MULTIPLE CHOICE (2 pts each): Write the letter corresponding to the correct answer(s) on the line next to each question. (These will only have one answer each.) The LETTER ASSOCIATED WITH THE CORRECT ANSWER <u>MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION</u> in order to receive full credit.

_____C_____ 1.) Which of the following is an ionic compound?

(a) H_2S (b) CBr_4 (c) CaF_2 (d) PF_3 (e) $XeCl_6$

_____A_____ 2.) Which of the following would conduct the most electricity in water?

(a) 2 M $Cu(NO_3)_2$ (b) 3 M $Mg(OH)_2$ (c) 3 M PbI_2 (d) 1 M NaCl   (e) 2 M KI

                    insoluble   insoluble

_____D_____ 3.) What is the concentration of sodium ions in a solution containing 0.5 M Na_2SO_4 and 2 M NaCl?

(a) 1. 5 M   (b) 2 M   (c) 2.5 M   (d) 3 M   (e) 3.5 M

from 0.5M Na_2SO_4 : $2 \times 0.5 M = 1 M$

from 2 M NaCl : $1 \times 2 M = \dfrac{2 M}{3 M}$

_____D_____ 4.) If you double the volume of a balloon at constant temperature, what happens to the pressure?

(a) increases by 2   (b) doubles   (c) increases by 1/2   (d) decreases by 1/2   (e) no change

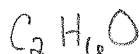$P_1 V_1 = P_2 V_2$ $P_1 V_1 = (\tfrac{1}{2} P_2)(2 V_2)$

_____B_____ 5.) What is the empirical formula for a compound with a mass composition of 52.1% C, 13.1% H, 34.7% O?

(a) CH_4O (b) C_2H_6O (c) C_3H_8O (d) $C_4H_{10}O$ (e) $C_5H_{12}O$

$52.1 gC \left(\dfrac{1 mol}{12.011 g}\right) = 4.3377$ mol /2.1688 mol $= 2$

$13.1 g H \left(\dfrac{1 mol}{1.00794 g}\right) = 12.997$ mol /2.1688 mol $= 6$

$34.7 g O \left(\dfrac{1 mol}{15.9994 g}\right) = 2.1688$ mol /2.1688 mol $= 1$

$C_2 H_6 O$

SHORT ANSWER: Completely answer all of the following questions. Read all questions carefully!!! <u>SHOW ALL WORK</u>. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated boxes or tables when they are provided.

$23.94834 g/mol$
$44.0098 g/mol$

1. (10 pts) For the following reaction: $2\ LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$
If a reaction vessel contains 105.37g LiOH and 140.83g CO_2 Answer:
   (a) Which compound is the limiting reagent? $73.8912 g/mol$
   (b) What is the theoretical yield?
   (c) If the reaction produced 152.6 g, what is the percent yield?

$105.37 g\ LiOH \left(\dfrac{1 mol}{23.94834 g}\right) = 4.3999\ mol \left(\dfrac{1 mol\ Li_2CO_3}{2 mol\ LiOH}\right) = 2.1999\ mol$
(a)

$140.83 g\ CO_2 \left(\dfrac{1 mol}{44.0098 g}\right) = 3.19997\ mol \left(\dfrac{1 mol\ Li_2CO_3}{1 mol\ CO_2}\right) = 3.19997\ mol$

$2.1999\ mol\ Li_2CO_3 \left(\dfrac{73.8912 g}{mol}\right) = 162.553 g$
(b)

$\left(\dfrac{152.6 g}{162.55 g}\right) \times 100 = 93.8788\%$
(c)

(a) | LiOH |
(b) | 162.55g |
(c) | 93.88% |

2. (10 pts) A gas at a temperature of 99.8°C occupies a volume of 641 mL. What will the volume be (in mL) at a temperature of 5.0 °C, assuming no change in pressure?

$\dfrac{P_1 V_1}{P_1 T_1} = \dfrac{P_2 V_2}{P_2 T_2} \qquad \dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$

$5.0°C + 273.15 = 278.15 K$ Answer:

$99.8°C + 273.15 = 372.95 K$

$278.15 K \times \dfrac{641 mL}{372.95 K} = \dfrac{V_2}{278.15 K} \times 278.15 K$

$V_2 = 478\ mL$

Answer: | 478 mL |

3. (10 pts) What is the molarity of a Lithium hydroxide solution if bubbling CO_2 through 0.30 L of the solution produces 0.884 g of lithium carbonate?

