PART II- REVIEW FINAL EXAM- CHEM 111

Name Key
Last First

1. What is the net-ionic equation for the reaction that occurs when:

a. nitrous acid and sodium hydroxide solutions are mixed.

$HNO_2 + Na^+ + OH^- \rightarrow Na^+ + NO_2^- + H_2O$ Total ionic

Answer: $HNO_2 + OH^- \rightarrow NO_2^- + H_2O$ net-ionic

b. potassium hydroxide and hydrofluoric acid solutions are mixed.

$K^+ + OH^- + HF \rightarrow K^+ + F^- + H_2O$ Total ionic

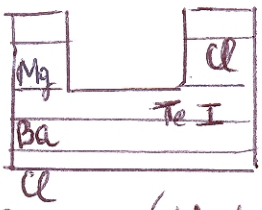
Answer: $OH^- + HF \rightarrow F^- + H_2O$ net-ionic

2. Which of the elements given below will have:

Ba Mg Cl Te I

a. largest atomic size. Ba b. highest ionization potential Cl

c. lowest electronegativity Ba d. lowest electron affinity Ba



3.a. Name the three classes of compounds that are considered as electrolytes. (that is strong electrolytes)

i. soluble salts ii. strong acids iii. strong bases

b. Label each of the following as strong electrolyte, weak electrolyte, or non-electrolyte.
(You must know the list of soluble salts, strong acids and strong bases to answer this question.)

i. $NaC_2H_3O_2$ strong ii. $HC_2H_3O_2$ weak iii. HCN weak

iv. $HClO_2$ weak v. NH_4BrO_4 strong vi. C_4H_{12} nonelectrolyte

4. Tell if a precipitate may form upon mixing each of the following solutions:
(You must know the list of solubility rules to answer this question)

a. ammonium chloride and lead (II) nitrate. $PbCl_2(s)$

b. barium nitrate and potassium sulfate. $BaSO_4(s)$

c. nickel (II) sulfate and sodium hydroxide. $Ni(OH)_2(s)$

5. a. Define: isoelectronic

Different species that have the same number and configuration of electrons

b. Which of the following isoelectronic species has the largest size?

	Se^{2-}	Br^-	Kr	Sr^{2+}
# protons	34	35	36	38
# electrons	36	36	36	36

The higher the nuclear charge (# of protons), the smaller the radius. The shells (energy levels) contract due to the greater attractive force of the nucleus. The radius decreases with increasing atomic number (no of protons). Se^{2-} will have the largest size.

6. Write an equation illustrating

a. the heat of formation of of LiCl (s)

$Li(s) + \frac{1}{2} Cl_2(g) \longrightarrow LiCl(s)$

b. the lattice energy of CsBr(s)

$Cs^+(g) + Br^-(g) \longrightarrow CsBr(s)$

c. the dissociation energy of Cl_2 (g)

$Cl_2(g) \longrightarrow 2Cl(g)$

d. the sublimation energy of Mg (s)

$Mg(s) \longrightarrow Mg(g)$

e. the electron affinity of I(g)

$I(g) + 1e^- \longrightarrow I^-(g)$

g) the first ionization energy of Ca(g)

$Ca(g) \longrightarrow Ca^+(g) + 1e^-$

7. Consider the types of crystalline solids:

a) ionic, b)metallic, c)covalent network, and d) molecular

to answer the questions given below:

Which conducts electricity in the solid state? metallic

Which conducts electricity only in the molten state (liquid state) ionic

Which has low melting point? molecular

Which is known to be the hardest? covalent network

Which is soft and does not conduct electricity? molecular

Which has lattice points occupied by positive and negative ions? ionic

Which has lattice points occupied by atoms? covalent network

8. List the major intermolecular force in each of the following

a) H_2 London

b) NH_3 hydrogen forces

c) OCl_2 (bent geometry) dipole-dipole

d) CH_4(tetrahedral geometry) London

9. Define: molal boiling point elevation constant, K_b.

The increase in B.P. of a solvent due to dissolving 1 mole of nonvolatile, non dissociating solute in 1 kg of solvent

If K_b for water is 1.86 °C.kg/mole. How many units of degrees will a solution of 1.00 m $Mg(C_2H_3O_2)_2$ rise in temperature?

