CHEMISTRY 111-Vining
October 28, 2015

NAME: Answer Key
EXAM #2

Points for each question in parentheses at end of question.

1. What mass of $Na_2C_2O_4$ (molar mass 134.0 g/mol) is needed to prepare 500. mL of a 0.0622 M solution? *(5)*

a) 1.04 g b) 4.17 g c) 10.7 g d) 8.33 g e) 0.834 g

$$0.500\,L \times \frac{0.0622\,mol\ Na_2C_2O_4}{1\ L} \times \frac{134.0\,g\ Na_2C_2O_4}{1\,mol} = 4.17\,g$$

2a) What type of reaction is each of the following? *(4)*

$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$

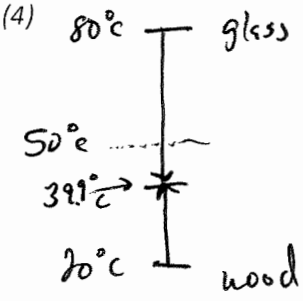
a) decomposition b) combination c) single displacement d) double displacement

2b) $Zn(s) + CuCl_2(aq) \rightarrow ZnCl_2(aq) + Cu(s)$

a) decomposition b) combination c) single displacement d) double displacement

3. 5.00 grams of glass at 80 °C is brought into contact with 5.00 g of wood at 20 °C. When thermal equilibrium is reached, both objects are at a temperature of 39 °C. Which has a greater specific heat capacity? *(4)*

a) glass b) wood c) not enough information is given to answer



4. Wood is burning in a fireplace. This reaction is... *(4)*

a) endothermic b) exothermic c) not enough information is given to answer

5. Circle the compounds below that are expected to be insoluble in water. *(8)*

Na_3PO_4 H_3PO_4 $Ca(NO_3)_2$ Cr_2S_3

6. You have an unlabeled vial that contains a solution. You mix portions of this solution with each of the following other solutions and observe the following results:

Mix with:	KCl	Na_2SO_4	$Pb(NO_3)_2$	NaOH	HCl
Observe:	no reaction	precipitate	precipitate	precipitate	no reaction

Which of the following could be the unknown solution? *(5)*

a) $AgNO_3(aq)$ d) $Na_2CO_3(aq)$

b) $NaCl(aq)$ e) $HCl(aq)$

c) $CaCl_2(aq)$ f) $Ba(NO_3)_2(aq)$

7. Indicate the oxidation number of the noted element in each case: *(3)*

H in H_2: 0 Fe in $FeCl_2$: +2 N in NO_3^-: +5

8. Circle the compounds below that are strong electrolytes. *(7)*

HNO_3 acetic acid $Fe(NO_3)_2$ FeS

What does the term "strong electrolyte" mean?

A soluble compound that completely breaks up to form ions in aqueous solution. (100% ionized.)

9. Consider the redox reaction: $\overset{0}{Ni(s)} + \overset{0}{F_2(g)} \longrightarrow \overset{+2}{Ni^{2+}(aq)} + 2\overset{-1}{F^-(aq)}$ *(8)*

Species oxidized: Ni Species Reduced: F_2

Oxidizing agent: F_2 Reducing agent: Ni

10. Give net ionic equations for the following reactions. If no reaction occurs, just write "No Reaction"

(16)

a. $NaCl + Pb(NO_3)_2$ $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$

b. $HCl + Ca_3(PO_4)_2$ $Ca_3(PO_4)_2(s) + 6H^+(aq) \rightarrow 3Ca^{2+}(aq) + 2H_3PO_4(aq)$

c. $HCl + NH_3$ $H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$

d. $Na_2CO_3 + HNO_3$ $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$

11. The heating curves for water and benzene are shown here. Answer the following questions regarding them. *(6)*

Part 1. Which has the greater heat of fusion?

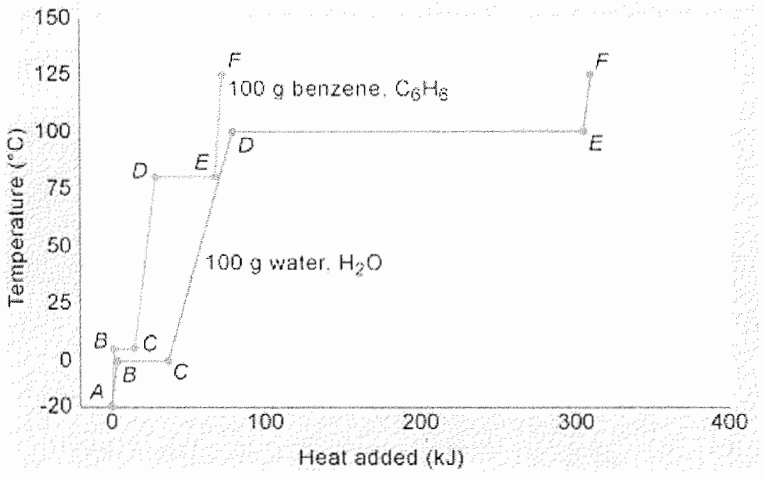
[water] or benzene

Part 2. From segment D to E for water, what type of energy (if any) is increasing?

a) no energy increase
b) kinetic energy
[c) potential energy]
d) both kinetic and potential energy

Part 3. Which has the higher melting point?

water or [benzene]