$2\ LiOH + CO_2 \rightarrow Li_2CO_3 \quad \leftarrow 73.8912 g/mol$
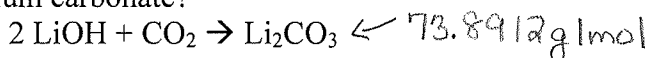
$M = \dfrac{mol}{L}$

$0.884 g\ Li_2CO_3 \left(\dfrac{1 mol\ Li_2CO_3}{73.8912 g\ Li_2CO_3}\right) = 0.0119635 mol \left(\dfrac{2 mol\ LiOH}{1 mol\ Li_2CO_3}\right)$

$= 0.0239271\ mol\ LiOH$

Answer: | 0.080 M |

$\dfrac{mol}{L} = \dfrac{0.0239271\ mol\ LiOH}{0.30 L} = 0.0797569 \dfrac{mol}{L}$

$$8.25 \text{ torr} \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right) = 0.010855 \text{ atm}$$

4. (10 pts) Calculate the volume of 4.00 mol of Argon gas at 8.25 torr and 27°C.

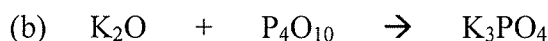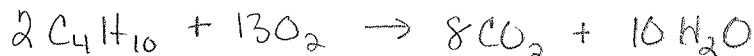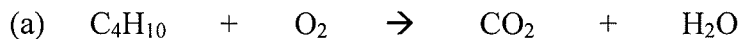$$+273.15 = 300.15 \text{ K}$$

Answer:

$$PV = nRT$$

$$\frac{(0.010855 \text{ atm})(V)}{0.010855 \text{ atm}} = \frac{(4.00 \text{ mol})(0.0821 \frac{L \cdot atm}{mol \cdot K})(300.15 \text{ K})}{0.010855 \text{ atm}}$$

$$\boxed{9.08 \times 10^{+3} \text{ L}}$$

or 9080 L

$$V = 9080.54 \text{ L} \rightarrow 9.08 \times 10^{+3} \text{ L}$$

5. (5 pts) Balance the following equations:

(a) C_4H_{10} + O_2 → CO_2 + H_2O

$$2 C_4H_{10} + 13 O_2 \rightarrow 8 CO_2 + 10 H_2O$$

(b) K_2O + P_4O_{10} → K_3PO_4

$$6 K_2O + P_4O_{10} \rightarrow 4 K_3PO_4$$

$$\swarrow 73.8912 \text{ g/mol}$$

6.) (10 pts) What is the resulting concentration (M) if 56.8 g Lithium Carbonate (Li_2CO_3) is dissolved in 250.0 mL water? $M = \frac{mol}{L}$

Answer:

$$250.0 \text{ mL} \left(\frac{1 L}{1000 \text{ mL}} \right) = 0.2500 \text{ L}$$

$$56.8 \text{ g} \left(\frac{1 \text{ mol}}{73.8912 \text{ g}} \right) = 0.768698 \text{ mol}$$

$$\boxed{3.07 \text{ M}}$$

$$M = \frac{0.768698 \text{ mol}}{0.2500 \text{ L}} = 3.07479 \frac{mol}{L}$$

7. (5 pts) What volume of a 4.50 M stock solution of potassium nitrate would be needed to make 500.0 mL of a dilute 2.46 M solution?
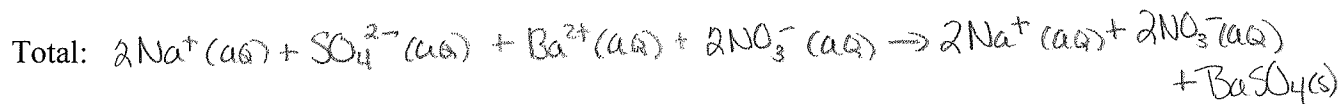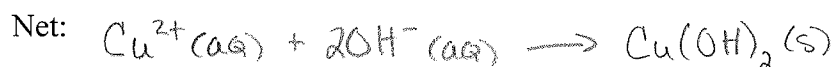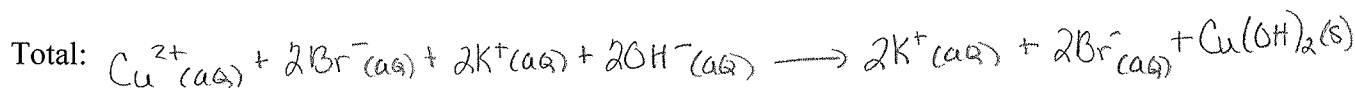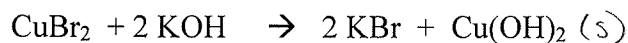
Answer:

