EXAM B

CHEM 1A Winter 2021: Midterm #1

Lecturer: Prof. Fokwa

January 28, 2021

Time: 1 h

Please note: This test has a total of 125 points (Part I) and 5 pts bonus question (Part II). The test covers chapters 1, 2 and 3.

Allowed for the test are: a blanc paper sheet, a copy of the periodic table given on the sample mid-term and below, a pen and a scientific calculator (non-graphing).

Part I: Multiple Choices (5 pts each; 125 pts in total)

____ 1. A hypothetical element has two stable isotopes: one isotope has a mass of 106.9051 u with an abundance of 48.183%, the other isotope has a mass of 108.9048 u with an abundance of 51.825%. What is the average atomic mass of this element?

a. 107.980 u
b. 107.970 u
c. 107.960 u
d. 107.950 u
e. 107.940 u

____ 2. Identify the correct statement regarding the mole.

a. A mole of oxygen gas contains 6.02×10^{23} atoms.
b. A mole of chlorine gas contains $2 \times 6.02 \times 10^{23}$ atoms.
c. A mole of carbon dioxide contains two moles of oxygen molecules.
d. A mole of ammonia gas (NH_3) has a mass of 34.0 g.
e. A mole consists of the number of particles in exactly 12 g of naturally occurring carbon.

____ 3. Which one of the following statements is *not* correct?

a. A compound has a specific constant composition.
b. The composition of a mixture can vary.
c. A compound has specific constant properties.
d. The properties of a mixture can vary.
e. Mixtures cannot be homogeneous.

____ 4. How many moles of ammonia are there in a 346 g sample of pure NH_3 (17.03 g/mol)?

a. 0.0496 mol
b. 20.3 mol
c. 24.7 mol
d. 5,930 mol
e. 3.46 mol

____ 5. Which statement best describes isotopes?

a. They have the same atomic mass.
b. They have the same number of neutrons but a different number of protons.
c They have the same total number of protons and neutrons.
d. They have the same number of protons but a different number of neutrons.
e. They have different chemical reactivity.

____ 6. A $^{55}_{25}Mn^{2+}$ ion has _____ protons, _____ neutrons, and _____electrons.

a. 23; 30; 25
b. 25; 30; 23
c. 30; 25; 23
d. 25; 30; 25
e. 30; 25; 30

____ 7. Which statement A–D about the reaction of methane with oxygen, which is called combustion and is represented by the reaction equation below, is *not* correct? The reaction products are carbon dioxide and water.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

a. One molecule of methane combines with two molecules of oxygen.
b. Four atoms of hydrogen combine with four atoms of oxygen to produce water.
c. The products are one molecule of carbon dioxide and two molecules of water.
d. The equation is balanced because the number of atoms of each element does not change.
e. Statements A–D all are correct.

____ 8. Which one of the following statements is *not* correct?

a. Helium is an element.
b. Table salt (sodium chloride) is a compound.
c. Water is a pure substance.
d. Elements occur only in the form of individual atoms.
e. Air is a solution.

____ 9. Which of the following is an element?

a. F_2
b. H_2O
c. NaCl
d. MgO
e. HCl

____ 10. Which of the following is most likely to exhibit covalent bonding?

a. NaF
b. $CaCl_2$
c. Cs_2O
d. CO_2
e. NaCl

____ 11. If the following operations are carried out, how many significant figures should be reported in the answer?

$$(2.30) / (21.13 - 1.271)$$

a. 1
b. 2
c. 3
d. 4
e. 5

____ 12. Which one of the following is *not* a chemical reaction?

a. dynamite exploding
b. iron rusting
c. wood burning
d. water turning to steam
e. eggs cooking

____ 13. Which substance listed below contains the most oxygen atoms?

a. 1 mol of Al_2O_3
b. 1 mol of Fe_2O_3
c. 1 mol of N_2O_4
d. 2 mol of CO_2
e. 2 mol of HNO_3

