cal 1 electron volt ev 1.602 × 1019 j 33.8 ounce oz 1 pound lb 1 atomic mass unit amu 1.661 × 1027 kg example car speedometer register speed 33 mile hour speed meter second solution convert distance measurement careful cancel arrange numerator denominator repeat procedure time measurement special case conversion occur temperature simply multiply conversion factor component addition subtraction follow formula relate fahrenheit celsius kelvin system f c k temperature degree fahrenheit degree celsius kelvin respectively important able convert fahrenheit celsius scale

degree celsius kelvin respectively important able convert fahrenheit celsius scale medicine different hospital different medical record use different unit body temperature 98.6 ° f 37 ° c

fever usually define temperature 100.4 ° f 38 ° c hypothermia usually define temperature 95.0 ° f 35 ° c unit analysis call dimensional analysis help determine correct answer forget relevant formula test day serve double check calculation unit calculate answer match unit answer choice example consider question give quantity volt answer choice question meter remember equation v = ed infer divide voltage electric field distance meter dimensional analysis foolproof strategy well know true relationship variable infer base unit strategy effective narrow choose answer choice test day example ejection fraction proportion blood volume left ventricle expel contraction heart patient know ejection fraction 0.6 cardiac output heart rate volume blood person left ventricle prior contraction solution formula provide question recognize desire answer volume start cardiac output heart rate term determine volume eject beat question explain 60 percent blood volume expel left ventricle heartbeat determine volume blood prior key mathematical skill test day ability solve system linear equation order solve system equation equation variable variable truly constitute system equation necessary example 6 x = 1 reduce x = 5 contrast equation like 3x + 4y = 17 insufficient datum solve variable equation second equation introduce 5x 2y = 11 solve variable method substitute variable term set equation equal manipulate equation eliminate substitution solve variable equation insert term equation step method list solve variable equation insert expression equation isolate variable solve result equation solve variable value set equation equal set equation equal specialized case substitution method solve variable equation set equation equal step method list solve variable equation set equation equal isolate variable solve solve variable value elimination multiply divide equation coefficient variable equation

solve variable value elimination multiply divide equation coefficient variable equation add subtract equation necessary eliminate variable step method list multiply divide equation constant coefficient variable equation sign coefficient subtract equation sign opposite add equation solve variable value note method result answer despite slight difference step take matter convention answer system equation variable x y report coordinate cartesian plane x y

answer system 3,2 system equation variable unlikely encounter system variable x y z mcat mcat concept check 10.4 assess understanding material question 1 conversion metric prefix accomplish distance convert millimeter kilometer 2 mean variable direct relationship inverse 3 method solve system equation discuss chapter solve variable use value solve method solve variable set equation equal chapter review skill necessary successful performance mcat science section begin examine relevant arithmetic calculation test day include scientific notation significant figure continue review examine logarithm exponent discuss common trigonometric function value finish math review work problem solve skill valuable studying mcat chapter review test day skill experimental design datum analysis ready ready answer test day question review content test knowledge critical thinking skill complete test like passage set online resource arithmetic significant figures scientific notation method write number way improve ease calculation comparability significant digit scientific notation take format significand × 10[exponent significand great equal 1 10 exponent integer significant figure include nonzero digit trail zero number decimal point measurement exception digit provide addition subtraction reduce answer number decimal place number few number decimal place multiplication division reduce answer number significant digit number few number significant entire number maintain calculation minimize rounding error estimation multiplication division logically multiplication number round round proportion division number round round proportion exponent logarithm exponent notation repeat multiplication manipulate mathematically especially basis logarithm inverse exponent subject similar natural logarithm use base e euler number convert common logarithm use base 10

base e euler number convert common logarithm use base 10 trigonometric relationship calculate base length side right triangle sine ratio length opposite angle length cosine ratio length adjacent angle length hypotenuse tangent ratio opposite angle adjacent inverse trigonometric function use calculate value ratio length calculate angle interest direct relationship variable increase increase inverse relationship variable increase decrease

conversion metric prefix require multiplication division corresponding power conversion unit different scale require multiplication division require addition subtraction unit analysis dimensional analysis determine appropriate computation base give information algebraic system solve substitution set equation equal elimination general idea solve variable substitute variable equation solve specific method different answer concept check determine digit significant preserve scientific notation decimal point significand great equal 1 10 finally determine power 10 necessary multiplication restore

original number 34,600 0.0003201 1.10 525,600 multiplication adjust decimal opposite direction division adjust decimal direction + b)2 = a2 + 2ab + b2 loga = 1 value 19 20

simplify log 7,426,135,420 log 7.4 × 109 9 + 0.74 = 9.74 actual = 9.87 note absurdly large number relatively accurate estimation follow basic logarithm rule value trigonometric function calculate dimension resultant vector inverse tangent function calculate resultant vector angle inverse trigonometric ratio general calculate angle sine angle equal ratio opposite angle hypotenuse cosine ratio adjacent angle hypotenuse tangent ratio opposite angle adjacent angle false calculate value sine cosine tangent complicated triangle contain right angle possible angle characteristic trigonometric value sin equal 1 90 ° cos 0 ° tan 45 ° mcat question utilize trend sin increase go 0 ° 90 ° cos decrease range conversion metric prefix accomplish multiplication division appropriate power convert millimeter 103 kilometer 103 necessary multiply 106 wise double check work convert kilometer large unit distance millimeter number kilometer small number millimeter direct relationship quantity increase increase proportion inverse relationship quantity increase decrease proportion substitution solve equation variable term substitute expression equation set equation equal modify version substitution solve equation variable set equal elimination multiply divide equation coefficient variable equation add subtract equation eliminate variable science mastery assessment question overtly test ability use scientific notation check appropriate use

significant digit decimal point zero significant scientific notation significand scientific notation significant digit include nonzero digit zero nonzero digit trail zero number decimal point 14,320,010 decimal point zero insignificant seven significant digit 3.618000 digit significant seven significant digit digit preserve calculation final determination number digit significant figure decimal place multiplication answer maintain small number significant digit addition maintain small number decimal place follow order operation addition operation decimal answer choice multiplication occur early result multiplication shorten accord significant figure 4.10

entire estimate product number good round round b d round number direction increase error answer c round number opposite direction degree rounding significantly large extreme answer choice differ small amount fourth root number number raise quarter power square root square root number square root 200 bit large 14 142 = 196 fourth root 200 bit 4 raise exponent exponent require multiply exponent a3)2 = a6 relationship natural logarithm number common logarithm number natural logarithm number divide constant 2.303

obtain common logarithm number minimum value cosine function 1 cos 180 ° = 1 minimum value 2 cos θ 1 2 × 1 1 = 3 sin θ  sin 90 °  θ sin θ = cos 90 °  θ statement true sine cosine value 1 1 product sine cosine magnitude 1 sum absolute value sine absolute value cosine hand great 1 eliminate sine ratio opposite hypotenuse cosine ratio adjacent hypotenuse quotient ratio opposite adjacent tangent angle b eliminate logic sin 90 ° = 1 cos 90 ° = 0 tan 90 ° undefined eliminate c question involve unit conversion millimolar value molar value calculation logarithm relationship ph pka describe henderson hasselbalch equation give question stem 100 mm = 0.1 m question require unit conversion algebra give temperature t calculate answer give kelvin 40 ° c + 273 = 233 k. direct relationship change variable associate proportional change pressure multiply temperature multiply note fractional relationship temperature kelvin gram unit mass pound unit force convert pound newton divide

acceleration gravity find kilogram weight person newton correspond mass determine dose accord question stem rate reaction measure change concentration time unit m molarity measure mole liter rate reaction equal rate constant time concentration certain reactant square case know unit rate constant solve unit system equation couch datum information construct equation equation solve set equal consult online resource additional equation remember 10.1 zero exponent identity x0 = 1 10.2 multiply like basis exponent xa × xb = x(a + b 10.3 divide like basis exponent 10.4 raise exponent exponent xa)b = x(a × b 10.5 raise fraction exponent 10.6 raise basis negative exponent 10.7 raise basis fractional exponent 10.8 square root approximation 10.9 logarithm 1 identity loga 1 = 0 10.10 logarithm base identity loga = 1 10.11 logarithm product log ×

b = log + log b 10.12 logarithm quotient 10.13 logarithm exponent contain expression log ab = b log 10.14 logarithm inverse 10.15 conversion natural common logarithm 10.16 scientific notation logarithm approximation log n × 10 m  m 10.17 definition sine 10.18 definition cosine 10.19 definition tangent 10.20 temperature conversion general chemistry chapter 5 general chemistry chapter 7 general chemistry chapter 10 acid basis physics math chapter 7 wave sound physics math chapter 9 atomic nuclear phenomena physics math chapter 12 data base statistical reasoning reasoning design execution research pre med know feeling content know mcat know first important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal is 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 get correct ensure thinking match explanation review concept summary end chapter experimenter attempt investigate effect new antibiotic e. coli plate cell administer milliliter antibiotic follow appropriate negative control experiment plate cell coat milliliter antibiotic plate e. coli additional treatment plate e. coli milliliter isotonic saline plate epithelial cell treat milliliter antibiotic follow well establish causal link cross sectional study survey datum

hand washing cold case control study exposure childhood development certain disease later life randomized clinical controlled trial new antipyretic drug iq test result later segregate gender experimenter attempt determine internal energy know compound clean glassware complete synthesis calibrate bomb calorimeter use measure appropriate thermodynamic value follow error determine compound novel information specific goal beginning research involve synthesis compound later testing calibrate calorimeter synthesis compound researcher wish generate parameter american woman mean weight follow significant concern measure person weight psychological consequence unethical gather necessary study participant prohibitive know average weight woman provide useful information study conduct topic render unnecessary cross sectional study current smoking status cancer history assess simultaneously satisfy hill criterion randomization discover group study twice woman follow appropriate response man woman group manually gender check randomization algorithm fair continue research eliminate subject potential bias randomize new cohort current cohort continue randomize subject gender profile experimenter attempt determine effect smoking low birth weight vlbw vlbw iq follow statement correct smoking independent variable smoking dependent variable vlbw independent variable vlbw dependent variable ii iv iii iv ii iii iv study perform new medication subject experimental group tell potential effect medication subject placebo group subject contact know group place effect end significantly severe treatment group see assessor physician likely cause physician unblinding patient unblinding physician patient unblinding physician patient blinding graduate program entrance exam student