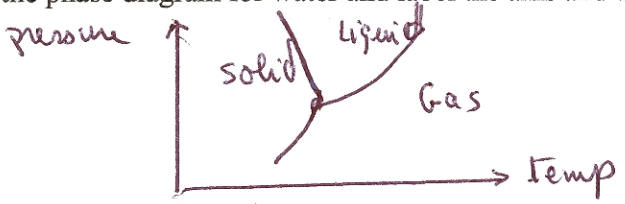
$$\frac{3 \text{ moles of ions}}{1 \text{ mole compound}} \times \frac{1.86\,^\circ C \cdot kg}{\text{mole of ions}} = 5.58\,^\circ C$$

10. A large value of an equilibrium constant, like 10^{+7}, indicates that the position of equilibrium lies further to the right (right, or left)

11. Define: Normal boiling point

It is the boiling point of a liquid at 1 atm.

12. Draw the phase diagram for water and label the axis and the physical states in each region.



13. State the physical state of the dispersed phase and continuous phase in each of the following colloids:

a. a sol dispersed phase is solid ; continus phase could be solid or liquid.

b. an emulsion dispersed phase is liquid ; continuous phase is liquid.

c. a gel dispersed phase is liquid; continuous phase is solid

14. a.. Determine if a decrease in pressure at constant temperature favors the formation of reactants, the formation of products, or neither?

i. $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$ a. neither

ii. $2\ KClO_3(s) \rightleftharpoons 2\ KCl(s) + 3\ O_2(g)$ b. products

iii. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ c. products

b. Which of the above equilibria has $K_c = K_p$?

$K_p = K_c (RT)^{\Delta n}$

$\Delta n = n_{products} - n_{reactants}$

15. a. What is the equilibrium constant for the reaction given below, if $K_{a1} = 1.0 \times 10^{-7}$ and $K_{a2} = 1.4 \times 10^{-14}$

$$H_2S\ (aq) + 2\ H_2O\ (l) \rightleftharpoons 2\ H_3O^+\ (aq) + S^{2-}\ (aq)$$

$K_{overall} = K_{a_1} \cdot K_{a_2} = (1.0 \times 10^{-7})(1.4 \times 10^{-14}) = 1.4 \times 10^{-21}$

Answer: _____

b. What is the $[S^{2-}]$ concentration of a 0.10 M $H_2S(aq)$?

Answer: $[S^{2-}] = K_{a_2} = 1.4 \times 10^{-14}$

16. Determine if each solution given below is acidic, basic, or neutral at the **equivalence point.**

a. titration of $NH_3(aq)$ by HCl at the equivalence point. NH_4Cl is present. NH_4^+ will hydrolyze forming acidic solution

b. titration of $HCHO_2$ by NaOH at the equivalence point $NaCHO_2$ is present. CHO_2^- will hydrolyze forming basic solution

c. titration of NaOH and by HCl at the equivalence point NaCl is present. No hydrolysis Solution is neutral

17. Oxalic acid, $H_2C_2O_4$, has values of $K_{a1} = 5.6 \times 10^{-2}$ and $K_{a2} = 5.1 \times 10^{-6}$. Find K_b for the following equilibrium:

$$HC_2O_4^- (aq) + H_2O (l) \rightleftharpoons H_2C_2O_4 (aq) + OH^- (aq)$$

Answer: $K_b = \frac{K_w}{K_{a1} \text{ for } H_2C_2O_4} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-2}} = 1.8 \times 10^{-13}$

18. Determine if each solution given below is a buffer.

a. 0.4 mole NH_3 and 0.2 mole HCl

a. NH_3 excess and NH_4Cl formed. Buffer

	NH_3	+ HCl	→	NH_4Cl
initial	.4	.2		0
change	−.2	−.2		+.2
final	.2	0		.2

b. 0.5 mole NH_3 and 0.5 mole HCl

b. NH_4Cl is produced. Not a Buffer.

	NH_3	+ HCl	→	NH_4Cl
Initial	.5	.5		0
change	−.5	−.5		+.5
final	0	0		.5

c. 0.2 mole HF and 0.4 mole NaOH

c. NaF is produced and NaOH in excess. Not a buffer.

