Key

Review - Chem 111

(MZ)

1) Which of the following compounds will produce an acidic solution when dissolved in water?
a) NO_2 b) $NaClO_4$ c) K_2SO_3 d) Na_2O e) $NaCN$

nonmetal oxide

2) Which of the following compounds will produce a basic solution when dissolved in water?
a) K_2O b) HNO_3 c) NH_4Cl d) HBr e) KBr

metal oxide

3) For the equilibrium given below, list the two pairs of base/conjugate acid:
$HSO_3^- + HF$ _____ $H_2SO_3 + F^-$
Answer:
a) F^- / HF
b) HSO_3^- / H_2SO_3

4) Consider a saturated solution of CaF_2 (s). Which of the following may take place upon the addition of $Ca(NO_3)_2$? Circle **all** correct answers.

$CaF_2(s) \rightleftharpoons Ca^{2+}_{(aq)} + 2F^-_{(aq)}$

a) More CaF_2 (s) dissolves. b) More CaF_2 will precipitate.
c) The concentration of the fluoride ions will decrease.
d) The concentration of Ca^{2+} ions will increase.
e) The concentration of NO_3^- will have no effect on the solubility of CaF_2 (s).
f) All of the above will happen g) None of (a) to (e) will happen.

5) The equilibrium concentration of HSO_3^- is much higher than the equilibrium conc. of SO_3^{2-} in the reaction:

$HSO_3^- + H_2O \rightleftharpoons SO_3^{2-} + H_3O^+$

List two conjugate acid /base pairs and label each species as stronger or weaker acid or base.
a) HSO_3^- / SO_3^{2-} weaker acid / stronger base
b) H_3O^+ / H_2O stronger acid / weaker base

6) A) Write the equilibrium equation for the solubility of $CaCO_3$ (s)

$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$ ← H^+ forming H_2CO_3

B) Circle **all** correct answers:
The molar solubility of $CaCO_3$(s) in a saturated solution can be decreased by:
a) Adding Na_2CO_3 b) Adding a strong acid c) Adding $CaCl_2$
d) Adding more $CaCO_3$ (s).

7) Fill in the table given below:

Unit cell	Simple cube	Body centered cube	Face-centered cube	Hexagonal unit cell
Number of particles inside the unit cell	1	2	4	4
The coordination number	6	8	12	12
Relative packing efficiency	lowest	high	highest	highest
Relative Density	lowest	high	highest	highest

(next page)

8) a) What are the structural components that exist in a compound for hydrogen bonding to take place?
Ans: HF, H–O, or H–N.
b) The intermolecular forces that exist between nonpolar molecules are called London forces.
c) The intermolecular forces that exist between polar molecules are called hydrogen bond and dipole-dipole

9) What are the forces of attraction between the lattice points of a crystalline solid made of:
a) $MgCl_2$ ionic bond b) SO_2 (bent geometry) dipole-dipole c) Copper (metal ion and sea of electrons) d) NH_3 (pyramidal) hydrogen forces
e) KBr ionic bond f) CO_2 (linear) London forces

10) a) What is the mass of one mole of cobalt atoms in grams? Ans: 58.939 g/mole
b) What is the mass of one cobalt atom in amu? Ans: 58.939 amu
c) What is the mass of one cobalt atom in grams? Show the set-up:

$$58.939\ \frac{g\ Co}{mole} \times \frac{1\ mole}{6.02\times10^{23}\ atoms} = 9.79\times10^{-23}\ g/atom$$

Ans: 9.79×10^{-23} g/atom

11) a) Define 'solution': homogeneous mixture.
b) Is air a compound, an element, or a solution? solution
c) If you combine sand and water, are you preparing a new element, a new compound, or a solution? none. Explain your answer. Sand and water is a "heterogeneous" mixture. The mixture can be separated into components by physical means.

