Chemical Reactions

1 (Give :	an ex	ample c	f a s	svstem	which is	closed	with	respect	to liaht.
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2 Give an example of a system which is open with respect to light but closed in respect to mass.

- 3 You rip a piece of paper into several pieces.
- a) What is conserved with respect to the paper?
- b) What is not conserved with respect to the paper?
- c) One piece of paper is taken away. What is conserved now?
- d) One piece of paper is taken away. What is NOT conserved now?

4 Which conservation laws, if any, are being broken in the following situations?

a) Fe + S
$$\rightarrow$$
 CuS

- b) 7.0 g of nitrogen are reacted with 8.0 g of oxygen to make 16.0 g of nitrogen monoxide.
- c) $2 Ag^+ + SO_4^{2-} \rightarrow Ag_2SO_4$
- d) 3 Cr + $O_2 \rightarrow Cr_2O_3$
- e) 71.0 g of chlorine gas and 64.0 g of oxygen gas produce 135 g of chlorine dioxide gas.

5 Which of the following are conserved in a chemical reaction?

- a) phase
- b) number of atoms
- c) volume

6 Do the following reactions obey the laws of conservation of atoms and mass? Explain.

a) ___ CH₄ + 2 O₂
$$\rightarrow$$
 ___ CO₂ + 2 H₂O

b) ___ NaOH + ___ HCl
$$\rightarrow$$
 ___ NaCl + ___ H₂O

7 Balance the following chemical equations:

a)
$$_$$
 Sn + $_$ O₂ \rightarrow $_$ SnO

b)
$$\underline{\hspace{1cm}}$$
 H₂ + $\underline{\hspace{1cm}}$ CI₂ \rightarrow $\underline{\hspace{1cm}}$ HCI

c) ____
$$N_2$$
 + ___ $H_2 \rightarrow$ ___ NH_3

d) ___ Na + ___
$$H_2O \rightarrow$$
 ___ NaOH + ___ H_2

e) ____ NH₃ + ____ O₂
$$\rightarrow$$
 ____ N₂ + ____ H₂O

f) ____
$$C_6H_{14}$$
 + ___ O_2 \rightarrow ___ CO_2 + ___ H_2O

g)
$$_$$
 KNO₃ \rightarrow $_$ KNO₂ + $_$ O₂

h) ___ CaC₂ + ___ O₂
$$\rightarrow$$
 ___ Ca + ___ CO₂

i) ____
$$C_5H_{12}$$
 + ____ $O_2 \rightarrow$ ____ CO_2 + ____ H_2O

j) ___ K₂SO₄ + ___ BaCl₂
$$\rightarrow$$
 ___ KCl + ___ BaSO₄

k) ___ KOH + ___ H
$$_2SO_4 \rightarrow$$
 ___ K $_2SO_4 +$ ___ H $_2O$

I) ___ Ca(OH)₂ + ___ NH₄CI
$$\rightarrow$$
 ___ NH₃ + ___ CaCl₂ + ___ H₂O

m) C +
$$SO_2 \rightarrow CS_2 + CO$$

n) ____ Mg
$$_3$$
N $_2$ + ____ H $_2$ O \rightarrow ____ Mg(OH) $_2$ + ____ NH $_3$

