Chemistry 1 Name _____KEY_____
Semester 2 Final Exam Study Guide Period _____ Date _____

**Directions for Questions #1 to #2**: For each word equation, (1) write an unbalanced chemical equation including correct chemical formulas and state symbols. (2) Then write the balanced chemical equation that satisfies the law of conservation of mass.

1. Solid sodium carbonate is reacted with aqueous hydrochloric acid, producing gaseous carbon dioxide, liquid water, and aqueous sodium chloride.
   $Na2CO3(aq) + 2\ HCl(aq) \rightarrow CO2(g) + H2O(l) + 2NaCl(aq)$

2. An electric current is passed through liquid water and it decomposes into oxygen gas and hydrogen gas.
   $2\ H_2O\ (l) \xrightarrow{\text{Electricity}} O(g) + 2\ H_2(g)$

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Directions: Predict the products for each reaction and then balance each equation.
DECOMPOSITION:

a. $FeCO_3 \rightarrow FeO + CO_2$

b $CaCl_2 \rightarrow Ca + Cl_2$

COMBINATION:

c. $Ca + N_2 \rightarrow Ca_3N_2$

SINGLE EXCHANGE:

d. $Cl_2 + KI \rightarrow I_2 + KCl$

e. $Al + CuCl_2 \rightarrow 3\ Cu + 2\ AlCl_3$

DOUBLE EXCHANGE:

f. $Pb(NO_3)_2 + K_2SO_4 \rightarrow PbSO_4 + 2\ KNO_3$

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**Directions: Use Eq. 1 to answer Questions #5-10. Show work.**

**Eq.** 1 $4\ Cr + 3\ O_2 \rightarrow 2\ Cr_2O_3$

5. What is the mole ratio of oxygen gas to chromium (III) oxide?
   $3\ O_2 : 2\ Cr_2O_3$

6. How many moles of oxygen is needed to produce 2 moles of chromium (III) oxide?

$$?\ mol\ O_2 = 2\ mol\ Cr_2O_3 \times \frac{3\ mol\ O_2}{2\ mol\ Cr_2O_3} = \boxed{3\ mol\ O_2}$$

7. What is the molar mass of chromium in grams/mole?
   52.00 g/mol - Find Cr on P.T. & use atomic mass w/ units g/mol

8. Using the molar mass from #7, how many moles of product can be made from 104 grams of chromium?

$$?\ mol\ Cr_2O_3 = 104\ g\ Cr \times \frac{1\ mol\ Cr}{52.00\ g\ Cr} \times \frac{2\ mol\ Cr_2O_3}{4\ mol\ Cr} = \boxed{1\ mol\ Cr_2O_3}$$

9. What is the molar mass of the product, chromium (III) oxide? Show work.

$$2(52.00) + 3(16) = 104 + 48 = \boxed{152\ g/mol}$$

10. Using the molar mass from #9, how many grams of product can be made from 52 grams of chromium (Cr) and excess oxygen gas?

$$?\ g\ Cr_2O_3 = 52\ g\ Cr \times \frac{1\ mole\ Cr}{52\ g\ Cr} \times \frac{2\ mol\ Cr_2O_3}{4\ mol\ Cr} \times \frac{152\ g\ Cr_2O_3}{1\ mol\ Cr_2O_3} = \boxed{76\ g\ Cr_2O_3}$$

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11. What is the molarity of a solution made by dissolving 0.5 moles of NaCl in water to make 5 liters of solution?

$$M = \frac{mol\ solute}{L\ soln't} = \frac{0.5\ mol}{5\ L} = \boxed{0.1\ M\ NaCl}$$

12. What is the molar mass of $Na_2CO_3$? Show work.

$$2(22.99) + 12.01 + 3(16) = \boxed{106\ g/mol}$$

13. Using the molar mass calculate in #12, find the molarity of a solution prepared by dissolving 31.9 grams of $Na_2CO_3$ in water to make 750 mL of solution.

$$?\ mol\ Na_2CO_3 = 31.9\ g\ Na_2CO_3 \times \frac{1\ mol\ Na_2CO_3}{106\ g\ Na_2CO_3} = 0.30\ mol \qquad M = \frac{0.30\ mol}{0.75\ L} = \boxed{0.4\ M}$$

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14. A student dissolved sodium hydroxide (NaOH) in water at 23 °C. The final temperature is 49.0 °C. Is the reaction endothermic or exothermic? How do you know?

Exothermic. The temp increased to 49°C indicating heat transfer from system to surroundings.

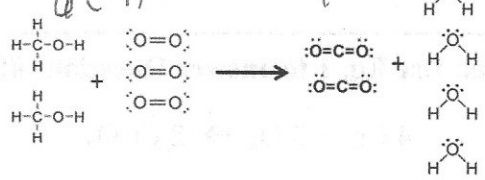
Use the following information to answer Question #15.

| Bond | C–H | C–C | O–H | C–O | C=O | O=O |
|---|---|---|---|---|---|---|
| Average bond energy (kJ/mol) | 413 | 347 | 467 | 358 | 799 | 495 |

15. What is the energy change during the combustion of 2 moles of methanol?

6 C-H
2 O-H
2 C-O
4 C=O
8 (H-O)

$$2CH_4O(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$$



a. Calculate the energy to break the bonds of the reactants:

$$6(C\text{-}H) + 2(C\text{-}O) + 2(O\text{-}H) + 3(O=O) =$$
$$6(413) + 2(358) + 2(467) + 3(495) = 2478 + 716 + 934 + 1485 = 5613\ kJ/mol$$

b. Calculate the energy released when the bonds of the products form:

$$4(C=O) + 8(O\text{-}H) = 4(-799) + 8(-467) = -6932\ kJ/mol$$

c. Which of the following is delta-H (ΔH) for the combustion of 2 moles of methanol?

A. 2214 kJ/mol
B. 1319 kJ/mol
C. -1319 kJ/mol
D. -2144 kJ/mol

$$\Delta H = \text{energy bond breaking} + (-\text{energy bond forming}) = 5613 + (-6932) = -1319\ kJ/mol$$

#16. Graph A shows exothermic like C. Graph B so ΔH is out.