submit grant proposal scientific investigation choosing hypothesis formulate preliminary datum proposal reject committee review proposal cite article support hypothesis mistake drafting formulate testable hypothesis spend sufficient time review existing study propose study adequately test hypothesis preliminary datum new study weight loss drug use radio advertisement generate study participation type error likely result hawthorne effect selection bias detection bias researcher design study pay professionally translate language discuss potential risk benefit participant allow bring documentation home review commit study

risk benefit participant allow bring documentation home review commit study researcher special focus justice explain potential risk beneficence describe potential benefit study respect person acknowledge subject perspective right selection bias make recruitment document inclusive follow method appropriate initial assessment hemoglobin saturation experiment breath holding pulse oximeter use small light adhesive bandage arterial cannula permit repeat blood draw single puncture repeated venipuncture single puncture cause data overlap swan ganz catheter insert femoral artery measure saturation nearest heart medical student attempt impress attend physician refer recent article say statistically significant difference pregnancy length new therapy follow likely valid criticism article medical student usually reference article new journal

unreliable effect change patient outcome secondary measure lack internal validity result despite significance selection bias inherent scientific process sample appropriate participant study hormone replacement therapy postmenopausal symptom prepubescent girl premenopausal adult woman pregnant woman postmenopausal woman use colorimetric assay determine protein concentration subject use standard measurement error hawthorne effect systematic error answer key follow page c ch 11.2 c ch 11.3 ch 11.1 b ch 11.5 d ch 11.3 b ch 11.3 c ch 11.2 ch 11.3 b ch 11.1 b ch 11.3 c ch 11.4 ch 11.4 b ch 11.5 d ch 11.5 c ch 11.3 reasoning design execution research chapter 11.1 scientific method finer method 11.2 basic

science research 11.3 human subject research respect person 11.5 research real world population vs. sample support intervention

modern world standard place search answer question encyclopedia academic journal online database publication peruse current research topic figure ask answer question is true scientist professional case search different direction is simple finde additional resource confirm answer question research oen complicated find conflicte answer perform critical analysis determine data set conclusion obtain legitimate unbiased way time find answer experiment observation data analysis previous chapter chapter contain content fall directly aamc content category say aamc confirm 10 science question mcat touch material chapter question require information chapter supportive science content make point point important chapter entire mcat review series order generate consistent body knowledge way scientist generate search information orderly uniform chapter discuss premise basic science biomedical social science research examination include necessary criterion causality different type error ethical implication human subject research ese research method core skill mcat test fact constitute scientific inquiry reasoning skills exam addition importance rest medical career physician constantly seek answer research determine prognosis assess appropriateness treatment modality give patient answer patient question researcher basic science clinical translational setting regardless path evaluate research critical progress field medicine key component life physician 11.1 scientific method chapter 11.1 able determine relative value research question apply finer method identify stage scientific method evaluate evaluate quality testability hypothesis e basic paradigm scientific inquiry scientific method e scientific method set step define appropriate order event structure carry experiment scientific method establish protocol transition question new body knowledge e step scientific method generate testable question is usually occur aer observe anomalous scientific inquiry daily life gather datum resource ink introduction phase journal database search compile information

step scientist careful look information consistent expectation form hypothesis hypothesis propose explanation propose answer testable question oen form statement test subsequent step collect new datum is step result experimentation involve manipulate control variable interest observation oen involve change subject environment analyze datum look trend perform mathematical manipulation solidify connection variable interpret datum exist hypothesis consider data analysis consistent original hypothesis data inconsistent consider alternative hypothesis publish publication provide opportunity peer review summary prior step include verify result experiment repeat verify result easy focus research agree expectation opinion ignore research go example confirmation bias work specific type bias discuss chapter 4 mcat behavioral sciences review later chapter mcat test experimental logical error research pay particular attention scientific method order recognize area error formulate testable question oen present student challenge tend overreach create encompass broad question order form good testable question restrict relatively narrow area e true hypothesis wonder hot object cause injury is testable question fact question begin broad testable single experiment case well testable question epithelial cell respond heat vivo question likely broad single experiment testable form relate hypothesis possible hypothesis heat apply vivo epithelial cell cell lyse pay attention format hypothesis format ensure testable examine component scientific method pertain basic science research biochemical biomedical research social science research relevant section finer method e finer method evaluate research question method determine answer question add body scientific knowledge practical way reasonable time period e finer method ask five question determination necessary research study go feasible question response chemosynthetic bacteria particular antibiotic require access chemosynthetic bacteria oen associate harsh difficult environment access scientist obtain necessary supply research feasible financial time constraint inability gather subject feasibility scientist find question interesting is somewhat subjective little interest outcome particular research question research little utility

particular question novel ask question answer satisfaction peer review journal confirmatory stage scientific method bar anomaly ask question likely gain new knowledge study obey ethical principle capable carry research study mean ethically morally acceptable ethical moral reason perform study dissuade researcher carry study inability secure funding question relevant outside scientific community e people research impact everyday life important usually ere exception course people agree cure rare fatal illness important improve odor popular perfume large group impact mcat concept check 11.1

assess understanding material question 1 rank following research question 1 good 3 bad finer method explain rationale long earth complete revolution sun medical error relate sleep deprivation medical resident average lifespan bacteria martian rock 2 error bias publication result likely affect stage scientific method 3 true false people hepatitis c acquire iv drug use example format hypothesis 11.2 basic science research chapter 11.2 able identify common type source error recognize independent dependent variable typically display explain importance different type control include positive negative distinguish accuracy precision basic science research kind conduct laboratory people generally easy design experimenter control oen causal relationship examine hypothesis generally state condition outcome order generalization experiment sure outcome interest occur intervention use control demonstrate causality relatively simple basic science research research area basic science research condition apply multiple trial experiment near identical possible way control standard act method verify result consider follow experiment scientist unknown concentration basic ammonia solution wish determine concentration experimentally take standardized solution hydrochloric acid comparison potassium hydrogen phthalate khp standard titrate basic solution presence calibrate ph meter hydrochloric acid standardization determine ammonia concentration result titration concentration acid determine ammonia concentration verifie standard confident calculate ammonia concentration accurate use control allow investigator

check contamination reagent control separate experimental condition altogether example test reaction tissue culture antibiotic separate culture generally grow administer equal quantity compound know inert like water saline e control correct impact simple addition volume experiment experiment positive negative control point comparison group control create curve know value positive control ensure change dependent variable expect development new assay detection hiv example administer test group blood sample know contain hiv constitute positive control negative control contrast ensure change dependent variable change expect assay administer test group sample know contain hiv virus constitute negative control drug trial negative control group oen assess placebo effect

control drug trial negative control group oen assess placebo effect observed report change individual give sugar pill sham intervention example clinical trial devise quantify effectiveness retinal scan system detection alzheimer disease trial include positive control group negative control group experimental group experimental group large sample 70 year old show symptom alzheimer disease assume retinal scan system effective detect alzheimer disease rank group decrease order percentage expect disease detection solution member positive control group consist patient previously diagnose alzheimer disease member negative control group consist patient previously test negative alzheimer disease positive control group negative control group establish upper low bound percent detection respectively experimental group likely fall extreme predict order positive experimental negative e big advantage able manipulate relevant experimental condition basic science researcher oen establish causality causality relationship oen hypothesis test basic science research manipulate independent variable measure observe dependent variable theoretical know mechanism link independent dependent variable causal relationship investigate change independent variable precede change dependent variable change dependent variable occur absence experimental intervention relationship say causal example test conduct determine water consumption impact systolic blood pressure mouse water consumption systolic blood

pressure mouse track week average daily water consumption average systolic blood pressure mouse list follow table average daily water average systolic blood researcher plot pressure consumption obtain follow graph identify independent dependent variable determine causal relationship exist solution independent variable average daily water consumption dependent variable average systolic blood pressure mmhg data give determine causal relationship exist information need determine difference systolic blood pressure occur difference water consumption possible mouse give systolic blood pressure value consume equal amount water independent variable experimenter manipulate dependent outcome variable observe graph independent variable belong x axis dependent variable belong y-

basic science research experimental bias usually minimal e likely way experimenter personal opinion incorporate generation faulty hypothesis incomplete early datum resource collection manipulation result eliminate trial appropriate background fail publish work contradict experimenter hypothesis e low level bias introduce experimenter eliminate error basic science research measurement especially important laboratory science instrument faulty reading instrument error affect accuracy precision accuracy call validity ability instrument measure true value example accurate scale register 170 pound person weight 170 pound precision call reliability ability instrument read consistently narrow range e person stand scale accurate imprecise reading 150 190 pound e person stand scale inaccurate precise reading 129 131 pound relatively narrow range accuracy precision represent figure 11.1 bias systematic error datum inaccurate tool introduce bias imprecise tool introduce error random chance introduce error experiment random error difficult avoid usually overcome large sample size figure 11.1 accuracy validity precision reliability measurement mcat concept check 11.2 assess understanding material question 1 experiment improperly tar zeroed mass balance suffer type error 2 label axis provide representative datum following situation experimenter add sodium hydroxide experimental solution record ph. find relationship sigmoidal ph rise 3 purpose control experiment characteristic experimental research reduce

absence control 11.3 human subjects research chapter 11.3 able apply hill criterion experiment determine likelihood causal distinguish observational experimental research