	HF	+ NaOH	→	NaF	+ H_2O
Initial	.2	.4		0	
change	−.2	−.2		+.2	
Final	0	.2		.2	

d. 0.5 mole HCN and 0.2 mole KOH

d. HCN excess and KCN is produced Buffer.

	HCN	+ KOH	→	KCN	+ H_2O
Initial	.5	.2		0	
Change	−.2	−.2		+.2	
Final	.3	0		.2	

19. Alcohol and water form ideal solution. At a certain temperature the vapor pressure of alcohol is 140 torr and that of water is 50 torr. What is the total vapor pressure in a closed container that has a solution made of 2.8 mole alcohol and 7.8 mole water?

Setup:

$$V.P = X_{alcohol} P^\circ_{alcohol} + X_{water} P^\circ_{water}$$

$$= \frac{2.8 \text{ mole}}{(2.8+7.8) \text{ mole}} (140 \text{ torr}) + \frac{7.8 \text{ mole}}{(2.8+7.8) \text{ mole}} (50 \text{ torr})$$

$$= (.264)(140 \text{ torr}) + .736 (50 \text{ torr})$$

$$= 37.0 \text{ torr} + 36.8 \text{ torr} = 73.8 \text{ torr}$$

Answer_____

20. A 0.010 M NH_3 solution has $[OH^-] = 1.00 \times 10^{-3}$ M. What is the percent dissociation of NH_3 in the solution?

Setup:

$$\% \text{ dissociation} = \frac{[OH^-]}{M_{NH_3 \text{ initial}}} \times 100 = \frac{1.00 \times 10^{-3} \text{ mole}}{.010 \text{ mole}} \times 100$$

$$= 10\ \%$$

Answer_____

21. The vapor pressure of water at a certain temperature is 450 torr. What is the vapor pressure of a solution that contains 2.00 moles sugar and 18 moles water at the same temperature?

Setup:

$$V.P = X_{solvent} P^\circ_{solvent}$$

$$= \left(\frac{18 \text{ moles}}{(2+18) \text{ moles}}\right)(450 \text{ torr}) = .90(450 \text{ torr})$$

$$= 405 \text{ torr}$$

Answer_____

22. Cadmium (molar mass= 112.4 g/mole) crystallizes in a body-centered cubic system. What is the mass of a unit cell of cadmium?

Setup:

mass of 2 atoms: $\frac{2 \text{ atoms}}{\text{unit cell}} \left(\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ atoms}}\right)\left(\frac{112.4 \text{ g}}{1 \text{ mole Cd}}\right) = 3.73 \times 10^{-22} \frac{\text{g}}{\text{unit cell}}$

Answer _____

23. A metal crystallizes in a body-centered cubic lattice. The radius of the atom is 2.22×10^{-8} cm. Calculate the volume of the unit cell.

Setup: $a = \frac{4r}{\sqrt{3}} = \frac{4(2.22 \times 10^{-8} \text{ cm})}{\sqrt{3}} = 5.13 \times 10^{-8} \text{ cm}$

$V_{unit\ cell} = a^3 = (5.13 \times 10^{-8} \text{ cm})^3 = 1.35 \times 10^{-22} \text{ cm}^3$

Answer _____

24. A metal crystallizes in a face-centered cubic lattice. The volume of the unit cell is 1.64×10^{-22} cm^3. What is the radius of an atom of this metal?

Setup: $a = \sqrt[3]{V} = \sqrt[3]{1.64 \times 10^{-22} \text{ cm}^3} = .547 \times 10^{-7} \text{ cm}$

$= 5.47 \times 10^{-8} \text{ cm}$

$r = \frac{\sqrt{2}\, a}{4} = \frac{\sqrt{2}\,(5.47 \times 10^{-8} \text{ cm})}{4} = 1.93 \times 10^{-8} \text{ cm}$

Answer _____

25. K_a for acetic acid, $HC_2H_3O_2$, is 1.8×10^{-5}. What is the $[OH^-]$ concentration for a 0.25 M of sodium acetate?