12) Write the chemical formulas of the following compounds:
a) sodium nitride Na_3N b) cobaltous phosphide Co_3P_2
c) nickel (II) bisulfide $Ni(HS)_2$ d) Antimony (III) bisulfite $Sb(HSO_3)_3$
e) lead (II) thiocyanate $Pb(SCN)_2$ f) Aluminum thiosulfate $Al_2(S_2O_3)_3$

13) How many moles of C_6H_6O contain 7.03×10^4 carbon atoms?
setup:

$$7.03\times10^{4}\ atoms\ C\left(\frac{1\ mole\ C}{6.02\times10^{23}\ atoms\ C}\right)\left(\frac{1\ mole\ C_6H_6O}{6\ moles\ C}\right) = 1.95\times10^{-20}\ mole\ C_6H_6O$$

Answer: 1.95×10^{-20} mole C_6H_6O

14) a) Explain how particles of a hydrophobic sol remain dispersed without precipitating.

b) Heating may cause a hydrophobic sol to coagulate. Why?

15) List three methods for coagulating a hydrophobic colloid.

a)

b)

c)

16) a) What kind of particles (atoms , molecules, cations, anions, or cations and anions) may occupy the lattice points in each of the crystalline solids given below.
b) Give one or two examples of an element or a compound that may exhibit each type of crystalline solids.

Type of crystalline solid	metallic crystal	Ionic crystal	covalent network crystal	molecular crystal
Kind of particles	cations	cations and anions	atoms	molecules
Give one or two examples of an element or a compound.	Na (s) or Cu (s)	Na^+Cl^- (s) or K^+Br^- (s)	C (s) Si (s)	CO_2 (s) H_2O (s)

17) Which of the 0.010 m solution given below :
K_3PO_4 , C_2H_6O(alcohol) , HCN , NaOH, $(NH_4)_2SO_4$
(4) (1) (1→2) (2) (3)
would have:
a) The highest boiling point K_3PO_4

b) The lowest freezing point. K_3PO_4

Explain your answer. $K_3PO_4(aq) \rightarrow 3K^+ + PO_4^{3-}$ (4 "particles" per formula unit)

18) a) Define :
i) critical temperature:

ii) normal boiling point:

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b) Draw a typical vapor pressure-temperature phase diagram for water. Label the axes and the regions on the diagram where H_2O is expected to be in the solid, liquid, and gaseous state. Indicate on the diagram the normal boiling point, the normal freezing point, the triple point and the critical temperature.

19) What is the term used for a colloidal dispersion of :

a) solid dispersed in liquid _____ b) gas dispersed in liquid_____

c) liquid dispersed in liquid_____ d) solid dispersed in gas_____

e) liquid dispersed in gas _____ f) gas dispersed in solid _____

20) A) What is the approximate size range of colloidal particles in nm (nanometer)? _____

B) List five characteristic properties of colloids:

a)

b)

c)

d)

e)

21) **Circle** any solution that may be considered as a buffer. Justify your answer by listing all particles present in the solution after the reaction goes to completion, if any.

Particles present after reaction

a) One mole ammonium fluoride plus one mole of HBr. a) NH_4^+, Br^-, HF

$NH_4F + HBr \rightarrow NH_4Br + HF$

Buffer b) One mole of formic acid, $HCHO_2$, plus 0.5 mole of KOH. b) $K^+, CHO_2^-, HCHO_2$

$HCHO_2 + KOH \rightarrow H_2O + KCHO_2$

1.0 excess 0.5 limiting

c) One mole of ammonia plus one mole of LiOH. c) NH_3, Li^+, OH^-

NH_3 and $LiOH$

d) One mole of formic acid, $HCHO_2$, plus one mole of HCl. d) $HCHO_2, H^+, Cl^-$

$HCHO_2$ and HCl

22) a) Give the equation that shows the relationship between K_p and K_c. Define 'Δn' given in your equation.

Answer: $K_p = K_c(RT)^{\Delta n}$ $\Delta n = n_{product\ (gas)} - n_{reactant\ (gas)}$

b) The equilibrium reaction given below is **exothermic**.