compare contrast bias confound case biomedical clinical research away petri dish cell experimental animal model aspect live condition control research human subject ethical reason discuss later level experimental control invariably low basic science research relationship establish research weak human subject research experimental observational study biomedical research possible perform experiment independent variable manipulate outcome observe experiment attempt elicit causal relationship subject control condition data analysis phase complicated laboratory study clinical social science research oen possible conduct experiment manipulate environment circumstance subject randomization method control difference subject group biomedical research randomization use algorithm determine placement subject control group receive treatment sham treatment treatment group proper randomization algorithm equivalent coin toss die roll individual assign group intervention perform result measure ideally group perfectly match condition age gender long appropriate randomization algorithm collect datum analyze measure biomedical research subjective perception subject investigator bias know group subject remove bias subject and/or investigator blind mean information group subject single blind experiment patient assessor person make measurement patient perform subjective evaluation blind double blind experiment investigator subject assessor know subject group blind placebo effect greatly reduce control group present treatment group blinding useful drug trial sham treatment acupuncture blind subject randomized controlled trial focus use acupuncture biomedical research data analysis account variable outside independent dependent variable consider oen include gender age lifestyle variable smoking status body mass index bmi factor affect measure outcome factor infer initial literature review unexpected confound variable exist soware program use binary yes vs. well vs. bad continuous weight lose percent improvement cardiac output categorical variable state residence socioeconomic status create regression

model regression analysis

demonstrate linear parabolic exponential logarithmic relationship discuss chapter 12 mcat physics math review research method generate numerical datum quantitative generate non numerical datum qualitative mix method research utilize wish study certain causal association experiment perform ethical practical reason case draw available datum analyze observational study medicine fit category cohort study cross sectional study case control study ese study oen look connection exposure outcome observational study demonstrate causality tendency causality demonstrate hill criterion examine later ethnographic study observational study utilize sociologist study attempt understand culture look complete social environment cohort study subject sort group base difference risk factor exposure assess interval determine subject group certain outcome example study 100 smoker 100 nonsmoker follow 20 year count number subject develop lung cancer group example cohort study longitudinal study observational research method follow subject time cohort study form longitudinal study cross sectional study attempt categorize patient different group single point time example study determine prevalence lung cancer smoker nonsmoker give point time example cross sectional study case control study start identify number subject particular outcome look backwards assess subject group exposure particular risk factor example study 100 patient lung cancer 100 patient lung cancer assess smoking history example hill criterion describe component observe relationship increase likelihood causality relationship first criterion necessary relationship causal sufficient e criterion satisfie relationship likeli relationship causal hill criterion provide absolute guideline relationship causal observational study relationship describe correlation temporality e exposure independent variable occur outcome dependent variable strength variability outcome variable explain variability study variable relationship likely causal dose response relationship study independent variable increase proportional increase response e consistent relationship likely causal consistency e relationship find similar multiple setting plausibility ere reasonable mechanism independent variable impact

dependent variable support exist literature consideration alternative explanation plausible explanation eliminate remain explanation likely experiment experiment perform causal relationship determine conclusively

remain explanation likely experiment experiment perform causal relationship determine conclusively specificity e change outcome variable produce associate change independent variable coherence e new datum hypothesis consistent current state scientific knowledge addition measurement error find basic science research aware bias error introduce human subject experimental observational model mention early bias systematic error generally impact precision datum skew datum direction bias result flaw data collection phase experimental observational study confounding error analysis e prevalent type bias selection bias subject study representative target population people volunteer study particular area significantly different people volunteer example volunteer drug trial require clinical visit healthy likely benefit study volunteer hospital selection bias apply case gender prevalent study difference age profile experiment group population measurement assessment selection bias occur intervention detection bias result educate professional knowledge inconsistent way prior study indicate correlation variable finde increase likelihood researcher search second example high blood pressure hypertension diabetes mellitus common obese population physician screen obese patient hypertension diabetes high rate healthy weight patient inflate true value secondary measurement describe chapter 12 mcat behavioral sciences review bias obese individual actually tend lead low rate screening preventative care e hawthorne effect observation bias posit behavior study participant alter simply recognize study oen lifestyle alteration improve health sample population example

patient study give weight loss drug begin exercise frequently healthy diet choice artificially increase perceive effect drug change datum systematic occur datum analysis example bias confound inaccurately call confound bias omit variable bias data analysis error e datum flawe

incorrect relationship characterize example consider statement have natural red hair lead decrease pain tolerance high opiate tolerance ere flaw statement statement imply causal relationship result certainly observational study second consider realistic red hair cause finding describe accord current research likely causality variable gene mutation potentially cause part statement measure degree red hair pigment degree pain intolerance strong statistical relationship causal relationship

ese party variable call confound variable confounder illustrate schematically figure 11.2 figure 11.2 confound mcat concept check 11.3 assess understanding material question 1 true false researcher fail demonstrate temporality provide evidence causal relationship satisfy rest hill criterion 2 observational research differ experimental research 3 difference bias confounding chapter 11.4 able distinguish autonomy medical ethic respect person research predict ethical issue respect person justice beneficence nonmaleficence study distinguish monetary compensation coercive influence research recall population receive special consideration coercion medicine core ethical tenet beneficence obligation act patient good interest nonmaleficence obligation avoid treatment intervention potential harm outweigh potential benefit respect patient autonomy responsibility respect patient decision choice healthcare justice responsibility treat similar patient similar care distribute healthcare resource fairly key ethical tenet medicine discuss chapter 11 mcat behavioral sciences review conjunction analysis major institution united states research principle replace slightly modified set e belmont report landmark document publish national commission protection human subjects biomedical behavioral research 1979 delineate necessary pillar research ethic respect person justice slightly inclusive version beneficence respect persons respect person include need honesty subject researcher generally prohibit deception respect person include process informed consent patient adequately counsel procedure risk benefit goal study knowledgeable decision participate study investigator exert coercive influence subject act autonomously is coercive influence result natural power imbalance teacher student result

extreme financial incentive inability receive treatment condition respect person include need respect subject wish continue cease participation study e subject withdraw consent previously grant time old study abide respect person example sentinel study severity untreated syphilis conduct participant knowledge consent early psychological sociological study involve significant deception disclose aer fact current practice hospital university institutional review board place systematic protection unethical study vulnerable person include child pregnant woman prisoner require special protection take general population confidentiality generally consider respect person research tuskegee syphilis experiment notorious

confidentiality generally consider respect person research tuskegee syphilis experiment notorious year study 1932–1972 united states public health service fraught extreme violation ethical principle respect person study poor african american man enrol study natural progression syphilis man give sham treatment bar access appropriate healthcare repeatedly deceive investigator include fact tell syphilis study significant bioethical history actually consider primary impetus writing justice research apply selection research topic execution research world individual question ethically way determine selection research question maintain justice random chance theory ankfully live world

morally relevant difference establish culture morally relevant difference define difference individual consider appropriate reason treat differently example age significant moral difference ethical deliberation equal transplant likely benefit young child elderly adult give child long life expectancy population size oen morally relevant study design study impact large population generally potential good impact small population contrast race ethnicity sexual orientation financial status generally consider morally relevant difference note religion valid moral criterion depend context example certain intervention prohibit give religion ground avoid treatment individual religion keeping patient autonomy justice important

selection subject execution research risk associate study fairly distribute unduly harm group is generally correspond seek diverse group study note benefit increase external validity discuss later chapter population likely benefit study require bear great proportion risk is apparent discrepancy individual equally share burden risk target population assume high proportion risk reflective fact likelihood benefit morally relevant difference individual erefore study perceive difference likelihood benefit individual individual assume equal risk particular population likely benefit population assume high proportion risk finally aware case drug trial necessary test intervention healthy individual unaffected illness drug design case burden risk fall secondary population is permissible long potential risk benefit subject address informed consent respect person maintain beneficence easy concept understand context research ethic intent cause net positive change study population general population good minimize potential harm is benefit intangible feeling personal satisfaction unrelated original purpose study small financial incentive future benefit participant member target population research conduct invasive painful traumatic way possible example measurement take finger stick indwelling catheter take finger stick far painful invasive addition study compare potential treatment option approach research knowledge treatment superior is term equipoise evident treatment option clearly superior study schedule finish trial stop provide inferior treatment net harm mcat concept check 11.4

assess understanding material question 1 difference autonomy medical ethic respect person 2 study design company wish market drug severe diabetic propose enroll mild diabetic principle research ethic company violate research concern propose study 3 difference coercive influence monetary compensation 4 population receive special consideration coercion 11.5 research real world chapter 11.5 able compare contrast internal external validity explain impact sample size generalizability recall quality study justify intervention point discuss research vacuum goal research application base order apply datum generate practical concern consider example account statistical strength weakness study especially relate

difference target population study sample consider way bias impact ability use study conclusion real world true justification intervention population vs. sample statistic research generally work sample entire population population complete group individual satisfie attribute interest population large example population human seven billion people contrast population large number qualifier example population american female 18 30 year old darier disease rare skin condition small case 100 people information calculate person population call work population generally feasible small group erefore generalization population base sample datum sample group take population include individual population ideally sample representative population method ensure random sample generally consider gold standard select certain small subgroup information sample call statistic comparatively large repeat sample statistic estimate population parameter single small sample take little information glean population analyze study look marker internal validity support causality discuss early external validity generalizability study low generalizability narrow condition sample selection reflect target population study high generalizability sample representative target population example psoriasis study low generalizability participant diagnose year study high generalizability participant distribution time diagnosis similar population psoriatic patient drug undergo continuous evaluation poor preclinical generalizability marketing change additional warning necessary drug take market unforeseen risk outcome apparent drug available entire population support interventions future doctor interested apply research patient need consider data

sufficient recommendation exclusion therapy treatment plan statistical vs. clinical effect research primary marker success able generate result statistically significant result random chance small difference treatment significant mathematically example decrease systolic blood pressure millimeter mercury statistically significant likely change patient outcome way assess clinical significance notable worthwhile change health status result intervention mcat concept check 11.5 assess understanding material question 1 difference internal validity external

validity 2 small sample provide insufficient information population 3 quality study provide justification intervention chapter focus scientific inquiry reasoning skills test mcat reason design execution research begin review scientific method value historical datum formulation research question compare methodology basic science research human subject research especially regard error finishe investigation examine ethical practical concern research design e question chapter design allow practice new skill test memorization content chapter specifically work data graphical analysis scientific inquiry reasoning skills essential test review content test knowledge critical thinking skill complete test like passage set online resource scientific method e scientific method series step generation new e initial step generate testable question gather datum resource form hypothesis focus generate hypothesis e intermediate step collect new datum analyze datum interpret datum exist hypothesis focus test hypothesis e final step publish verify result relate provide result testing hypothesis e finer method assess value research question basis feasible interesting novel ethical relevant basic science research basic science research use chemical cell culture animal subject research manipulate independent variable observe change dependent variable control correct influence intervention model control positive negative positive control ensure change dependent variable occur negative control ensure change dependent variable occur expect basic science research oen good type demonstrate causality experimenter high degree control error basic science research oen result error