$$M_1 V_1 = M_2 V_2$$

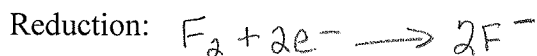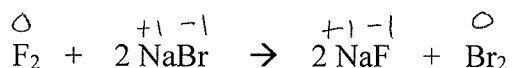$$(4.50 M)(V_1) = (2.46 M)(500.0 \text{ mL})$$
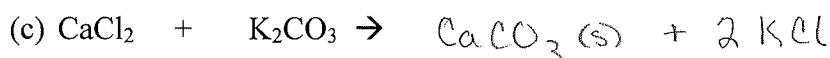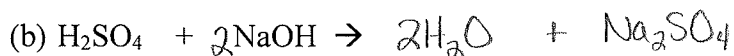
$$\boxed{273 \text{ mL}}$$

$$V_1 = 273.33 \text{ mL}$$

8. (a) (5 pts) Determine the insoluble product and write total ionic and net ionic equations for the following reactions:

$CuBr_2 + 2 KOH \rightarrow 2 KBr + Cu(OH)_2 (s)$

Total: $Cu^{2+}_{(aq)} + 2Br^-_{(aq)} + 2K^+_{(aq)} + 2OH^-_{(aq)} \longrightarrow 2K^+_{(aq)} + 2Br^-_{(aq)} + Cu(OH)_2 (s)$

Net: $Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Cu(OH)_2 (s)$

$Na_2SO_4 + Ba(NO_3)_2 \rightarrow 2 NaNO_3 + BaSO_4 (s)$

Total: $2Na^+_{(aq)} + SO_4^{2-}_{(aq)} + Ba^{2+}_{(aq)} + 2NO_3^-_{(aq)} \rightarrow 2Na^+_{(aq)} + 2NO_3^-_{(aq)} + BaSO_4 (s)$

Net: $Ba^{2+}_{(aq)} + SO_4^{2-}_{(aq)} \longrightarrow BaSO_4 (s)$

(b) (5 pts) Write oxidation and reduction half reactions for the following redox reactions.

$\overset{0}{F_2} + 2 \overset{+1 \ -1}{NaBr} \rightarrow 2 \overset{+1 \ -1}{NaF} + \overset{0}{Br_2}$

Oxidation: $2Br^- \longrightarrow Br_2 + 2e^-$

Reduction: $F_2 + 2e^- \longrightarrow 2F^-$

$\overset{0}{Ca} + \overset{+2 \ -1}{Sn(NO_3)_2} \rightarrow \overset{0}{Sn} + \overset{+2 \ -1}{Ca(NO_3)_2}$

Oxidation: $Ca \longrightarrow Ca^{2+} + 2e^-$

Reduction: $Sn^{2+} + 2e^- \longrightarrow Sn$
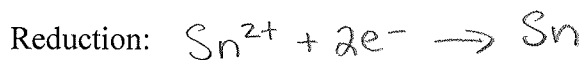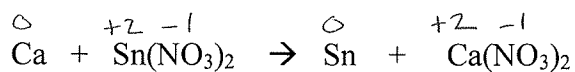
9. (10 pts) Write the products of each of the following reactions and balance the equations. If no reaction will occur, write NO REACTION.

(a) $Sn + BaCl_2 \rightarrow$ no reaction

(b) $H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4$

(c) $CaCl_2 + K_2CO_3 \rightarrow CaCO_3 (s) + 2KCl$

(d) $Mg + 2AgCl \rightarrow MgCl_2 + 2Ag$

10. (10 pts) If 21.4 mL of a 0.250 M NaOH solution was needed to neutralize 16.8 mL of sulfuric acid (H_2SO_4), what was the concentration (M) of the acid solution?

$H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4$
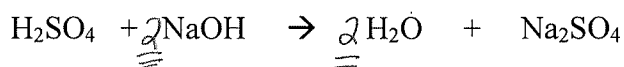
need to balance!

Answer:

$$0.159 \ M$$

$0.250 \dfrac{mol\ NaOH}{L} \times 0.0214\ L = 0.00535\ mol\ NaOH \left(\dfrac{1\ mol\ H_2SO_4}{2\ mol\ NaOH}\right)$

$= \dfrac{0.0026775\ mol\ H_2SO_4}{0.0168\ L} = 0.1594226 \dfrac{mol}{L}$