$A(g) + B(g) \rightleftharpoons C(g) + D(g)$ + heat

Circle any factor given below that will cause the above equilibrium to shift to the right.

a) Removal of 'A'. b) The addition of 'D'

c) Removal of 'C'. d) Increasing the temperature

e) Increasing the volume of the container.

23) Which of the molecules given below is nonpolar?

a) CH_4 (tetrahedral) b) PF_3 (pyramidal) c) HBr d) H_2S (bent)

24) What is the solubility product expression, Ksp, for $Fe_3(PO_4)_2$?

Answer: $K_{sp} = [Fe^{2+}]^3 \cdot [PO_4^{3-}]^2$ $Fe_3(PO_4)_2(s) \rightleftharpoons 3Fe^{2+} + 2PO_4^{3-}$

-4

Answer

25) How many moles of chlorine atoms are needed to combine with 28.88 moles of oxygen atoms to produce Cl_2O_7 ?

Setup:

$$28.88 \text{ moles } O \left(\frac{2 \text{ moles } Cl}{7 \text{ moles } O} \right) = 8.251 \text{ moles } Cl$$

26) A) Define:

a) Electronegativity:

b) Electron affinity

c) ionization energy:

B) Give the general trend for the variation of the above properties by filling in the table given below:

	Electronegativity	Electron affinity	Ionization energy	Metallic property
From left to right across a period	increases	increases	increases	decreases
Down a group	decreases	decreases	decreases	increases

27) A) Give the definitions of acids, bases, and acid-base reactions by filling in the table below:

	An acid	A base	An acid-base reaction
According to Arrhenius			
According to Bronsted-Lowry			
According to Lewis			

B) i) What is the conjugate acid for NH_3. NH_4^+

ii) What is the conjugate base for NH_3 NH_2^-

iii) What is the conjugate acid for H_2O. H_3O^+

iv) What is the conjugate base for H_2O. OH^-

28) a) When heat is added to a mixture of ice and water at 0 °C, the temperature remains unchanged for a while. Why? Heat is used to break bonds between the particles of the solid.

b) When will the temperature of water start to increase? When all ice melt.

29) a) Is the pressure of the atmosphere higher on a mountain or in a valley? valley

b) The higher the external pressure (atmospheric pressure), the (higher / lower) the boiling point of a liquid.

c) The higher the temperature, the (higher, or lower) the vapor pressure of a liquid.

d) The stronger the intermolecular forces, the (higher, or lower) the normal boiling point.

30) What factor changes the numerical value of the equilibrium constant, K, for a particular reaction? Temperature.

31) How are real gases different from ideal gases?

a) _____

b) _____

c) _____

32) The behavior of a real gas may approach that of an ideal gas at a (high, or low) temperature and a (high, or low) pressure.

33) Balance the following equations:

a) $2\ C_7H_{14} + 21\ O_2 \rightarrow 14\ CO_2 + 14\ H_2O$

b) $3\ Ca(OH)_2 + 2\ Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ NaOH$

34) A) A n ion-exchange (double-displacement) reaction may go to completion due to the formation of any of the following three classes of compounds:

a) gas b) insoluble salt c) weakly ionized compound (weak acid, weak base, H_2O)

B) In a double-displacement reaction, formation of which of the compounds listed below would **not** necessarily lead to a chemical change? (Hint: You must memorize the solubility rules and the list of strong acids and bases)

a) CO_2 b) NH_3 c) AgBr d) $HCHO_2$ e) H_2O f) $Co(OH)_3$

g) $PbCl_2$ (h) Na_2CO_3

C) In a double-displacement reaction, formation of which of the compounds listed below would lead to a chemical change? (Hint: You must memorize the solubility rules and the list of strong acids and bases)

a) HNO_3 strong acid b) LiOH strong base c) K_3PO_4 soluble salt d) $(NH_4)_2SO_4$ soluble salt (e) $BaSO_4(s)$ insoluble salt

35) Name the following acids:

a) HIO_2 iodous acid b) HI hydroiodic acid

c) HBrO hypobromous acid d) HCN hydrocyanic acid

e) HF hydrofluoric acid f) $HBrO_3$ Bromic acid

$CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$

36) The molar solubility of $CaF_2(s)$ in a saturated solution can be increased by adding:
a) $CaCl_2$ b) NaF c) HBr d) none of these
(Hint: You need to write the equilibrium equation for the solubility of CaF_2 given above)

37) When barium chloride is added to a saturated solution of $BaSO_4(s)$, which of the following will result? (Hint: Write the equilibrium equation for the solubility of $BaSO_4$ (s).)