o) ____
$$V_2O_5$$
 + ___ $Ca \rightarrow$ ___ CaO + ___ V

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p) ___ Na_2O_2 + ___ H_2O \rightarrow ___ NaOH + ___ O_2
q) ___ Fe<sub>3</sub>O<sub>4</sub> + ___ H<sub>2</sub> \rightarrow ___ Fe + ___ H<sub>2</sub>O
r) ____ Cu + ___ H_2SO_4 \rightarrow ___ CuSO_4 + ___ H_2O + ___ SO_2
s) ____ Al + ___ H_2SO_4 \rightarrow ____ H_2 + ___ Al_2(SO_4)_3
t) ____ Si<sub>4</sub>H<sub>10</sub> + ____ O<sub>2</sub> \rightarrow ____ SiO<sub>2</sub> + ____ H<sub>2</sub>O
u) ____ NH_3 + ____ O_2 \rightarrow ____ N_2H_4 + ____ H_2O
V) _{---} C_{15}H_{30} + _{---} O_2 \rightarrow _{---} CO_2 + H_2O
w) ____ BN + ____ F_2 \rightarrow ____ N_2 + ____ BF<sub>3</sub>
X) ___ CaSO<sub>4</sub>·2H<sub>2</sub>O + ___ SO<sub>3</sub> \rightarrow ___ CaSO<sub>4</sub> + ___ H<sub>2</sub>SO<sub>4</sub>
y) ____ C_3H_7N_2O_7 + ___ O_2 \rightarrow ___ CO_2 + ___ H_2O + ___ N_2
z) ___ C_7H_{16}O_4S_2 + ___ O_2 \rightarrow ___ CO_2 + ___ H_2O + ___ SO_2
a1) ___ Na + ___ Znl<sub>2</sub> \rightarrow ___ Nal + ___ NaZn<sub>4</sub>
b1) ____ HBrO<sub>3</sub> + ____ HBr \rightarrow ____ Br<sub>2</sub> + ____ H<sub>2</sub>O
c1) ____ Al<sub>4</sub>C<sub>3</sub> + ____ H<sub>2</sub>O \rightarrow ____ Al(OH)<sub>3</sub> + ____ CH<sub>4</sub>
d1) ___ Ca(NO<sub>3</sub>)<sub>2</sub>·3H<sub>2</sub>O + ___ LaC<sub>2</sub> \rightarrow ___ Ca(NO<sub>3</sub>)<sub>2</sub> + ___ La(OH)<sub>2</sub> + ___ C<sub>2</sub>H<sub>2</sub>
e1) ___ CH<sub>3</sub>NO<sub>2</sub> + ___ Cl<sub>2</sub> \rightarrow ___ CCl<sub>3</sub>NO<sub>2</sub> + ___ HCl
f1) ____ Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> + ____ SiO<sub>2</sub> + ____ C \rightarrow ____ CaSiO<sub>3</sub> + ____ CO + ___ P
g1) ____ Al<sub>2</sub>C<sub>6</sub> + ____ H<sub>2</sub>O \rightarrow ____ Al(OH)<sub>3</sub> + ____ C<sub>2</sub>H<sub>2</sub>
h1) ___ NaF + ___ CaO + ___ H_2O \rightarrow ___ CaF_2 + ___ NaOH
i1) LiH + AlCl<sub>3</sub> \rightarrow LiAlH<sub>4</sub> + LiCl
j1) ___ CaF_2 + ___ H_2SO_4 + ___ SiO_2 \rightarrow ___ CaSO_4 + ___ SiF_4 + ___ H_2O
k1) ___ CaSi_2 + ___ SbCl_3 \rightarrow ___ Si + ___ Sb + ___ CaCl_2
I1) \underline{\hspace{1cm}} TiO_2 + \underline{\hspace{1cm}} B_4C + \underline{\hspace{1cm}} C \rightarrow \underline{\hspace{1cm}} TiB_2 + \underline{\hspace{1cm}} CO
m1) NH_3 + O_2 \rightarrow NO + H_2O
n1) ___ SiF<sub>4</sub> + ___ NaOH \rightarrow ___ Na<sub>4</sub>SiO<sub>4</sub> + ___ NaF + ___ H<sub>2</sub>O
o1) ___ NH<sub>4</sub>Cl + ___ CaO \rightarrow ___ NH<sub>3</sub> + ___ CaCl<sub>2</sub> + ___ H<sub>2</sub>O
              NaPb + ___ C_2H_5Cl \rightarrow ___ Pb(C_2H_5)_4 + ___ Pb + ___ NaCl
p1) ____
q1) ____ Be<sub>2</sub>C + ___ H<sub>2</sub>O \rightarrow ___ Be(OH)<sub>2</sub> + ___ CH<sub>4</sub>
r1) ____ NpF<sub>3</sub> + ____ O<sub>2</sub> + ____ HF \rightarrow ____ NpF<sub>4</sub> + ____ H<sub>2</sub>O
S1) _{---} NO_2 + _{---} H_2O \rightarrow _{---} HNO_3 + _{---} NO_3
t1) ___ LiAlH<sub>4</sub> + ___ BF<sub>3</sub> \rightarrow ___ LiF + ___ AlF<sub>3</sub> + ___ B<sub>2</sub>H<sub>6</sub>
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Solubility and Precipitates

1. Use a Table of Solubilities to predict whether or not the following compounds are soluble in water.

Write "yes" or "no" for each compound.