____ 14. ^{12}C, ^{13}C, and ^{14}C are examples of _____ because they have different numbers of _____.
a. isotopes; protons
b. isotopes; neutrons
c. isotopes; electrons
d. allotropes; neutrons
e. allotropes; protons

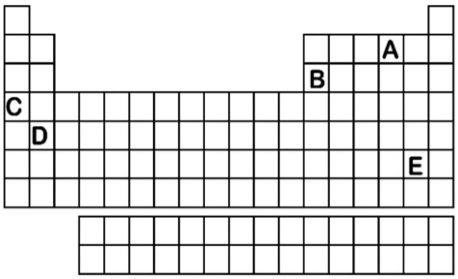
____ 15. You are a technician in an analytical laboratory and are asked to determine from its density whether an antique coin might be gold. You weigh the coin and find that its mass is 84.6419 g. When you place the coin in a graduated cylinder containing 105.53 mL of water, the water level rises to 114.64 mL. Calculate the density of the coin from your measurements and determine how many significant figures should be included in the reported result. Which one of the following numbers will you put in your report for the density of the coin?
a. 0.73833 g/mL
b. 9.3 g/mL
c. 9.29 g/mL
d. 9.29109769 g/mL
e. 9.2911 g/mL

____ 16. Locate each element in the periodic table and identify which statement is *not* correct. The common ion of _____ has _____ electrons and a charge of _____.
a. Na; 10; +1
b. K; 18; +1
c. Mg; 10; +2
d. O; 10; –2
e. F; 10; –2

____ 17. Which of the following is an alkaline earth metal?
a. K
b. Ca
c. Al
d. Cu
e. Na

____ 18. How many gold atoms are there in a 1.00 kg bar of gold (M_{Au} = 196.97 g/mol)?
a. 3.06×10^{24}
b. 197 mol
c. 3.06×10^{21}
d. 5.08×10^{-3} mol
e. 5.08×10^{18}

____ 19. Which element labeled A–E in the periodic table below will most likely have a charge of +3 in an ionic compound?



a. A
b. B
c. C
d. D
e. E

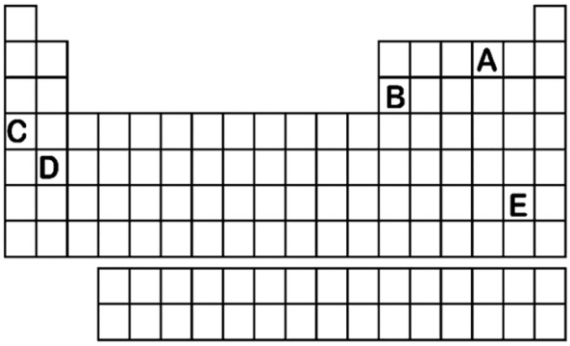
____ 20. When 5.0 g of sulfur is combined with 5.0 g of oxygen, 10.0 g of sulfur dioxide is formed. What mass of oxygen would be required to convert 5.0 g of sulfur into sulfur trioxide?
a. 5.0 g
b. 10 g
c. 7.5 g
d. 30 g
e. 20 g

____ 21. Based on the element's position in the periodic table, which statement below is *not* correct?
a. The charge on an ion of sodium is 1+.
b. The charge on an ion of magnesium is 2+.
c. Ca^{2+} has more electrons than Ar.
d. The charge on an ion of oxygen is 2–.
e. The charge on an ion of chlorine is 1–.

____ 22. What is the energy (*E*, in J) of the photons emitted by an Ar^{+} laser with a wavelength of $\lambda = 488$ nm?
a. 2.46×10^{18} J
b. 9.69×10^{-23} J
c. 1.36×10^{-36} J
d. 4.07×10^{-19} J
e. 2.46×10^{-18} J

____ 23. A radio station's operating frequency has a wavelength of 2.81 m. What is this frequency?
a. 1.068×10^{8} MHz
b. 106.8 MHz
c. 100.1 MHz
d. 94.5 MHz
e. 9.37×10^{-9} MHz