$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$

a) The concentration of SO_4^{2-} will increase.
b) The concentration of Ba^{2+} in solution will not change.
c) The added $BaCl_2$ will not dissolve and will settle to the bottom of the container.
d) More $BaSO_4$ (s) will precipitate.
e) All of the above will take place.

38) A mixture containing 25.53 g $AlCl_3$ and 19.38 g Na_2CO_3 is allowed to react according to the reaction given below:
(molar mass: $AlCl_3$= 133.5, Na_2CO_3 = 106, NaCl= 58.5 , $Al_2(CO_3)_3$ = 234)

$$2\ AlCl_3 + 3\ Na_2CO_3 \longrightarrow 6\ NaCl\ (aq) + Al_2(CO_3)_3\ (s)$$

a) How many grams of NaCl are produced?
Setup:

$$25.53\text{g } AlCl_3 \left(\frac{1\text{mole } AlCl_3}{133.5\text{g } AlCl_3}\right)\left(\frac{6\text{ moles NaCl}}{2\text{ moles } AlCl_3}\right)\left(\frac{58.5\text{g NaCl}}{1\text{mole NaCl}}\right) = 33.6\text{g NaCl}$$

$$19.38\text{g } Na_2CO_3\left(\frac{1\text{mole } Na_2CO_3}{106\text{g } Na_2CO_3}\right)\left(\frac{6\text{ moles NaCl}}{3\text{moles } Na_2CO_3}\right)\left(\frac{58.5\text{g NaCl}}{1\text{mole NaCl}}\right) = 21.4\text{g NaCl}$$

Answer

b) Find the mass of any unreacted $AlCl_3$ or Na_2CO_3 assuming 100 % yield.
Setup:

$$19.38\text{g } Na_2CO_3\left(\frac{1\text{ mole } Na_2CO_3}{106\text{g } Na_2CO_3}\right)\left(\frac{2\text{ moles } AlCl_3}{3\text{ moles } Na_2CO_3}\right)\left(\frac{133.5\text{g } AlCl_3}{1\text{mole } AlCl_3}\right)$$

$$= 16.3\text{g } AlCl_3 \text{ reacted}$$

$25.53\text{g } AlCl_3 - 16.3\text{g } AlCl_3 = 9.23\text{g } AlCl_3$ left unreacted

39) How many grams of oxalic acid, $H_2C_2O_4$, are required to completely neutralize 35.0 ml of 0.670 ***M*** NaOH ? (molar mass: $H_2C_2O_4$ = 90.0, NaOH = 40.0, $Na_2C_2O_4$ =134.0, H_2O = 18.0)

$$H_2C_2O_4 + 2\ NaOH \longrightarrow Na_2C_2O_4 + 2\ H_2O$$

Setup:

$$\frac{.670\text{ mole NaOH}}{1\text{ liter}} \times .0350\text{l}\left(\frac{1\text{mole } H_2C_2O_4}{2\text{ moles NaOH}}\right)\left(\frac{90.0\text{g } H_2C_2O_4}{1\text{mole } H_2C_2O_4}\right)$$

$$= 1.06\text{ g } H_2C_2O_4$$

40) What is the mole fraction of ethylene glycol, $C_2H_6O_2$, in 5.55 ***m*** ethylene glycol solution? (molar mass of ethylene glycol= 62.0, H_2O = 18.0)
Setup: 5.55 moles ethylene glycol in 1000g H_2O

i) change 1000g H_2O into moles H_2O: $1000\text{g } H_2O\left(\frac{1\text{mole } H_2O}{18.0\text{g } H_2O}\right) = 55.5\text{ mole } H_2O$

ii) $$\chi_{\text{ethylene glycol}} = \frac{n_{\text{ethylene glycol}}}{n_{\text{ethylene glycol}} + n_{H_2O}} = \frac{5.55\text{ mole}}{(55.5 + 5.55)\text{ mole}} = .091$$

Answer

41) The folowing equilibrium was achieved in a 3.00 liter container.