accuracy validity quality approximate true value precision reliability quality consistent approximation human subjects research human subject research subject ethical constraint generally absent basic science research experiment perform causal conclusion hard determine circumstance hard control human subject research observational cohort study record exposure time assess rate certain outcome cross sectional study assess exposure outcome point time case control study assess outcome status assess exposure causality observational study support hill criterion include temporality strength dose response

relationship consistency plausibility consideration alternative explanation experiment specificity coherence error form bias confounding random error bias systematic result problem datum collection selection bias sample differ population common human subject research detection bias arise educate professional knowledge inconsistent way search outcome disproportionately e hawthorne effect result change behavior subject experimenter occur result knowledge subject observe confound error data analysis result common connection dependent independent variable medical ethic generally refer principle beneficence nonmaleficence respect patient autonomy justice research ethic establish belmont report respect person include autonomy informed consent justice dictate study question worth pursue subject use beneficence require good harm perform intervention equipoise lack knowledge arm research study well subject research

real world populations individual share set characteristic population datum call parameter sample subset population estimate population datum sample datum call statistic internal validity refer identification causality study independent dependent variable external validity refer ability study generalize population describe order support intervention display statistical statistical significance refer low likelihood experimental finding chance clinical significance refer usefulness importance experimental finding patient care patient outcome answer concept check medical error relate sleep deprivation medical resident is current topic investigation consensus scientific community reach medical resident available interview research relevant outcome average lifespan bacteria martian rock feasible acquire martian rock result novel long earth complete revolution sun is question ask answer satisfaction scientific community novel interesting term error publication current study adversely affect quality future experimentation

provide incomplete flawed research base accurate resource subsequent hypothesis likely flawe false statement true easily testable hypothesis require formatting hypothesis necessarily

imply testable relationship idea is experiment likely inaccuracy error imprecision error word scale reliably read mass weight mass weight read correct is lead bias control experiment help establish causality demonstrate outcome occur absence intervention control manipulation different system similar possible know standard judge experimental manipulation control far difficult establish causality false temporality necessary criterion hill criterion temporality satisfie relationship say causal e addition criterion increase probability causal relationship assume temporality invalidate observational research involve manipulation subject environment generally conclusive subjective experimental research involve manipulation subject bias systematic unidirectional error occur selection subject measurement collection datum confound error occur data analysis association erroneously draw variable share connection autonomy simply right individual decision behalf decision respect respect person require honesty confidentiality informed consent freedom coercion e company violate principle justice choose participant target population e company introduce e line coercive influence compensatory influence oen debate general compensatory influence impact decision participate coercive influence subject lose autonomy decision participate child pregnant woman prisoner consider especially risk coercion grant special protection internal validity tendency experiment produce result repeat provide support causality external validity ability information generate research apply large group external validity call generalizability small sample subject random variation large sample person select outlier large sample select outlier effect result study statistical significance clinical significance provide justification intervention study statistical significance result random chance clinical significance impact patient science mastery assessment e purpose control condition experiment close possible establish causality case milliliter volume addition impact growth e. coli control administer equal volume theoretically inert compound plate e. coli experiment establish clear causal link observational study b d example observational datum e experimenter

complete initial phase research ere data acquisition refinement indication question require experiment answer experimenter doubtful validity report value experiment appropriate information indicate base question stem clear experimenter clear goal eliminate b human subject research task divide facilitate blinding generally unnecessary basic science research eliminate c long calorimeter calibrate prior use matter calibration occur relative synthesis compound eliminate d parameter population measure calculate single member measure identify measure record datum population large 160 million essentially impossible common biometric measure misuse generally cause significant psychological harm unethical eliminate know mean weight major ramification include public health measure medical recommendation shiing body image eliminate c number study weight perform parameter describe entire population eliminate d exposure outcome measure time conclusion temporality

e cancer patient begin smoke aer diagnosis type study examine possibility randomization base idea result vary result random chance long assignment proper e appropriate response fair algorithm assign group unexpected way proceed research participant assign researcher continue randomize sample achieve desire outcome likely introduce error leave unequal group eliminate d unnecessary drop entire cohort assume randomization algorithm fair eliminate relationship assess relationship smoking low birth weight vlbw smoking independent variable vlbw dependent variable second relationship vlbw compare iq vlbw independent variable iq dependent variable physician see control group experimental group potential physician realize group receive treatment especially subject mention expect effect study patient tell group assign medication group tell effect patient talk experience patient unblinding tell communication scientific method aer formulate testable question search journal database review available information is student likely spend sufficient time review exist study review committee able cite study test affirme hypothesis mean hypothesis scientifically interesting is observation consistent b hand question stem indicate hypothesis

formulate preliminary datum eliminate d ere state criticism research method eliminate c require subject volunteer study seek study introduce selection bias e people end volunteer listen radio general population interested topic willing volunteer study suffer selection bias common impediment generalizability e behavior describe question stem inform patient provide time decision consistent informed consent

autonomy respect person appear question ask determine method accurate reliable ethic question method exception venipuncture c measure oxygen saturation accord principle beneficence minimize potential harm associate investigation noninvasive pulse oximeter greatly favor measurement statistical significance clinical significance ere medication increase length pregnancy preterm labor hour impact patient outcome inform treatment decision sample take target population population interest give target population postmenopausal woman group sample prepubescent girl pregnant woman population special precaution coercion appropriate study eliminate c premenopausal woman unlikely require hormone replacement therapy condition specifically necessitate eliminate b e hawthorne effect change behavior result knowledge observe present human subject basic science research generally suffer hawthorne effect consult online resource additional behavioral science chapter 4 cognition consciousness language behavioral sciences chapter 8 social process attitude behavior behavioral science chapter 11 social structure demographic behavioral science chapter 12 physics math chapter 12 data based statistical reasoning data based statistical pre med know feeling content know mcat know first important high yield badge book help identify important topic science mastery assessment tool mcat prep arsenal is 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 get correct ensure thinking match explanation review concept summary end chapter inclusion outlier statistical analysis greatly affect follow equally affect sample hospital patient mean

analysis greatly affect follow equally affect sample hospital patient mean age find significantly low median following well describe distribution skew right skew left median following data set 7 17 53 23 4 2 4

santa cruz island available food source lead disruptive selection beak size finch large small beak size favor intermediate sized beak result finch intermediate sized beak sample finch analyze distribution well describe distribution beak size skew left skew right 95 confidence interval fall distance mean approximately 20 americans eat fast food week new study conduct national heart association show 48 americans form cardiovascular disease following hypothetical finding cardiovascular disease independent weekly fast food consumption individual consume fast food cardiovascular disease 48 cardiovascular disease half eat fast food 9.6 americans cardiovascular disease consume fast food weekly basis individual consume fast food weekly basis develop cardiovascular following outlier likely easy correct typographical error data transfer measurement error instrument calibration heavily skew distribution correctly measure anomalous result assume blonde hair blue eye independent recessive trait parent carrier gene parent homozygous recessive gene probability offspring blonde hair blue eye base county level map follow statement

well represent datum elderly individual note dark shade green high percentage elderly person county elderly people united states live center country people live center united states elderly

center united states tend large proportion elderly people elderly people move center country confidence level increase confidence interval wide thin shift high value shift low value follow measure distribution useful determine probability average distance mean interquartile range standard deviation outlier follow box plot yes 1575 outlier yes 2600 outlier yes 1575 2600 outlier outlier gas station attendant notice assault near store day sell lot ice cream hypothesize ingestion excess glucose lead increase violent behavior begin tally ice cream sell daily basis check daily crime statistic generate graph analyze datum conclude hypothesis true flaw number assault increase pint ice cream sell increase study appropriately control yes study miss positive control yes prove correlation causal link follow histogram contain bimodal distribution analyze separate distribution contain mode ii ii iii ii iii cardiologist investigate new drug therapy treatment hypertension measure patient baseline blood pressure treat patient drug week time measure blood pressure base datum doctor advocate make drug standard treatment hypertension yes statistically significant decrease blood pressure yes drug effective decrease blood pressure statistically significant result clinically significant data statistically significant answer key follow page c ch 12.1 b ch 12.2 b ch 12.1 b ch 12.2 b ch 12.5 c ch 12.4 ch 12.3 ch 12.4 c ch 12.6 ch 12.5 d ch 12.3 c ch 12.3 d ch 12.7 d ch 12.6 c ch 12.7 data base statistical chapter 12.1 measure central tendency 12.3 measure distribution independence mutual exclusivity exhaustiveness 12.5 statistical testing 12.6 chart graph table type chart graph axis 12.7 apply data correlation causation context scientific knowledge

academic paper extremely predictable ey generally begin abstract reflect major point rest paper e author provide expand introduction material method datum discussion e key high quality research paper make discussion unnecessary scientist give prior section lead conclusion give author e testmaker keenly aware fact test day present research form experiment base passage task infer important conclusion support finding study chapter 12 contain chapter profile directly cover aamc content category say like chapter 11 book aamc confirm 10 science question mcat require material chapter question require information

chapter supportive science content 10 chapter 11 10 chapter 12 30 question exam test is chapter cover scientific inquiry reasoning skills test mcat statistical analysis raw datum interpretation visual representation datum application

datum answer research question begin examine basic statistical principle like distribution type measure central tendency measure distribution discuss probability semantic branch mathematic conclude discussion probability statistic exploration statistical significance basic hypothesis testing confidence interval en interpretation chart graph finally link information skill gain chapter assess future use validity study 12.1 measure central tendency chapter 12.1 able calculate mean median mode datum set predict good measure central tendency give data set measure central tendency describe middle sample define middle vary mathematical average number datum set result data set divide set half sample value result half sample value datum important difference provide useful information shape e mean average set datum accurately arithmetic mean calculate add individual value datum set divide result number value xi xn value data point set n number datum point set discuss chapter mean parameter statistic true measure central tendency depend discuss population sample mean value good indicator central tendency value tend fairly close have outlier extremely large extremely small value compare data value shi mean end range example average income united states $ 70,000 half population make $ 50,000 case small number extremely high-income individual distribution shi mean high end example following datum