2. Write formulas for the following compounds, and using a Table of Solubilities, predict whether or not the compound is soluble in water.

Fill in the formula and "y/n" in the table.

Compound Name Formula Soluble (y/n)

- a. potassium phosphate
- b. calcium carbonate
- c. copper (II) bromide
- d. aluminium sulphide
- **3.** For each of the following reactions:
 - Predict the products and write a balanced molecular equation.
 - Determine if any product forms a **precipitate**.

- If no precipitate forms, write **NR** (No Reaction).
- If a precipitate forms, write the **net ionic equation**.

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a. Mg(NO_3)_2 (aq) + 2 NaOH (aq) \rightarrow b. CuSO_4 (aq) + FeCl_3 (aq) \rightarrow c. K_2CO_3 (aq) + Sr(OH)_2 (aq) \rightarrow
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4. An aqueous solution contains a mixture of Ba²⁺, Pb²⁺, and Ca²⁺. Which **one negative ion** from the list below could be used to **separate Pb²⁺** from the other two positive ions?

- a. NO₃⁻
- b. S²⁻
- c. OH-
- d. PO₄3-
- $e.\ SO_4{}^{2^-}$

5. An aqueous solution contains the following cations: Ca^{2+} , Ag^{+} , Cu^{2+} , K^{+}

You are given the following solutions to separate the cations: Na_2S , Na_2CO_3 , NaBr

To separate the cations by precipitating **only one at a time**:

- In what **order** should the three solutions be added?
- Identify the **three precipitates** that form.
- Which **one cation remains in solution** at the end?

Types of Chemical Reactions

Instructions – For each of the following equations, write the type of reaction in front (use the short form), then balance the equation using the correct coefficients and phases.

SR – Single ReplacementDR – Double ReplacementSYN – SynthesisDECOMP – Decomposition

COM – Combustion

Energy Changes in Chemical Reactions

1.) You can think of this reaction, $CH_4 + 2 O_2 \rightarrow CO_2 + 2 H_2O$, as occurring in two steps (it doesn't go this way, but it is convenient to think of it this way).

Step 1 - CH_4 + 2 $O_2 \rightarrow C$ + 4 H + 4 O (the reactants are broken down to individual atoms)

Step 2 - C + 4 H + 4 O \rightarrow CO₂ + 2 H₂O (the individual atoms are assembled into products)

- a.) Does step 1 absorb or give off energy?
- b.) Does step 2 absorb or give off energy?
- c.) Since the overall reaction is exothermic, which step involves more energy, step 1 or 2?
- 2.) The energy needed to break an H–Cl bond is 432 kJ.

 $2 HCI + 432 kJ \rightarrow H_2 + CI_2$

How many kilojoules of energy are given off in the following reaction? Why?

 $H_2 + Cl_2 \rightarrow HCl +$ _____kJ

3.) Is the burning of wood exothermic or endothermic?

- 4.) Is the melting of sugar exothermic or endothermic?
- 5.) A beaker becomes warm when a reaction occurs in it. Are the chemicals in the beaker gaining or losing energy? Is the reaction endothermic or exothermic?
- 6.) Which contains more energy in an endothermic reaction, the reactants or products?
- 7.) In an exothermic reaction, do you have to add or remove energy in order to allow particles to form?
- 8a.) Is $\Delta H > 0$ or $\Delta H < 0$ for an endothermic reaction?
- b.) Is $\Delta H > 0$ or $\Delta H < 0$ for an exothermic reaction?
- 9.) Draw an energy diagram having $\Delta H = +25 \text{ kJ}$.
- 10.) Draw an energy diagram having $\Delta H = -50 \text{ kJ}$.
- 11.) $\Delta H = -50$ kJ for the reaction F \rightarrow G. Re-write this equation to show the 50 kJ properly on the reactant or product side.
- 12.) If a reaction absorbs 30 kJ of heat, what is the ΔH for the reaction?
- 13.) If P \rightarrow Q + 25 kJ, what is the ΔH for the reaction? Which have more energy, the reactants or products?