Setup:

	$C_2H_3O_2^- + H_2O \rightleftharpoons$	$HC_2H_3O_2$	$+ OH^-$
Initial conc.	.25	0	0
change in conc.	$-x$	$+x$	$+x$
Equi. conc.	$.25-x$	x	x

$K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10} = \frac{[HC_2H_3O_2][OH^-]}{[C_2H_3O_2^-]} = \frac{(x)(x)}{0.25-x}$

Answer 1.2×10^{-5} M

26. It took 47 seconds for an unknown gas to effuse, whereas Cl_2(g) (molar mass=71.00 g/mole) required 85 seconds. What is the molar mass of the unknown gas?

Setup: step i)

$\frac{\frac{1}{t_{gas}}}{\frac{1}{t_{Cl_2}}} = \sqrt{\frac{\text{molar mass } Cl_2}{\text{molar mass gas}}}$; step ii) $\frac{\frac{1}{47 \text{ sec}}}{\frac{1}{85 \text{ sec}}} = \sqrt{\frac{71.0 \text{ g/mole}}{\text{molar mass gas}}}$

Answer 21.7 g/mole

27. The amount of phosphorus in a 17.50 g sample of a compound was determined by converting the phosphorus to $Ca_3(PO_4)_2(s)$. The $Ca_3(PO_4)_2$ weighed 28.55 g . What is the percent phosphorus in the original sample? (molar mass: $Ca_3(PO_4)_2$ =279.3 g/mole)

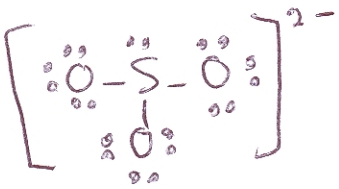
Setup: $28.55\text{g } Ca_3(PO_4)_2 \left(\frac{1\text{ mole } Ca_3(PO_4)_2}{279.3\text{g } Ca_3(PO_4)_2}\right)\left(\frac{2\text{ moles P}}{1\text{ mole } Ca_3(PO_4)_2}\right)\left(\frac{31.0\text{g P}}{1\text{ mole P}}\right) = 6.34\text{g P}$

$\%P = \frac{6.34\text{g P}}{17.50\text{g compound}} \times 100 = 36.2\%$

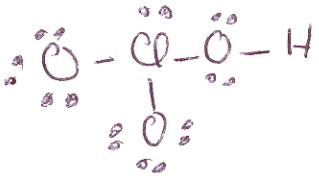
Answer_____

28. Draw the Lewis electron dot structure for the following:

a. SO_3^{2-}



b. $HClO_3$ (Cl is chlorine)



29. Find the concentration of $[Na^+]$ after mixing 12.5 ml of 0.320 M $NaNO_3$ and 8.44 ml of 0.540 M Na_3PO_4.

Setup:

$.0125\ell \left(\frac{.320\text{ mole } NaNO_3}{\ell}\right)\left(\frac{1\text{ mole } Na^+}{1\text{ mole } NaNO_3}\right) = 4.00\times10^{-3}\text{ mole } Na^+$

$.00844\ell \left(\frac{.540\text{ mole } Na_3PO_4}{\ell}\right)\left(\frac{3\text{ moles } Na^+}{1\text{ mole } Na_3PO_4}\right) = 13.6\times10^{-3}\text{ mole } Na^+$

$[Na^+] = \frac{4.00\times10^{-3}\text{ mole} + 13.6\text{ mole}}{.0209\ell} = .842\ \frac{\text{mole}}{\ell}$

Answer_____

30. Consider the hypothetical equilibrium:

$$3\ C + 4\ B \rightleftharpoons 2\ A + 3\ D$$

If 3 moles of C and 4 moles of B are placed in a 4.00 liter container and allowed to reach equilibrium, the mixture is found to contain 1.5 moles of D. What is the amount of C at equilibrium?

Setup:

$1.5\text{ moles } D_{formed}\left(\frac{3\text{ moles } C_{react}}{3\text{ moles } D_{formed}}\right) = 1.5\text{mole } C_{react}$

$3\text{ moles } C_{initial} - 1.5\text{ moles } C_{react} = 1.5\text{ mole } C_{left\ over\ at\ equilibrium}$

Answer:_____