collect age attendee ray birthday 23 22 25 22 22 24 36 20 mean age attendee appropriate measure datum solution mean sum data point divide number data point mean relatively near value collect datum set appropriate mind presence outlier fact mean great value collect indicate mean shift high end range presence single outlier invalidate mean interpretation context necessary e median value set datum midpoint half datum point great value half small data set odd number value median actually data point data set number value median

mean central data point calculate median data set first list increase fashion e position median calculate follow n number datum value datum set number data point equation solve noninteger number example datum set 18 point e

median case arithmetic mean ninth tenth item datum set sort ascend order e median tend susceptible outlier useful data set large range distance large small data point discuss later chapter multiple mode example datum question find median age attendee compare value mean median well bad indicator central tendency sample solution step find median order datum small large original datum 23 22 25 22 22 24 36 20 reorder 20 22 22 22 23 24 25 36 n number datum point 8 median average fourth fifth data point median median well indicator central tendency datum mean 24.25 median unaffected outlier lie close value datum set improve representativeness mean exclude 36 datum set case mean 22.6 median 22 mean median far imply presence outlier skewed distribution discuss later chapter mean median close imply symmetrical median divide datum set group 50 value high median 50 value low e mode simply number appear oen set datum ere multiple mode datum set number appear equally mode datum set examine distribution peak represent mode e mode typically measure central tendency set datum number mode distance oen informative data set mode small number value useful analyze portion separately look variable responsible divide distribution part mcat concept check 12.1 assess understanding material question 1 type datum set well analyze mean measure central 2 calculate mean median mode following datum set 25 23 23 6 9 21 4 4 2

chapter 12.2 able assess datum normal distribution analyze measure central tendency distribution distinguish normal skewed bimodal distribution describe relationship mean median mode different type oen single statistic data set insufficient detailed relevant analysis case useful look overall shape distribution specific shape impact interpretation datum e shape distribution impact measure central tendency discuss measure distribution examine

later statistic oen work normal distribution show figure 12.1 know case use special technique datum approximate normal distribution is important normal distribution solve sense transform normal distribution standard distribution mean zero standard deviation use newly generate curve information probability percentage population e normal distribution basis bell curve see scenario include exam score mcat figure 12.1 normal distribution mean median mode center distribution approximately 68 distribution standard deviation mean 95 99 normal distribution counterpart standard distribution basis statistical testing mcat normal distribution measure central tendency distribution symmetrical skewed distribution contain tail datum set mcat skewed distribution oen test simply identify type is oen area confusion student visual shi datum appear opposite direction skew negatively skewed distribution tail le negative positively skewed distribution tail right positive mean susceptible outlier median mean negatively skewed distribution low median mean positively skew distribution high median ese distribution measure central tendency show figure 12.2 skewed distribution negatively skewed distribution mean low median b positively skew distribution mean high median direction skew sample determine tail bulk distribution distribution peak distribution contain peak valley call bimodal show figure 12.3 important note

bimodal distribution strictly speak mode peak slightly high peak different size distribution bimodal sufficient separation peak sufficiently small datum valley region bimodal distribution oen analyze separate distribution hand bimodal distribution analyze separate distribution measure central tendency measure distribution apply figure 12.3 bimodal distribution mcat concept check 12.2 assess understanding material question 1 mean median mode compare right skewed distribution 2 datum follow normal distribution analyze measure central tendency measure distribution 3 difference normal skewed distribution bimodal 12.3 measure distribution chapter 12.3 able identify outlier interquartile range standard deviation describe relationship range standard deviation justify certain measure distribution appropriate give distribution characterize center point spread datum is information describe number way

range absolute measure spread datum set interquartile range standard deviation provide information distance data fall measure central tendency use quantity determine data point truly outlier e range datum set difference large small range = xmax  xmin range consider number item datum set consider placement measure central tendency range heavily affected presence datum outlier case possible calculate standard deviation normal distribution entire datum set provide possible approximate standard deviation fourth range interquartile range relate median first quartile quartile include median q2 divide datum place ascend order group comprise fourth entire set ere debate appropriate way calculate quartile purpose mcat use common simple calculate position quartile q1 set datum sort ascend order multiply n number quartile mean value position high position decimal round number quartile position calculate position quartile q3 multiply value n number mean position decimal round number quartile position e interquartile range calculate subtract value first quartile value quartile iqr = q3 q1 e interquartile range

determine outlier value fall 1.5 interquartile range first quartile quartile consider outlier definition outlier value low 1.5 × iqr q1 value high 1.5 × iqr q3 example interquartile range determine 36 year old ray party outlier age provide numerical order convenience 20 22 22 22 23 24 25 36 solution order determine point outlier determine interquartile range determine quartile data set contain value multiply 8 give 2 quartile mean second value order datum set multiply 8 give 6 quartile mean sixth seventh value order datum set interquartile range difference iqr = q3  q1 = 24.5  22 = 2.5 outlier data value 1.5 interquartile range q1 q3 value 24.5 + 1.5 × 2.5 = 24.5 + 3.75 = 28.25 22  1.5 × 2.5 = 22  3.75 = 18.25 outlier 36 28.25 outlier datum standard deviation informative measure distribution mathematically laborious calculate relative mean datum standard deviation calculate take difference datum point mean square value divide sum square value number point datum set minus take square root result express mathematically σ standard deviation xi xn value datum point set mean n number datum point set e use n  1 instead n mathematically practically example calculate standard

deviation following datum set 1 2 3 9 10 solution determine value mean find difference datum point mean square value tedious project well solve use table see determine standard deviation mind calculate mean use n denominator calculate standard deviation use n 1 e standard deviation determine data point outlier

data point fall standard deviation mean consider outlier e standard deviation relate normal distribution normal distribution approximately 68 datum point fall standard deviation mean 95 fall standard deviation 99 fall standard deviation show figure 12.1 early integration specialized soware determine percentage fall interval definition outlier value lie standard deviation discuss method determine data point outlier useful know approach datum outlier outlier typically result cause true statistical anomaly e.g. person seven foot tall measurement error example read centimeter tape measure instead inch distribution approximate normal distribution e.g. skewed distribution long tail outlier find trigger investigation determine cause apply measurement error data point exclude analysis situation clear existence outlier key determine mean appropriate measure central tendency indicate measurement error outlier result true measurement representative population weight reflect rarity include normally exclude analysis depend purpose study preselecte protocol e decision study begin outlier find outlier indication data set approximate normal distribution repeat sample large sample generally demonstrate true mcat concept check 12.3 assess understanding material question 1 compare method determine outlier interquartile range interquartile range standard deviation 2 range standard deviation generally relate mathematically relationship accurate data set early section 1 2 3 9 10 σ 3 average difference mean inappropriate measure chapter 12.4 able define independence mutual exclusivity exhaustiveness calculate probability event co occurrence multiple independent probability usually test mcat context science question test particular genetic question involve hardy weinberg equilibrium punnett square common application probability probability underlie statistical testing investigate section independence mutual exclusivity probability problem first determine relationship event outcome event

interested independence dependence conceptually independent event effect roll die 3 pick roll probability get 3 second roll different first roll independent event occur order impact independent event impact probability expect dependent event impact order change probability consider container five red ball five blue ball e probability choose red ball

red ball five blue ball e probability choose red ball red ball choose probability draw red ball blue ball choose probability draw red ball way probability second event get red ball second draw dependent result first event concern event mutually exclusive is term apply outcome event mutually exclusive outcome occur time flip head tail throw year old e probability mutually exclusive outcome occur 0

finally consider set outcome exhaustive group outcome say exhaustive possible outcome example flippe head tail say exhaustive outcome coin flip possibility independent event probability event occur time product probability p(a  b = p(a b = p(a × p(b example probability get head coin flip twice row probability get head first time times probability get head second time 0.5 × 0.5 = 0.25 e probability independent event co occur show diagrammatically figure 12.4 venn diagram p(a p(b overlap form region p(a b figure 12.4 probability independent event co occur p(a b = p(a × p(b e probability event occur equal sum initial probability minus probability occur p(a  b = p(a b = p(a + p(b  p(a b probability word multiply probability add probability subtract probability happen example certain population 10 population diabete 30 obese 7 population diabete obesity event independent choose individual random population probability patient have condition solution number give event independent independent event p(a b = p(a × p(b = p(having diabetes × p(bee obese = 0.1 × 0.3 = 0.03 population probability have diabete obese 0.07 determine probability individual have condition use equation p(a b = p(a + p(b  p(a b = 0.1 + 0.3  0.07 = 0.33 33 mcat concept check 12.4 assess understanding material question 1 assume likelihood have male child equal likelihood have female child series live birth probability have boy 2 define following term 12.5 statistical

testing chapter 12.5 able distinguish hypothesis test confidence interval recall p value calculate hypothesis test predict outcome test give p- α- value

explain importance power statistical testing hypothesis testing confidence interval allow draw conclusion population base sample datum interpret context probability deem acceptable risk error hypothesis testing begin idea different population null hypothesis hypothesis equivalence word null hypothesis say population equal single population describe parameter equal give value e alternative hypothesis nondirectional population equal directional example mean population great mean e common hypothesis test z- t test rely standard distribution closely relate t distribution datum collect test statistic calculate compare table determine likelihood statistic obtain random chance assumption null hypothesis true is p value compare p value significance level α 0.05 commonly p value great α fail reject null hypothesis mean statistically significant difference population p value α reject null hypothesis state statistically significant difference group null hypothesis reject state result statistically significant e value α level risk willing accept incorrectly reject null hypothesis is call type error word type error likelihood report difference population actually exist type ii error occur incorrectly fail reject null hypothesis word type ii error likelihood report difference population actually exist e probability type ii error symbolize β e probability correctly reject false null hypothesis report difference population actually exist refer power equal 1 β finally probability correctly fail reject true null hypothesis report difference population exist refer confidence ese condition summarize table 12.1 table 12.1 result hypothesis testing truth population h0 true ha true difference type error α power 1 β truth population fail reject h0 type ii error β confidence interval essentially reverse hypothesis testing confidence interval determine range value sample mean standard deviation finde p value begin desire confidence level 95 standard use table find correspond z- t score multiply z- t score standard deviation add subtract number mean create range value example consider population wish know mean age draw sample population

example consider population wish know mean age draw sample population find mean sample 30 standard deviation 3 wish 95 confidence correspond z score provide test day 1.96 us range 30  3)(1.96 30 + 3 1.96 = 24.12 35.88 report 95 confident true mean age population sample draw 24.12 35.88 mcat concept check