NH_4HS (s) ____ NH_3 (g) + H_2S (g)

At equilibrium, there were 0.20 mole NH_4HS (s), 0.45 mole NH_3 (g), and 2.11 mole H_2S (g). Calculate K_c under these conditions.

Setup:

$$K_c = [NH_3]\cdot[H_2S] = \left(\frac{.45\ mole}{3.00\ l}\right)\left(\frac{2.11\ mole}{3.00\ l}\right)$$

$$= .11$$

42) The density of an unknown gas is 2.89 g/liter at 33 ° C and 745 torr. Calculate the molar mass of the unknown gas. (R= 0.0821 L . atm/mol . K)

Setup:

$$P = \frac{DRT}{\text{molar mass}}$$

$$\text{molar mass} = \frac{DRT}{P}$$

$$= 2.89\ \frac{g}{liter}\left(.0821\ \frac{latm}{mole\,K}\right)\frac{306\ K}{745\ torr}\left(\frac{760\ torr}{1\ atm}\right)$$

$$= 74.0\ \frac{g}{mole}$$

43) For the equilibrium:

CH_4 (g) + H_2O (g) $\rightleftharpoons$ CO (g) + 2 H_2 (g)

at 1500 ° C, K_c is 5.67. What is K_p for the equilibrium at 1500 ° C ?

Setup:

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

$$= 5.67\left[(.0821)(1773)\right]^{3-2=1}$$

$$= 825$$

44) For the equilibrium:

CH_3OH (g) $\rightleftharpoons$ CO (g) + 3 H_2 (g)

at 275 ° C , K_p is 1.14×10^3 . What is K_c for the equilibrium at 275 ° C ?

Setup:

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{1.14\times10^3}{[(.0821)(548)]^{4-1=3}} = .0125$$

45) What is the molar solubility of MgF_2 in a 0.20 *M* NaF ? (Ksp for MgF_2 = 8.0×10^{-8})

(Hint: Write the equilibrium equation for the solubiliyt of MgF_2)

Setup:

$MgF_2(s) \rightleftharpoons Mg^{2+} + 2F^-$

	Mg^{2+}	$2F^-$
initial conc.	0	.20
change conc.	+S	+2S
equi conc.	S	.20+2S

$$K_{sp} = [Mg^{2+}][F^-]^2 = (S)(.20+2S)^2 \quad \text{(2S negligible)}$$

$$8.0\times10^{-8} = (S)(.20)^2$$

$$S = 2.0\times10^{-6}\ M$$

46) What is the pH of a 0.0030 *M* HNO_3 solution?

Setup:

$HNO_3 \rightarrow H^+ + NO_3^-$

strong acid

$[H^+] = .0030M$

$pH = 2.52$ Two sig. figures

47) What is the $[H^+]$ of a solution which is 0.15 ***M*** HNO_2 and 0.75 ***M*** $NaNO_2$? (K_a for HNO_2= 4.5×10^{-4})

Setup:

$$HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$$

	HNO_2		H_3O^+		NO_2^-
Initial conc.	.15		0		0.75
change in conc.	$-x$		$+x$		$+x$
Equi conc.	$.15-x$		x		$.75+x$

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]} \; ; \quad 4.5 \times 10^{-4} = \frac{(x)(.75+x)}{(.15-x)}$$

$[H_3O^+] = 9.0 \times 10^{-5} M$

48) What is the $[OH^-]$ of a solution which is 0.080 ***M*** $(CH_3)_2NH$ and 0.32 ***M*** $(CH_3)_2NH_2Cl$? ([K_b for $(CH_3)_2NH$ is 7.4×10^{-4}]