12. Consider the reaction below:

If 43.7 g Fe is allowed to react with 28.0 g O_2, what mass of FeO can be produced? *(10)*

$$2\ Fe(s) + O_2(g) \rightarrow 2\ FeO(s)$$

	Fe	O_2	FeO
I	~~0.875~~ 0.782	0.875	0
C	−0.782		+0.782
F	0	0.782	0.782

$$43.7\text{g Fe} \times \frac{1\text{mol Fe}}{55.85\text{g}} = 0.782\text{ mol Fe}$$

$$28.0\text{g } O_2 \times \frac{1\text{mol } O_2}{32.00\text{g}} = 0.875\text{ mol } O_2$$

$\frac{0.782}{2} < \frac{0.875}{1}$ so, Fe is limiting reactant

$$0.782\text{ mol FeO formed} \times \frac{71.85\text{g FeO}}{1\text{mol}} = 56.2$$

56.2 g FeO

If the experimental (actual) yield of FeO is 49.0 g, what is the percent yield?

$$\%\text{ yield} = \frac{49.0\text{g}}{56.2\text{g}} \times 100 = 87.2\%$$

87.2 %

13. A titration is performed to determine the molar mass of an unknown monoprotic acid. A solution of 0.122 M NaOH is used to titrate 1.082 grams of acid. If 39.9 mL of the NaOH solution are required to titrate the acid, what is the molar mass of the acid? *(10)*

$$\text{molar mass} = \frac{\text{g acid}}{\text{mol acid}} \leftarrow 1.082\text{g acid (given)}$$

mol acid = mol NaOH used in titration

$$\text{mol NaOH} = 0.0399\text{L NaOH} \times \frac{0.122\text{mol NaOH}}{\text{L}} = 0.00487\text{ mol NaOH} < 0.00487\text{mol acid}$$

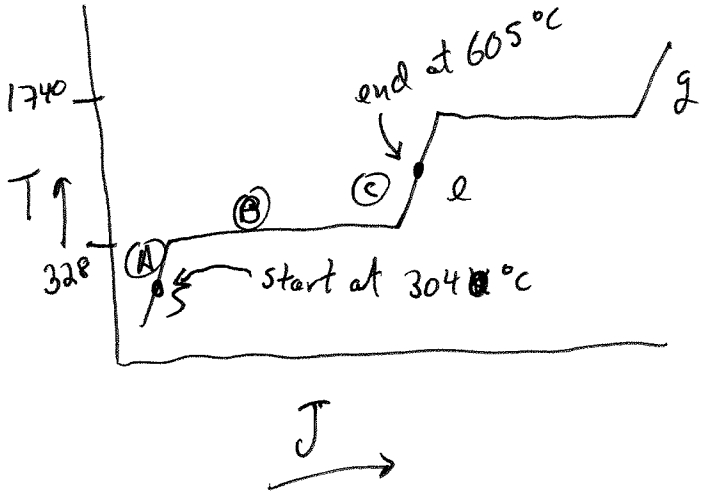
$$\text{molar mass}_{\text{acid}} = \frac{1.082\text{g}}{0.00487\text{ mol}} = 222\text{ g/mol}$$

Molar mass = 222 g/mol

14. The following information is given for **lead** at 1atm:

boiling point = **1740** °C $\quad \Delta H_{vap}$1740 °C) = **858.2** J/g
melting point = **328.0** °C $\quad \Delta H_{fus}$(**328.0** °C) = **23.00** J/g
specific heat solid = **0.1300** J/g°C
specific heat liquid = **0.1380** J/g°C

A **24.60** g sample of solid **lead** is initially at **304.0** °C. If the sample is heated at constant pressure (P = 1 atm), [ ] kJ of heat are needed to raise the temperature of the sample to **605.0** °C. *(10)*



(A) $\#J = 0.1300\ \frac{J}{g\cdot°C} \times 24.60\ g \times (328 - 304\ °C)$
$= 76.75\ J$

(B) $\#J = 24.60\ g \times \frac{23.00\ J}{g} = 565.8\ J$

(C) $\#J = 0.1380\ \frac{J}{g\cdot°C} \times 24.60\ g \times (605 - 328\ °C)$
$= 940.4\ J$

Total Energy $= 76.8\ J + 565.8\ J + 940.4\ J =$
$1583\ J$

1583 J

15. Extra Credit: 6 points

A compound is known to be a carbonate salt but the exact cation is not known but we do know the cation has a 2+ charge. So, the compound has the general formula MCO_3. M represents an element.

4.56 g of this compound is added to water. It does not dissolve. An excess of strong acid (HCl) is added and (as you would expect) the solution bubbles and the compound dissolves. The mass loss caused by escaping CO_2 gas is 1.164 g.

To the remaining solution, an excess of sodium phosphate is added and a new precipitate forms.

Identify the element M and write the formula of the new precipitate. $\Delta mass = 1.164\,g$

$$MCO_2 + 2H^+ \rightarrow \underbrace{CO_2(g)}_{1.164g} + H_2O(\ell) + M^{2+}(aq)$$
$$4.56g$$

$$1.164\,g\ CO_2 \times \frac{1\,mol\ CO_2}{44.01\,g} = 0.02645\,mol\ CO_2$$

$\therefore$ 0.02645 mol MCO_3 was present

$$\text{molar mass } MCO_3 = \frac{4.56\,g\ MCO_3}{0.02645\,mol} = 172\,g/mol$$

CO_3 has molar mass of 60 g/mol

Formula : ~~$CdCO_3$~~ $Cd_3(PO_4)_2$

So M has molar mass of $172 - 60 = 112\,g/mol$.

M is Cd.

The phosphate experiment supports this answer but is not needed to solve the problem.