12.5 assess understanding material question 1 hypothesis test confidence interval differ 2 p value great α give statistical test outcome 3 p value calculate hypothesis test 4 true false power probability correctly reject null hypothesis 12.6 chart graph table chapter 12.6 able recognize datum relationship transformation semilog log log plot recall pro con different type visual datum representation include pie chart bar graph box plot map graph table distinguish exponential parabolic curve career fille evidence base medicine important able recognize interpret datum multiple form consider mathematical statistic let look visual mcat anticipate passage science accompany visual aid way frequently chart graph data table type charts charts present information visual format frequently pie circle charts pie circle chart represent relative amount entity especially popular demographic ey label raw numerical value percent value e primary downside pie chart number represent category increase visual representation lose impact confusing example figure 12.5 population 50 state district columbia present pie chart large number entity make graph complex colorful pie chart 51 sliver state dc figure 12.5 pie chart

united states population state 2010 census pie chart difficult interpret category include question pie chart likely qualitative ask small large group percentage occupy group combine question unlikely require additional analysis pie chart dense information pie chart frequently present demographic information demographic statistical arm sociology discuss chapter 11 mcat behavioral sciences bar charts histograms bar chart histogram likely contain significantly information pie chart page space bar chart categorical datum sort data point base

predetermined category e bar sort increase decrease bar length e length bar generally proportional value represent possible break avoid chart potential distort scale end wary graph contain break enlarge difference bar figure 12.6 show representative bar graph cause cancer death united states 2010 bar graph type cancer bar entry male female figure 12.6 cause cancer death type 2010 source centers disease control prevention national vital statistics histogram present numerical datum discrete category histogram particularly useful determine mode datum set display distribution datum set box plot range median quartile outlier set datum label box plot call box whisker show plot show maximum minimum interquartile range median outlier figure 12.7 box plot measurement speed light e box box whisker plot bound q1 q3 q2 median line middle box e end whisker correspond maximum minimum value datum set alternatively outlier present individual point end whisker correspond large small value datum set 1.5 × iqr

median box whisker plot especially useful compare datum contain large datum small space multiple plot orient single axis addition form chart datum illustrate geographically map health condition population density political district ethnicity relatively easy comprehend geographic clustering datum e good map datum examine piece information simultaneously datum inhibit clarity map population density country world show figure 12.8 map country color different shade brown dark brown correspond high density figure 12.8 population density country 2006 graph axis familiar construct graph especially scatter plot line graph important know important feature potential stumbling block graph test day present graph attempt draw rough conclusion immediately spend time analyze detail graph ask question e first thing encounter graph test day look axis linear graph relationship variable ey generally involve direct measurement strictly speak straight line e shape curve type graph linear parabolic exponential logarithmic ese show figure 12.9 test day able recognize shape linear straight line parabolic u shaped exponential positive slope upward curvature logarithmic positive slope figure 12.9 shape common relationship linear graph linear b parabolic c exponential d

logarithmic e axis linear graph consistent sense unit occupy space distance 1 2 3 4 axis remain size bar graph wary scale break axis shape graph graph type linear able calculate slope line slope m change y direction divide change x direction point slope like wake morning slope rise vertical run horizontal bed rise move run example calculate slope line graph show line x intercept -1.66 y intercept 5 solution slope line equal difference value point y direction divide difference value point x- direction x- y intercept generally good choice value zero point semilog log log graphs semilog graph specialized representation logarithmic datum set ey easy interpret curved nature logarithmic datum linear change axis ratio semilog graph axis usually x axis maintain traditional unit spacing

semilog graph axis usually x axis maintain traditional unit spacing e axis assign spacing base ratio usually 10 100 1000 e multiple number long consistency ratio point axis figure 12.10 show example semilog plot y axis power 10 x axis 0 10 straight line figure 12.10 semilog plot axis graph determine type plot provide key information underlie relationship relevant variable case axis give different axis ratio create linear plot axis use constant ratio point point axis term log log graph note difference plot type linear semilog log log base labeling axis erefore crucial pay attention axis test day able interpret graph correctly example patient undergo positron emission tomography pet scan inject radioactive flouride-18 f-18 graph show percent f- 18 remain function time typical dose f-18 measure unit becquerel bq syringe f-18 initially contain 0.37 gbq f-18 approximately f-18 syringe hour line graph time x axis percent remain y axis y axis logarithmic scale line straight start 100 time zero 5 480 solution notice value y axis equally space multiple mean y axis logarithmic x axis linear graph semilog plot use graph determine percent remain determine remain start find hour know value x axis fourth distance 0 240 minute find corresponding point line note location y axis y axis label 1 10 100 axis divide equally value mark unequally space axis marker 10 100 represent 20 30 40 50 60 70 80 90 point hour correspond mark 100 70 find f-18 remain original multiply 0.70 correct answer approximately 0.26 gbq unlike graph brief moment glance title table approach test day

question table likely contain disjointed information chart graph oen contain categorical datum

experimental result table unusual data value zero outlier change trend approach especially briefly table contain significant organization example list result progressively structure likely relevant answer question example trend suddenly appear disappear oen require explanation additionally provide datum form table able convert rough graph linear equation e mcat test interpretation slope actually provide graph mcat concept check 12.6 assess understanding material question 1 type datum relationship likely require transformation semilog 2 fill follow table pro con type visual datum type visual aid 3 exponential parabolic curve differ shape 12.7 apply datum chapter 12.7 able distinguish correlation causation relate statistical result study impact finding scientific knowledge policy change finally reach discussion section academic paper datum

gather interpret apply original problem begin draw conclusion create new question base result cover discussion experimental method chapter 11 mcat physics math review terse review correlation causation discuss previously careful wording discuss variable relationship correlation refer connection direct relationship inverse relationship datum variable trend increase positive correlation variable trend opposite direction increase decrease negative correlation ese relationship quantifie correlation coefficient number 1 +1 represent strength relationship correlation coefficient +1 indicate strong positive relationship value 1 indicate strong negative relationship value zero indicate apparent relationship correlation necessarily imply causation avoid assumption insufficient evidence draw conclusion experiment perform rely hill criterion discuss chapter 11 mcat physics math review remember hill criterion uniformly necessary causation context scientific knowledge interpret datum important state apparent relationship datum begin draw connection concept science background knowledge minimum impact new datum exist hypothesis consider ideally new datum integrate future

investigation topic additionally develop plausible rationale result finally decision data impact real world determine evidence substantial impactful necessitate change understanding example textbook publisher want study effectiveness new advanced placement ap study aide 2006 2015 researcher recruit high school country participate randomly assign school group receive study aide group group b grade track ap statistics 10 year time period year statistically significant difference group high likelihood pass study aide average ap grades group error bar 95 ci solution order support claim study aide help student pass ap exam evidence statistically significant difference receive aide true score confidence interval 95 time receive aide passing true score passing datum 2010 2011 2014 fit description provide good support mcat concept check 12.7 assess understanding material question 1 true false statistical significance sufficient criterion enact policy change 2 true false variable causally relate correlate congratulation complete mcat physics math review challenge journey equip physics content knowledge scientific inquiry reasoning skills sirs need perform test

content knowledge scientific inquiry reasoning skills sirs need perform test day complete discussion mcat sirs cover transformation raw datum actionable information take mcat concept present opportunity use statistical method interpretation draw conclusion analysis figure adjunct passage discrete question briefly review connection real world research determine newfound datum apply ultimately role physician construct foundation content knowledge seek new research draw conclusion research improve patient life good luck continue prepare mcat future excellent physician review content test knowledge critical thinking skill complete test like passage set online resource measures central tendency measures central tendency provide single value representation middle group datum e arithmetic mean average measure central tendency equally weigh value affected outlier e median value lie middle data set fiy percent datum point median e mode data point appear oen

multiple zero mode datum set distribution characteristic feature exemplifie shape distribution classifie measure central tendency measure distribution e normal distribution symmetrical e mean median mode normal distribution e standard distribution normal distribution mean zero standard deviation calculation 68 data point occur standard deviation mean 95 99 skewed distribution difference mean median mode skew direction direction tail distribution bimodal distribution multiple peak necessarily multiple mode strictly speak useful perform datum analysis group separately measures distribution range difference large small value data set interquartile range difference value quartile first quartile interquartile range determine outlier standard deviation measurement variability mean standard deviation determine outlier outlier result true population variability measurement error non normal distribution procedure handle outlier formulate beginning study e probability independent event change base outcome event e probability dependent event change depend outcome event mutually exclusive outcome occur simultaneously set outcome exhaustive possible outcome hypothesis test use known distribution determine hypothesis difference null hypothesis reject finding statistically significant determine comparison p value select significance level α significance level 0.05 commonly confidence interval range value sample mean estimate population mean wide interval associate high confidence level 95 common chart graph table pie chart circle chart bar chart compare histogram box plot box whisker plot compare numerical datum map compare demographic indicator linear semilog log log plot distinguish axis slope calculate easily linear plot table contain related unrelated categorical datum correlation causation separate concept link hill datum interpret context current hypothesis exist scientific knowledge statistical practical significance distinct answer concept check e mean good measure central tendency datum set relatively normal distribution e mean perform poorly data set median e fih position 2 4 4 6 9 21 23 23 25 9

mode ere number appear twice 4 23 ese mode datum set e mean right positively skewed distribution right median right mode distribution mathematically procedurally transform

follow normal distribution virtue central limit theorem scope mcat regardless distribution normal analyze measure bimodal distribution peak normal skewed distribution outlier define data point 1.5 × iqr q1 q3

