Chem 10113, Quiz 7 **Answer Key**

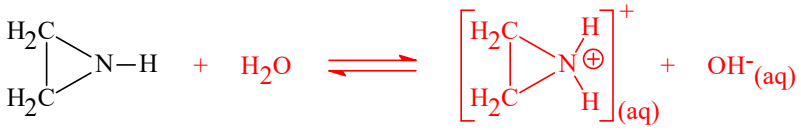
December 5, 2018

	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) Quartz glass, SiO_2, which is the major component of ordinary sand, melts above 1700 °C and does not conduct electricity as a solid or when melted. The most likely crystal type (i.e., ionic, metallic, etc.) for SiO_2 is covalent (network).

2. (3 points) Among the following substances: $HClO_4$, K_2O, HCN, CsOH, As_2O_5, HBr, C_5H_5N, which one best matches each description?
strong base: CsOH acidic anhydride: As_2O_5 weak acid: HCN

3. (2 points) Write a complete, ***balanced chemical equation*** to show how aziridine (structure below) behaves as a ***weak base*** in aqueous solution.



4. (5 points) **SHOW ALL WORK.** The element germanium (Ge) crystallizes in a type of cubic unit cell that is different from any that we have discussed in class. The edge dimension of the unit cell is 565.8 pm (*pico*meters) and the specific gravity of Ge is 5.323. Determine the number of Ge atoms in the unit cell.

$L = (565.8\ pm)(10^{-12}\ m / pm)(1\ cm / 10^{-2}\ m) = 5.658 \times 10^{-8}\ cm$

$V = L^3 = (5.658 \times 10^{-8}\ cm)^3 = 1.811 \times 10^{-22}\ cm^3$

$mass\ Ge\ in\ unit\ cell = (1.811 \times 10^{-22}\ cm^3)(5.323\ g/cm^3) = 9.642 \times 10^{-22}\ g$

$(9.642 \times 10^{-22}\ g)(1\ mole / 72.61\ g)(6.022 \times 10^{23}\ atoms/mole) = 8\ atoms$

5. (5 points) Identify each of the following solids by its crystal type (metallic, ionic, etc.).

(a) $CaO_{(s)}$ ionic

(b) $BN_{(s)}$ covalent (network)

(c) $CH_3OH_{(s)}$ molecular

(d) $SiF_{4(s)}$ molecular

(e) $Ca_{(s)}$ metallic

(f) $Kr_{(s)}$ non-bonding (atomic)

6. Lakes that have been acidified by acid rain (containing H_2SO_4 and HNO_3) can be neutralized by a process called liming, i.e., addition of lime ($CaCO_3$).

(a) (2 points) Write a ***balanced <u>net ionic</u> equation*** for the liming process.

$$2\ H^+_{(aq)} + CaCO_{3(s)} \longrightarrow Ca^{2+}_{(aq)} + H_2O + CO_{2(g)}$$

(b) (5 points) **SHOW ALL WORK.** What mass (in kg) of $CaCO_3$ (molar mass = 100.1) is required to completely neutralize a 15-billion-liter lake that is 7.5×10^{-6} M in H_2SO_4 and 2.5×10^{-5} M in HNO_3?

moles H^+ from H_2SO_4 = $(15 \times 10^9$ L$)(7.5 \times 10^{-6}$ mole H_2SO_4 / L)
x (2 mole H^+ / 1 mole H_2SO_4) = 2.25×10^5 mole

moles H^+ from HNO_3 = $(15 \times 10^9$ L$)(2.5 \times 10^{-5}$ mole HNO_3 / L)
x (1 mole H^+ / 1 mole HNO_3) = 3.75×10^5 mole

total mole H^+ = $2.25 \times 10^5 + 3.75 \times 10^5 = 6.0 \times 10^5$ mole H^+

$(6.0 \times 10^5$ mole $H^+)$ (1 mole $CaCO_3$ / 2 mole H^+) (100.1 g/mole) (1 kg / 10^3 g)
= 3.0×10^4 kg $CaCO_3$

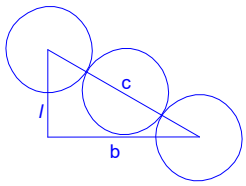
7. (1 point) Which solid has the lowest band gap? (circle one)

$C_6H_{6(s)}$ $Ge_{(s)}$ $H_2O_{(s)}$ $Al_{(s)}$ $C_{(s,\ graphite)}$

8. The element molybdenum (Mo) crystallizes in a body-centered cubic lattice in which the edge dimension (l) of the unit cell is 0.3141 nm (*nano*meters).

(a) (2 points) **SHOW ALL WORK.** Determine the atomic radius (r) of Mo in pm (*pico*meters).

The atoms are in contact along the body diagonal of the cube.
In the figure, l = edge dimension of the cube,
b = face diagonal, and c = body diagonal.



$l^2 + b^2 = c^2$ where: $c = 4\ r$ and $b = (2)^{1/2}\ l$

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

$3\ l^2 = 16\ r^2 \therefore r = (3)^{1/2}\ l\ /\ 4$ $(0.3141\ nm)(10^{-9}\ m/nm)(1\ pm/10^{-12} m) = 314.1\ pm$

so, $r = (3)^{1/2}\ (314.1\ pm)\ /\ 4 = 136\ pm$

(b) (3 points) **SHOW ALL WORK.** Determine the specific gravity of Mo. (***Note***: The answer to part a is not needed here!)

mass of Mo in unit cell = (2 atoms) (1 mole / 6.022×10^{23} atoms) (95.94 g/mole)
= 3.186×10^{-22} g

volume of unit cell = l^3 = $[(0.3141\ nm)\ (10^{-9}\ m/nm)\ (1\ cm / 10^{-2}\ m)]^3$
= 3.099×10^{-23} cm^3

density = $(3.186 \times 10^{-22}$ g$)(3.099 \times 10^{-23}$ $cm^3) = 10.3$ g/cm^3

$\therefore$ specific gravity = 10.3