Chem 10113, Quiz 7 **Answer Key**

December 11, 2019

	IA (1)												IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	VIIIA (18)
1	1 **H** 1.0080	IIA (2)																2 **He** 4.0026
2	3 **Li** 6.9410	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.179
3	11 **Na** 22.990	12 **Mg** 24.305	IIIB (3)	IVB (4)	VB (5)	VIB (6)	VIIB (7)	(8)	VIIIB (9)	(10)	IB (11)	IIB (12)	13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
4	19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.880	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.690	29 **Cu** 63.546	30 **Zn** 65.380	31 **Ga** 69.723	32 **Ge** 72.610	33 **As** 74.922	34 **Se** 78.960	35 **Br** 79.904	36 **Kr** 83.800
5	37 **Rb** 85.468	38 **Sr** 87.620	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.940	43 **Tc** 98.907	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
6	55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.20	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.20	83 **Bi** 208.98	84 **Po** 208.98	85 **At** 209.99	86 **Rn** 222.02
7	87 **Fr** 223.02	88 **Ra** 226.03	89 **Ac** 227.03	104 Unq 261.11	105 Unp 262.11	106 Unh 263.12	107 Uns 262.12											

1. (2 points) Among the following substances: HBr, Al_2O_3, $HClO_2$, $Ba(OH)_2$, As_2O_5, $HONH_2$, KNO_3, SiH_4 which one best matches each description?
strong base: $Ba(OH)_2$ acidic anhydride: As_2O_5 weak acid: $HClO_2$

2. (2 points) Molybdenum hexafluoride, MoF_6, is a liquid at room temperature that does not conduct electricity and boils at 34 °C. In the solid state, it forms colorless crystals that melt at 17 °C. The most likely crystal type (i.e., ionic, metallic, etc.) for solid MoF_6 is molecular.

3. (2 point) Boron carbide (B_4C) is a hard, ceramic material that melts above 2700 °C and does not conduct electricity as a solid or when melted. The most likely crystal type (i.e., ionic, metallic, etc.) for B_4C is covalent (network).

4. (6 points) **SHOW ALL WORK.** The element silicon (Si) crystallizes in a "diamond" cubic unit cell in which there are eight Si atoms per unit cell. The edge dimension (*l*) of the unit cell is 543.1 pm (*pico*meters) and the specific gravity of Si is 2.329. ***Determine*** (i.e., calculate) the value of Avogadro's number using any information in this problem and/or the periodic table.

volume of unit cell = $(5.431 \times 10^{-8}\ cm)^3 = 1.602 \times 10^{-22}\ cm^3$

$(1.602 \times 10^{-22}\ cm^3)(2.329\ g/cm^3)(1\ mole\ Si / 28.086\ g) = 1.328 \times 10^{-23}$ mole Si

Avogadro's number = (8 atoms) / $(1.328 \times 10^{-23}$ mole) = 6.022×10^{23} atoms/mole

5. (6 points) **SHOW ALL WORK.** A 50.00 mL portion of a solution containing La^{3+} was treated with excess sodium oxalate to precipitate $La_2(C_2O_4)_3$ (molar mass = 541.9). The precipitate was carefully collected by filtration, re-dissolved in acid, and then titrated with 41.15 mL of 0.0825 M $KMnO_4$ according to the following balanced redox equation. Determine the molarity of La^{3+} in the original solution.

$$5\ C_2O_4^{2-} + 2\ MnO_4^- + 16\ H^+ \longrightarrow 10\ CO_2 + 2\ Mn^{2+} + 8\ H_2O$$

(41.15 mL) (0.0825 mole MnO_4^- / 1000 mL) (5 mole $C_2O_4^{2-}$ / 2 mole MnO_4^-)

= 8.487 x 10^{-3} mole $C_2O_4^{2-}$

(8.487 x 10^{-3} mole $C_2O_4^{2-}$) (2 mole La^{3+} / 3 mole $C_2O_4^{2-}$) = 5.658 x 10^{-3} mole La^{3+}

molarity of La^{3+} = (5.658 x 10^{-3} mole La^{3+}) / 0.0500 L = 0.113 M

6. (4 points) For each of the following aqueous-solution reactions, ***complete and balance the molecular equation*** and also write the ***balanced, net ionic equation***. Use appropriate subscripts [(s), (aq), (g), etc.] to indicate the phase of each compound or ion.

(a) $(NH_4)_2SO_{4(aq)} + 2\ KOH_{(aq)} \longrightarrow K_2SO_{4(aq)} + 2\ H_2O + 2\ NH_{3(g)}$

net ionic:

$NH_4^+{}_{(aq)} + OH^-{}_{(aq)} \longrightarrow H_2O + NH_{3(g)}$ (gas formation)

(b) $2\ Fe(C_2H_3O_2)_{3(aq)} + 3\ H_2SO_{4(aq)} \longrightarrow Fe_2(SO_4)_{3(aq)} + 6\ HC_2H_3O_{2(aq)}$

net ionic:

$C_2H_3O_2^-{}_{(aq)} + H^+{}_{(aq)} \longrightarrow HC_2H_3O_{2(aq)}$ (weak electrolyte formation)

7. Tantalum (Ta) crystallizes in a body-centered cubic lattice in which the edge dimension (*l*) of the unit cell is 0.3306 nm (*nano*meters).

(a) (4 points) **SHOW ALL WORK.** Determine the atomic radius (r) of Ta in pm (*pico*meters).

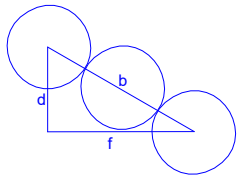
In a body-centered cubic lattice, there are 2 atoms per unit cell. The atoms are in contact along the body diagonal of the cube. (In the figure, d = edge dimension of the cube, f = face diagonal, b = body diagonal.)

$d^2 + f^2 = b^2$ where: $b = 4r$ and $f = (2)^{1/2} d$

$d^2 + 2\ d^2 = (4\ r)^2$

$3\ d^2 = (4r)^2$ $\therefore r = (3)^{1/2} d / 4$

so, $r = (3)^{1/2}$ (330.6 pm) / 4 = 143 pm



(b) (4 points) **SHOW ALL WORK.** Determine the specific gravity of Ta.

specific gravity = density of Ta in g/cm^3

mass of Ta per unit cell = (2 atoms) (1 mole / 6.022 x 10^{23} atoms) (180.95 g/mole)

= 6.010 x 10^{-22} g

volume of unit cell = (3.306 x 10^{-8} cm)^3 = 3.613 x 10^{-23} cm^3

density = (6.010 x 10^{-22}) / (3.613 x 10^{-23}) = 16.6 g/cm^3