____ 24. What is the most probable chemical formula made of elements C and A?



a. AC_3
b. A_2C
c. A_3C
d. C_2A
e. CA

____ 25. Which of these regions of the electromagnetic spectrum has the shortest wavelength?
a. Visible
b. Infrared
c. Gamma rays
d. Ultraviolet
e. X-rays

Part II: Bonus Question (5 pts)

____ 26. How many C atoms are in 56.10 grams of C_2H_4?
a. 2
b. 2.408×10^{24}
c. 6.022×10^{23}
d. 1.204×10^{24}
e. 2×10^{23}

EXAM B

Useful equation, constants and conversions:

density $= \dfrac{\text{mass}}{\text{volume}}$

$c = \lambda\nu$ (λ is wavelength; ν is frequency; c = 2.998× 10^8 m/s)

$E = h\nu$ $\quad E = \dfrac{hc}{\lambda}$; $\quad \lambda = \dfrac{hc}{E} = \dfrac{hc}{mc^2} = \dfrac{h}{mc} = \dfrac{h}{mu}$

$\dfrac{1}{\lambda} = \left(1.097\times10^{-2}\text{nm}^{-1}\right)\left(\dfrac{1}{n_1^{\,2}} - \dfrac{1}{n_2^{\,2}}\right)$; $\quad \Delta E = -2.178\times10^{-18}\ \text{J}\left(\dfrac{1}{n_{\text{final}}^{\,2}} - \dfrac{1}{n_{\text{initial}}^{\,2}}\right)$

h = 6.626 x 10–34 J•s (Planck's constant); Avogadro's number N = 6.022x10^{23}/mol

$KE_{electron} = h\nu - \Phi$, where Φ = work function.

Mean: $\bar{x} = \dfrac{\sum_i (x_i)}{n}$; Standard deviation(s): $s = \sqrt{\dfrac{\sum_i (x_i - \bar{x})^2}{n-1}}$

Percent Yield = $\dfrac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

Beer's aw: $A = \varepsilon \cdot b \cdot c$

Molarity: $M = \dfrac{n}{V}$

Bond Order = (# bonding e^- – # antibonding e^-)/2

Mass solute: $m_{\text{solute}} = V \times M \times \mathcal{M}$

Dilution equation: $V_{\text{initial}} \times M_{\text{initial}} = V_{\text{dilute}} \times M_{\text{dilute}}$

Potential energy (PE): PE = $m \times g \times h$
(m = mass; g = acceleration due to gravity; h = vertical distance)
Kinetic energy (KE): $KE = {}^1/_2 mu^2$ (m = mass; u = velocity)
Total energy = PE + KE

Electrostatic Potential Energy: $E_{el} \propto \dfrac{(Q_1 \times Q_2)}{d}$

Internal energy: ΔE = q + w = q - PΔV

$\Delta H = \Delta E + P\Delta V$; $\quad \Delta H_{rxn} = \dfrac{q_{rxn}}{\text{mol rxn}}$

Heat capacity: $q = C\,\Delta T$
Specific heat (c_s): $q = mc_s\Delta T$
Molar heat capacity (c_p): $q = nc_p\Delta T$
Phase change: $q = n\Delta H_{fus}$; $q = n\Delta H_{vap}$

Clapeyron Equation $\ln\left(\dfrac{P_2}{P_1}\right) = \dfrac{\Delta H_{vap}}{R}\left(\dfrac{1}{T_1} - \dfrac{1}{T_2}\right)$ Gas constant: R = 8.314 J/(mol K) = 0.08206 atm L/(mol K)

$h = \dfrac{2T\cos\theta}{r\rho g}$ g = acceleration = 9.8 m/s^2; ρ is the density; T = surface tension; r = radius of the tube;

ϑ = contact angle between the liquid and the tube.

1 H 1.008																1 H 1.008	2 He 4.003
3 Li 6.939	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Ti 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Ha (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

58 Ce 140.1	59 Pr 140.1	60 Nd 144.2	61 Pm 144.9	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lw (262)

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