Setup:

$$(CH_3)_2NH + H_2O \rightleftharpoons (CH_3)_2NH_2^+ + OH^-$$

	$(CH_3)_2NH$		$(CH_3)_2NH_2^+$		OH^-
	.080		.32		0
	$-x$		$+x$		$+x$
	$.080-x$		$.32+x$		x

$$K_b = \frac{[(CH_3)_2NH_2^+][OH^-]}{[(CH_3)_2NH]} \; ; \quad 7.4 \times 10^{-4} = \frac{(.32+x)(x)}{(.080-x)} \; ; \quad [OH^-] = 1.9 \times 10^{-4} M$$

49) What is the concentration of the H^+ ion in a 0.30 ***M*** HCN ? (K_a for HCN = 4.0×10^{-10})

Setup:

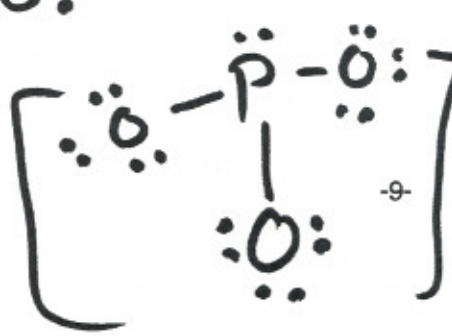
$$HCN + H_2O \rightleftharpoons H_3O^+ + CN^-$$

	HCN		H_3O^+		CN^-
	.30		0		0
	$-x$		$+x$		$+x$
	$.30-x$		x		x

$$K_a = \frac{[H_3O^+][CN^-]}{HCN} \; ; \quad 4.0 \times 10^{-10} = \frac{(x)(x)}{(.30-x)} \; ; \quad [H_3O^+] = 1.1 \times 10^{-5} M$$

50) Draw the Lewis structure(electron-dot structure) for the following molecules and ions:

a) CO_2 b) PO_3^{3-} c) CO_3^{2-} d) HCN (C is the central atom)



51) The addition of 8.83 g $C_{12}H_{22}O_{11}$ (a nonionizing compound) to a 125 ml of water at 23 ° C resulted in 143 ml solution. (The density of water at 23 °C is 1.00g/ml ; molar mass: $C_{12}H_{22}O_{11}$ =342.0, H_2O= 18.0)

a) Calculate the molarity of the solution.

Setup: moles $C_{12}H_{22}O_{11}$ = $\frac{8.83\ g\ C_{12}H_{22}O_{11}}{342.0\ g/mole}$

= .0258 mole

Molarity = $\frac{.0258\ mole\ C_{12}H_{22}O_{11}}{0.143\ l_{solution}}$ = .181 $\frac{mole}{l}$

b) Calculate the molality of the solution.

Setup:

Molality = $\frac{.0258\ mole\ C_{12}H_{22}O_{11}}{0.125\ kg\ H_2O}$ = 0.206 $\frac{mole}{kg}$

c) Find the freezing point of the solution given above. (K_f for water= 1.86 ° C .kg/mole)

Setup: $\Delta T = K_f$ molality

= 1.86 °C. $\frac{kg}{mole}$ $\left(\frac{.206\ mole}{kg}\right)$ = 0.384 °C

T_f = − 0.384°C

52) Consider the following equilibria:

$H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$ $K_{a1} = 4.2 \times 10^{-7}$

$HCO_3^- + H_2O \rightleftharpoons H_3O^+ + CO_3^{2-}$ $K_{a2} = 4.2 \times 10^{-11}$

a) What is the the hydrogen ion concentration, $[H^+]$, in a 0.300 *M* solution of H_2CO_3 ?

Setup:

	H_2CO_3	+ H_2O	⇌	H_3O^+	+	HCO_3^-
	0.300			0		0
	− x			+ x		+ x
	0.300 − x			x		x

$K_{a_1} = \frac{[H_3O^+][HCO_3^-]}{[H_2CO_3]}$ ≈ $4.2 \times 10^{-7} = \frac{x^2}{(0.300 - x)}$ ← negligible

Answer: $[H_3O^+] = 3.5 \times 10^{-4}$

b) What the carbonate ion concentration, $[CO_3^{2-}]$, in the above 0.300 *M* H_2CO_3 ?