e define data point 3σ mean e cutoff value calculate method likely different selection method preference study design general use standard deviation method superior datum available range approximate time standard deviation datum set relationship fail e range 9 little twice standard deviation is datum set fall normal distribution e average distance mean zero is calculation standard deviation square distance mean square root end force value positive number cancel zero simplify question reword probability have girl have boy have girl mutually exclusive event possibility occur us probability have girl 0.5)10 probability have boy 1 0.5)10 independence condition event outcome event effect outcome mutual exclusivity condition outcome occur simultaneously set outcome exhaustive possible outcome hypothesis test validate invalidate claim population different population differ give parameter hypothesis test calculate p value compare choose significance level α conclude observe difference population population parameter significant confidence interval determine potential range value true mean population p value great α fail reject null hypothesis aer test statistic calculate computer program table consult determine p value statistic true power probability individual reject null hypothesis alternative hypothesis true population linear relationship analyze datum axis transformation semilog log log plot type visual easily construct useful categorical datum small number easily overwhelm multiple category difficult estimate value multiple organization strategy good large categorical data set axis oen misleading information dense useful highlight outlier mean value data set useful provide relevant integrate geographic demographic represent variable coherently provide information relationship useful estimation axis label logarithmic scale require careful interpretation categorical datum present comparison require estimation calculation disorganized unrelated datum present exponential parabolic curve steep component exponential curve horizontal

asymptote flat parabolic curve symmetrical steep component side center point false discuss chapter practical clinical statistical significance conclusion useful true variable correlate necessarily causally relate variable causally relate correlate way direct relationship inverse relationship

relate variable causally relate correlate way direct relationship inverse relationship science mastery assessment e mean compute take sum datum point divide total number data point large data point include sum significantly large inflate mean is observation justifies c hand median middle number mode common value inclusion outlier minimal effect measure e mean le median imply tail distribution le distribution skew le.

expect low plateau le distribution account shi mean e median central data point order list data set seven number central point fourth position reorder list read 2 4 4 7 17 23 53 us median 7 4 mode c 15.7 mean base population description question stem expect large number finche small beak small number finche intermediate beak large number finche large beak is pattern consistent bimodal distribution choice b approximately 95 value fall standard deviation ±2σ mean normal distribution confidence interval construct value approximately 68 value standard deviation 99 standard deviation eliminate answer choice event independent probability occur simultaneously equal product probability occur separately us weekly fast food consumption prevalence cardiovascular disease independent probability occur 20%)(48 = 9.6 support c d tempting answer choice lack cardiovascular disease fast food consumer imply independence factor imply fast food consumption actually decrease eliminate likelihood cardiovascular disease error datum transfer original source datum consult allow inclusion correct datum point error instrument calibration introduce bias affect standard deviation sample certainly affect mean e instrument recalibrate relevant data point measure correct type outlier eliminate choice b skewed distribution long tail case challenging determine particular value outlier simply value long tail distribution repeated sampling large sample size

usually require determine sample truly skew eliminate choice c anomalous result challenging interpret correct result unclear case result inflate weigh heavily reflect significance case interpret regular value case appropriate drop anomalous result is decision ideally study begin certainly require consideration simply check result original data set eliminate choice d make choice correct parent homozygous trait concerned parent is parent 50 chance transmit independent trait 25 chance transmit is probability pregnancy independent event probability child exhibit datum percentage draw conclusion percentage us information number people incorrect is map show high percentage resident middle country elderly comparison part country

ere course exception rule include florida pacific coast part appalachia category appear clustering county high percentage elderly individual middle country population elderly place map give actual value percentage ere plurality insufficient information posit majority eliminate b e map give indication migration pattern eliminate d increase confidence level increase size confidence interval likely true value mean range erefore confidence interval wide standard deviation common measure distribution closely link mean distribution calculate p value probability specifically p value probability observe difference population outlier determine respect interquartile range q3 q1 e interquartile range box plot 2280 2075 205 value 1.5 time iqr q1 q3 consider outlier 2075 1.5 time 205 approximately 2075 300 1775 actual = 1767.5 erefore 1575 outlier 2280 + 1.5 time 205 approximately 2580 actual = 2587.5 erefore 2600 outlier e attendant hypothesize glucose ice cream cause increase violent behavior design observational study increase assault increase ice cream sale relationship correlation correlation prove causation us conclusion glucose cause significant flaw make d histogram contain peak valley bimodal distribution e color separation distinct population provide evidence qualitative difference datum peak datum analyze accord gender ere mode 5'6 is measurement large number corresponding data point consider finding study merit policy change statistical clinical significance evaluate compare difference systolic diastolic

blood pressure aer treatment effect drug minimal result statistically significant unlikely small reduction lead significant clinical improvement us doctor advocate make c correct answer consult online resource additional equation remember 12.1 arithmetic mean 12.2 median position 12.3 range range = xmax  xmin 12.4 interquartile range iqr = q3  q1 12.5 standard deviation 12.6 probability independent event co occur p(a  b = p(a b = p(a × p(b 12.7 probability event occur p(a  b = p(a b = p(a + p(b  p(a b

behavioral sciences chapter 11 social structure demographic biology chapter 12 genetics evolution general chemistry chapter 5 physics math chapter 1 kinematic dynamic physics math chapter 10 physics math chapter 11 reasoning design execution research alternate current ac visual alteration result imperfect optical device chromatic spherical e actual pressure give depth fluid include ambient pressure surface pressure associate increase depth fluid call hydrostatic pressure e theoretically cold temperature atomic movement halt 0 k e rate change velocity object relate force mass measure e tendency datum represent true answer know e intermolecular force molecule liquid molecule substance thermodynamic process occur heat exchange e resistance oppose motion fall object method determine value variable equation relate helium nucleus emit alpha decay circuit pattern current flow change direction periodically device measure current circuit e maximum displacement equilibrium point wave oscillatory motion point maximum displacement stand wave state body immerse volume fluid experience buoyant force equal weight displace fluid process electron jump low high energy orbit absorb photon light process electron fall high low energy level emit photon light e number proton nucleus give element e loss energy propagate wave result nonconservative force know damping e ethical principle state individual right decision healthcare e difference frequency interact e ethical principle state practitioner act patient good interest research ethic state research project create net positive change study population general population electron emit β decay positron emit β+ decay equation relate static dynamic pressure fluid pressure exert wall tube speed result flaw data collection phase

experimental observational study typically skew datum study distribution datum peak valley center gravity center mass ideal absorber wavelength light withhold information research subject group assignment subject evaluator remove potential bias result e temperature vapor pressure liquid equal ambient incident pressure usually atmospheric pressure temperature liquid boil region laminar flow turbulent system occur edge

temperature liquid boil region laminar flow turbulent system occur edge vessel visual representation range datum quartile interquartile range contain outlier separate e upward force result immersion fluid describe archimedes principle measure ability capacitor store charge magnitude charge plate divide potential difference plate measure farad f conduct surface store charge equal magnitude opposite sign connect voltage source observational study start identify subject give outcome look correlation specific exposure group relationship variable partially depend order occur point entire force gravity act object think act point e point act entire mass object concentrate point e acceleration object travel circle direct center circle object uniform circular motion e force responsible centripetal acceleration usually result gravity tension normal force entity influence environment electrostatic force influence electrostatic force measure coulomb c dispersive effect spherical lens form motion occur force cause object circular pathway e intermolecular force experience molecule observational study subject sort group base different exposure assess interval determine outcome surface similar curvature interior sphere e phase transition gas liquid transfer charge degree object conduct electricity conductance metallic electrolytic thermodynamic transfer heat physical motion fluid material route current resistor material allow free movement electrical charge low zero resistance statistical indicator likelihood acquire result occur random chance equal 1 α error result causal variable associate variable study account falsely indicate variable associate force cause energy dissipate system gravity electrostatic force spring approximately conservative pathway independent associate potential energy function set experimental condition mean ensure result experimental group result intervention heat transfer result bulk

flow fluid object e tendency parallel light ray concave mirror convex lense converge parallel light focal point surface similar curvature exterior sphere e degree variable relationship numerical value 1 +1 indicate strong relationship variable relate electrostatic force charge particle charge distance e angle incident light undergo total internal reflection occur light move material high

light undergo total internal reflection occur light move material high refractive index low refractive index e speed flow fluid turbulent observational study patient categorize different group point time e orderly movement charge oen circuit measure convention direction positive charge flow circuit measure ampères e proportionality constant rate radioactive nucleus decay number radioactive nucleus remain measure mass unit volume useful buoyancy calculation usually measure e measure observe variable experiment affected manipulation independent variable direct current dc error data collection result tendency look carefully certain outcome know association outcome exist material atom unpaired electron net magnetic field insulate material increase capacitance e spreading bending light ray electrostatic calculation product charge circuit pattern current charge flow direction relationship increase variable proportionately increase e separation light component wavelength pass medium prism e vector represent straight line distance direction initial point necessarily equal total distance travel measure meter e tendency parallel light ray away convex mirror concave lense diverge parallel light ray quantifie perceive change frequency sound relative movement source detector observer experiment assessor subject know subject group kinematic dynamic study force torque machine ratio useful work output compare work separation equal opposite charge small distance see polar molecule electric potential energy region generate electric charge multiple charge exert force charge bring field measure device measure circuit quantity like current potential difference resistance measure electric potential energy unit charge give volt v difference electric potential voltage drive current electromotive force circuit form potential energy dependent relative position charge respect charge

collection charge form energy compose oscillate electric magnetic field perpendicular perpendicular direction propagation include visible light type transverse wave travel vacuum e range frequency wavelength electromagnetic wave e difference electric potential voltage drive current circuit battery subatomic particle remain outside nucleus carry single negative charge process unstable atom absorb inner electron combine proton form neutron

process unstable atom absorb inner electron combine proton form neutron release e study stationary charge force create act charge e capacity work transfer heat measure joules j statistical measure distribution unusable energy heat randomness introduce system measure e state net torque net force equal zero acceleration e state know difference intervention ethically necessary comparative study region electric field equal electric potential movement point line cause change energy system describe atom electron occupy energy state minimum energy ground state describe set outcome leave room