$[CO_3^{2-}] = K_{a_2}$ = 4.2×10^{-11} M

53) The pH of a 0.20*M* weak monoprotic acid, HX, is 4.60. Calculate the ionization constant, K_a, for this acid.

Setup:

	HX	+ H_2O	⇌	H_3O^+	+	X^-
	0.20			0		0
	-2.5×10^{-5}			$+2.5 \times 10^{-5}$		$+2.5 \times 10^{-5}$
	$0.20 - 2.5 \times 10^{-5}$			2.5×10^{-5}		2.5×10^{-5}

$K_a = \frac{[H_3O^+][X^-]}{[HX]} = \frac{(2.5 \times 10^{-5})^2}{(0.20 - 2.5 \times 10^{-5})}$ = 3.0×10^{-9}

54) What would be the ionization constant, K_a, of a weak monoprotic acid, HX, if it is 5.0 % ionized in a 0.18 M solution?

Setup:

$HX + H_2O \rightleftharpoons H_3O^+ + X^-$

.18	0	0	
$-\left[\frac{5.0}{100}(.18)\right]$	$+\left[\frac{5.0}{100}(.18)\right]$	$+\left[\frac{5.0}{100}(.18)\right]$	
$\left[.18-\frac{5.0}{100}(.18)\right]$	$\left[\frac{5.0}{100}(.18)\right]$	$\left[\frac{5.0}{100}(.18)\right]$	

ii) $K_a = \frac{[H_3O^+][X^-]}{[HX]} = \frac{(9.0\times10^{-3})2}{(0.18-9.0\times10^{-3})} = 4.7\times10^{-4}$

55) A compound contains 1.55 g Phosphorus and 1.20 g oxygen. Calculate the simplest formula of the compound. (molar mass: P = 31.00, O=16.00)

Setup:

i) P : O

$\frac{1.55g}{31.0g/mole} : \frac{1.20g}{16.0g/mole}$

.0500mole : .0750mole

ii) P : O

$\frac{.0500}{.0500} : \frac{.0756}{.0500}$

1 : 1.5

2 : 3

Answer P_2O_3

56) Calculate the molarity of a solution made by diluting 8.00 ml of 15.00 ***M*** H_3PO_4 to a 0.500 L.

Setup:

$M_{before} V_{before} = M_{after} V_{after}$

$15.00\ \frac{mole}{l}\ (.00800l) = M_{after}\ (0.500l)$

$M_{after} = 0.240\ mole/l$

57) What would be the H^+ concentration of a solution resulting from mixing 35.0 ml of 0.20 ***M*** HCl and 35.0 ml of 0.15 ***M*** NaOH? $HCl + NaOH \rightarrow NaCl + H_2O$

Setup:

* moles $HCl = .20\ \frac{mole}{l} \times .350\ l = 7.0\times10^{-3}$

moles $NaOH = .15\ \frac{mole}{l} \times .0350\ l = 5.3\times10^{-3}$

* moles HCl leftover $= 7.0\times10^{-3} - 5.3\times10^{-3} = 1.7\times10^{-3}$ moles

$[H^+] = \frac{1.7\times10^{-3}\ mole}{.0700\ l} = .024\ M$

58) What is the mass of CO_2 (g) collected in a 580 ml flask at 50 ° C and 1.50 atm ? (R= 0.0821 L.atm/mol.K)

Setup:

$PV = \frac{mass}{molar\ mass} RT$

$.580\ l \times 1.50\ atm = \frac{mass}{44.0g/mole}\left(.0821\ \frac{l\,atm}{mole\,K}\right)323K$

$mass = 1.44g$

59) What is the density of NH_3 (g) at 100 ° C and 1.35 atm? (R= 0.0821 L.atm/mol.K)