e ability apply finding research study population call generalizability material atom unpaired electron strongly magnetized expose external visual representation electric field point direction force exert positive test charge electric way determine usefulness research question basis feasibility interest novelty ethic relevance e splitting large nucleus small nucleus release e volume unit time fluid motion material conform shape container e study fluid motion process electron certain substance excite high energy level high frequency photon emit gravitational potential energy visible light energy release step ground e distance mirror lens focal point e point ray light parallel axis mirror lens converge appear diverge reflecte mirror refract lens push pull measure newton n system force gravity e phase transition liquid solid call e rate recur event occur usually measure nonconservative force arise interaction surface contact e first harmonic pipe string e merging small nucleus large nucleus release high energy photon release gamma decay pressure atmospheric pressure form potential energy dependent relative position object gravitational field attractive force object depend masse

distance means return charge earth e low energy state atom e time take half sample radioactive nucleus decay heat transformation index refraction e set frequency create stand wave give pipe string e tendency research participant change behavior know observe e transfer thermal energy measure joule j calorie cal kilocalorie kcal cal e heat necessary cause phase transition unit mass substance characteristic temperature pressure phase transition call latent heat systematize way evaluate evidence causality temporality absolutely necessary demonstrate causality visual representation numerical datum relate bar simple machine exert mechanical advantage incompressible fluid base pascal principle conservation e study fluid system rest

farsightedness ability distant object nearby object unfocused blurry statistical method compare result group theoretical value give level confidence e region light ray converge appear converge aer reflecte mirror pass lens e manipulate variable experiment affect measurement observation dependent variable ratio speed light vacuum speed light give medium object resistance change motion force ethical requirement treatment research require patient participant able understand procedure consequence alternative relate autonomy region electromagnetic spectrum visible perceive heat sound frequency low range material resist movement charge electron tightly associate nucleus e average rate energy expenditure power unit area wave intensity relate amplitude wave interaction wave travel space constructive wave add destructive wave cancel partially constructive partially destructive e ability infer causality study

replicate result condition measure distribution sample outlier lie 1.5 interquartile range q1 q3 relationship increase variable associate proportional decrease describe image upside relative object single mirror single lens system inverted image real thermodynamic process extraordinarily unfavorable reverse usually result change entropy thermodynamic process occur constant pressure thermodynamic process occur constant atom give element different

number neutron different mass number thermodynamic process occur constant volume call isochoric e ethical principle state practitioner fairly distribute healthcare resource require difference treatment choice individual morally relevant e energy movement depend mass speed measure joules j e friction exist slide object surface object slide rule describe conservation charge conservation energy electric circuit include junction rule loop rule smooth flow fluid characterize streamline cross absence backwards movement device act create image refract light usually e inverse function exponentiation logarithmic scale oen mask large absolute difference quantity present small scale difference wave oscillation material parallel direction propagation sound classic example e sum electrostatic magnetic force act perceive intensity sound correlate sound level measure decibel db field create move charge force exert charge move magnetic field provide charge perpendicular component velocity comparison magnetic field vector measure central tendency apparent increase decrease size image result form image converge diverge system measure inertia stuff object measure kilogram e difference sum masse unbound nucleon form nucleus mass nucleus bind state e sum number proton neutron atom call atomic mass e average group datum specifically arithmetic mean measure describe middle e reduction input force require accomplish desire output work simple machine e central value datum set e phase transition solid liquid know fusion system measurement base power commonly scientific discipline long wavelength electromagnetic radiation capable induce vibration bond e common data point data set electromagnetic radiation wavelength incident photon describe outcome occur simultaneously nearsightedness ability nearby object distant object unfocused blurry e

simultaneously nearsightedness ability nearby object distant object unfocused blurry e frequency system resonate call resonant frequency thermodynamic process occur expect nature newton first law newton second law newton law e first law call law inertia state object remain rest constant velocity net force object is law account conservation is law state acceleration result sum force act object mass is law state object interact experience equal

opposite force result point zero displacement stand wave force cause energy dissipate system friction air resistance viscous drag pathway e ethical principle state practitioner obligation avoid treatment intervention potential harm great potential good line perpendicular surface interest e force surface contact exert perpendicular plane contact proton neutron e hypothesis difference give statistical evidence null hypothesis reject study look connection exposure outcome demonstrate causality device measure resistance relate voltage current resistance give circuit data point deviate significantly perceive pattern distribution depend context outlier disregard analyze normally give disproportionate weight calculate arrangement circuit element current element material atom unpaired electron weakly magnetize presence external magnetic measure population datum state pressure apply noncompressible fluid distribute equally point fluid wall e time take wave oscillation complete cycle measure second inverse frequency e difference phase wave frequency reference point phenomenon light sufficiently high frequency incident metal vacuum cause metal emit perception sound result frequency frequency increase pitch get high measurement device pressure flow rate dynamic reflecte surface infinite radius curvature result equal image object distance electromagnetic radiation electric field vector orient parallel relate viscosity tube dimension pressure differential rate flow point system e group individual certain desire principle superposition antiparticle electron mass electron opposite charge e+ β+ e difference electric potential distinct point measure volt v call voltage energy associate position measure joule j include gravitational elastic chemical electrical form rate work accomplish energy expenditure unit time measure watt w

rate work accomplish energy expenditure unit time measure watt w statistic probability correctly reject false null hypothesis e tendency measurement agree e ratio force area apply measure pascal pa millimeter mercury mmhg torr atmosphere atm wave interact displacement resultant wave point sum displacement interact wave physical quantity depend path take state include work heat wave sound movement wave subatomic particle carry single

positive charge mass slightly 1 amu relationship side right triangle square hypotenuse equal sum square side discrete bundle energy photon value separate datum ascend order evenly method heat transfer rely electromagnetic wave occur vacuum respect person naturally occur spontaneous decay certain nucleus accompany emission specific particle long wavelength electromagnetic radiation experiment error cause natural variation subject data point reduce impact increase sample method reduce bias confounding research participant assign group random number generator similar method participant researcher choose e difference small number data set

visual representation geometrical optic system describe image lens mirror refract reflecte light project screen single- mirror single len system real image invert phenomenon light travel straight line pass homogeneous medium e return light ray medium angle equal e bending light ray result change index refraction medium measure opposition current flow material measure ohm ω inverse conductance measure intrinsic resistance material independent shape size resistivity generally increase temperature oscillation maximum amplitude result periodically apply force natural resonant frequency object principle research ethic encompass autonomy informed consent e sum difference product vector mathematic refer sum difference wave method determine direction vector product vector e turning extended body axis center subset population generalization population mathematical quantity lack directionality systematize way evaluate datum investigate mathematical representation quantity multiple power occur research participant differ general population meaningful way arrangement circuit element current element call tangential force force exert surface object parallel surface object e buildup wave front occur source travel speed sound tool maintain appropriate level precision perform mathematical calculation basic mechanical device apply force e simple machine include incline plane wedge wheel axle system lever pulley screw experiment subject assessor blind party aware treatment subject relate incident angle refract angle index refraction medium source charge q material distinct boundary strong

intermolecular force capable resist shear force e perception longitudinal wave pressure change air electrostatic charge create electric e ratio object density density water e relationship thermal energy temperature change unit mass substance measure e ratio distance travel time give point instantaneous speed magnitude instantaneous velocity measure blurring periphery image result inadequate reflection parallel beam edge mirror lens mirror cause convergence divergence light ray incident surface measure distribution datum mean sample outlier lie standard deviation waveform steady node antinode form interference incident reflected wave boundary physical quantity determine base state object pressure density temperature volume

physical quantity determine base state object pressure density temperature volume enthalpy internal energy gibbs free energy entropy pathway independent e friction exist stationary object surface rest measure sample datum strong nuclear force test charge q visual representation movement fluid laminar flow fundamental interaction responsible binding proton neutron nucleus e result cohesive force liquid create barrier interface liquid environment measure give e observe quantifie region universe interest experimenter system isolate unable exchange energy matter surrounding closed able exchange energy surrounding open able exchange matter energy error experiment typically cause measure instrument create flaw datum offset increase datum pool measure average kinetic energy particle substance measure degree fahrenheit ° f degree celsius ° c necessary criterion causality independent variable occur dependent variable e velocity air resistance equal gravitational force acceleration occur object free fall electrostatic charge place electric field equilibrium thermal energy exist heat flow object thermal contact increase length volume substance result increase temperature e minimum frequency light cause ejection e quality sound produce instrument total internal reflection total mechanical energy type error type ii error

e

primary motivator rotational movement combine force lever arm angle measure n·m phenomenon light incident boundary reflecte original material e sum object potential kinetic motion space rotation wave propagate direction perpendicular direction oscillation wave propagate medium change location crest trough fluid movement follow parallel streamline backflow eddy swirl error conclusion null hypothesis error conclusion experimenter fail correctly reject null hypothesis frequency human hear treatment diagnostic modality ultrasonic wave medical purpose region electromagnetic spectrum visible primarily responsible damaging effect sunlight skin thermodynamic process undergo naturally predict change heat energy time describe image orientation object single mirror single len system upright image virtual e phase transition liquid gas call boiling mathematical quantity magnitude direction weak nuclear force zeroth law thermodynamic e rate change displacement object measure describe relationship continuity equation bernoulli equation cross sectional area tube decrease speed fluid increase pressure exert wall tube describe image opposite lens mirror refract reflecte light single mirror single lens system virtual image upright measure resistance flow fluid nonconservative force exert fluid manner proportional viscosity fluid e electromagnetic spectrum visible device measure voltage e distance correspond point successive cycle waveform measure meter fundamental interaction responsible radioactive decay contribute nuclear stability e force gravity act object function apply force distance apply pressure volume change gas system work use energy accomplish measure joules j state net work equal change energy usually kinetic energy object type electromagnetic radiation primarily medical thermodynamic system thermal equilibrium system thermal equilibrium note material figure table indicate italic f t aer page chromatic 304 304f spherical 303 303f absolute pressure 130–131 471 absolute zero 93 93 t 471 absorption light 334–336 334f 335f 348 motion constant acceleration definition 23 471 gravity 26 force force acceleration accuracy 406 407f 471 action reaction newton law 19 25 exponent