Setup:

$D = \frac{P \cdot molar\ mass}{RT} = \frac{1.35\ atm\left(17.0\ \frac{g}{mole}\right)}{.0821\ \frac{l\,atm}{mole\,K}(373K)}$

$= 0.749\ g/l$

60) Consider the following reaction:

$2\ C_2H_6\ (g) + 7\ O_2\ (g) \_\_\_\_\_ 4\ CO_2\ (g) + 6\ H_2O\ (g)$

a) What volume of oxygen gas is required for the complete combustion of 15.0 L of ethane, C_2H_6 (g), if all gases are measured at the same temperature and pressure?

Setup: At the same temp & pressure, equal volumes of gases contain the same # of particles [$V \propto n$]

$$15.0\,l\ C_2H_6 \left(\frac{7\,l\ O_2}{2\,l\ C_2H_6}\right) = 52.5\,l$$

b) What volume of oxygen gas is required for the complete combustion of 15.0 L of ethane, C_2H_6 (g), if all gases are measured at STP condition?

Setup: Again, all gases are measured at the same temp and pressure of 273 K & 1 atm

$$15.0\,l\ C_2H_6 \left(\frac{7\,l\ O_2}{2\,l\ C_2H_6}\right) = 52.5\,l$$

61) How many grams of Fe(s) are needed to produce 100. L of H_2 (g), measured at STP ?

$3\ Fe\ (s) + 4\ H_2O\ (g) \_\_\_\_\_ Fe_3O_4\ (s) + 4\ H_2\ (g)$

(molar mass: Fe= 55.8, Fe_3O_4 = 231.4, H_2O= 18.0, H_2 = 2.00)

Setup:

$$100.\,l_{STP} \left(\frac{1\ mole\ H_2}{22.4\,l_{STP}}\right)\left(\frac{3\ moles\ Fe}{4\ moles\ H_2}\right)\left(\frac{55.8\,g\ Fe}{1\ mole\ Fe}\right) = 187\,g\ Fe$$

Answer: 187 g Fe

62) 350 ml of Ar (g) at 30 ° C and 1.50 atm are mixed with 540 ml of N_2 (g) at 50 ° C and 0.80 atm. The two gases do not react. What would be the total pressure, if the two gases were transferred to a 2.50 L flask at 80 ° C . (R= 0.0821 L.atm/mol.K; molar mass: Ar = 39.95, N_2 = 28.0)

Setup:

i) $\frac{P_{Ar} V_{Ar}}{T_{Ar}} = \frac{P'_{Ar} V'_{Ar}}{T'_{Ar}}$

$$\frac{1.50\ atm \cdot 350\,l}{303\,K} = \frac{P'_{Ar}\ 2.50\,l}{353\,K}$$

$P'_{Ar} = 0.244$ Atm

ii) $\frac{P_{N_2} V_{N_2}}{T_{N_2}} = \frac{P'_{N_2} V'_{N_2}}{T'_{N_2}}$

$$\frac{0.80\ atm \cdot 540\,l}{323\,K} = \frac{P'_{N_2}\ 2.50\,l}{353\,K}$$

$P'_{N_2} = 0.19$ atm

$P'_{Ar} + P'_{N_2} = .244 + .19 = 0.435$ atm

Answer

63) A mixture of 40.0 g oxygen gas and 40.0 g helium gas exerts a total pressure of 0.900 atm . What is the partial pressure of the oxygen gas ? (molar mass of O_2= 32.0 , He = 4.0)

Setup:

$$n_{O_2} = \frac{40.0\,g\ O_2}{32.0\,g/mole} = 1.25\ mole$$

$$n_{He} = \frac{40.0\,g\ He}{4.0\,g/mole} = 10.\ mole$$

$$P_{O_2} = \left(\frac{n_{O_2}}{n_{O_2} + n_{He}}\right) P_{total}$$

$$= \left(\frac{1.25\ mole}{(1.25 + 10.)\ mole}\right) .900\ atm = 0.10\ atm$$

Answer: atm