Chemistry 211 Name: _____
Spring 2024 Please Print
Test 2

Multiple Choice: (4 points each. Put answers in left margin as capital letters.)

1. Two isotopes of an element exist in the ratio 26.400 g/mol (47.222%) and 28.522 g/mol (52.778%). What is the weighted average of this sample (g/mol)?

   A) 26.400 B) 27.402 C) 27.520 D) 27.461 E) 28.522

2. Tomato soup is a

   i) compound iii) heterogenous mixture v) solution
   ii) pure substance iv) homogeneous mixture

   A) i B) ii C) iii D) iv E) v
   F) i and ii G) iii and v H) iv and v

3. Which of the following aqueous acids is a weak acid?

   A) HCl B) $HClO_4$ C) HNO_3 D) H_3PO_4 E) H_2SO_4

4. Which of the following is a combustion reaction?

   A) $Cu(OH)_{2\,(aq)} + 2\ HNO_{3\,(aq)} \rightarrow Cu(NO_3)_{2\,(aq)} + 2\ H_2O_{(\ell)}$
   B) $CH_{4\,(g)} + 2\ O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\ H_2O_{(\ell)}$
   C) $FeCl_{3\,(s)} + 3\ AgNO_{3\,(g)} \rightarrow 3\ AgCl_{(s)} + 3\ Fe(NO)_{3\,(aq)}$
   D) $Na_2CO_{3\,(s)} \rightarrow NaO_{(s)} + CO_{2\,(g)}$
   E) None is a combustion reaction.

5. What is the oxidation number of the sulfur atom in $MgSO_3$?

   A) -2 B) 0 C) +2 D) +4 E) +6

6. For the reaction: $Cu(OH)_{2\,(aq)} + 2\ HNO_{3\,(aq)} \rightarrow Cu(NO_3)_{2\,(aq)} + 2\ H_2O_{(\ell)}$, which element is reduced?

   A) Cu B) H C) N D) O E) None are reduced

7. Enthalpy is the _____ for a system.

   A) energy change
   B) energy change with no heat
   C) energy change with no work
   D) heat change
   E) heat change at constant pressure

8. Which of the following represents a heat of formation reaction?

A) $2\ C_4H_{10\,(g)} + 13\ O_{2\,(g)} \rightarrow 8\ CO_{2\,(g)} + 10\ H_2O_{(\ell)}$
B) $CaO_{\,(s)} + H_2O_{(\ell)} \rightarrow Ca(OH)_{2\,(s)}$
C) $2\ HgO_2 \rightarrow 2\ Hg_{(\ell)} + O_{2\,(g)}$
D) $Ca_{(s)} + Cl_{2\,(g)} \rightarrow CaCl_{2\,(s)}$
E) None are formation reactions

9. What is ΔH for the net reaction below?

$Pb + PbO_2 + 2SO_3 \longrightarrow 2PbSO_4$	$\Delta H = -775$ kJ
$SO_3 + H_2O \longrightarrow H_2SO_4$	$\Delta H = -113$ kJ
$Pb + PbO_2 + 2H_2SO_4 \longrightarrow 2PbSO_4 + 2H_2O$	$\Delta H = ?$

A) -1001 kJ B) -888 kJ C) -549 kJ D) 888 kJ E) 1001 kJ

Discussion Questions: (Show your work to receive credit.)

1. Provide names/formulae as appropriate. (10 points)

H_3PO_4 – phosphoric acid
VS_2 – vanadium(IV) sulfide
potassium acetate – $K(CH_3CO_2)$
hydriodic acid – HI(aq)

2. When silver(I) nitrate is mixed with calcium chloride according to the reaction:

$$2\ AgNO_{3\,(aq)} + CaCl_{2\,(aq)} \longrightarrow 2\ AgCl_{(s)} + Ca(NO_3)_{2\,(aq)}$$

silver(I) chloride forms. What is the maximum mass of silver(I) chloride that can be produced by combining 3.00 g of each reactant? What is the precent yield if 1.50 g AgCl is produced? (15 points)

Determine the limiting reagent by first calculating the number of moles of each substance present.

$$mol_{AgNO3} = (3.00\ g)\left(\frac{1\ mol_{AgNO3}}{169.9\ g_{AgNO3}}\right) = 0.0176\ mol_{AgNO3}$$

$$mol_{CaCl2} = (3.00g)\left(\frac{1\ mol_{CaCl2}}{111.0\ g_{CaCl2}}\right) = 0.0270\ mol_{CaCl2}$$

Now determine how much calcium chloride is required to use up all of the silver(I) nitrate.

$$mol_{CaCl2}(required) = (0.0176\ mol_{AgNO3})\left(\frac{1\ mol_{CaCl2}}{2\ mol_{AgNO3}}\right) = 0.00883\ mol_{CaCl2}$$

But you have 0.0270 mol_{Al}, which is more than enough $CaCl_2$ so all of the $AgNO_3$ is consumed. Thus, silver(I) nitrate is the limiting reagent.

$$mass_{AgNO3} = (3.00\ g)\left(\frac{1\ mol_{AgNO3}}{169.9\ g_{AgNO3}}\right)\left(\frac{2\ mol_{AgCl}}{2\ mol_{AgNO3}}\right)\left(\frac{143.3\ g_{AgNO3}}{1\ mol_{AgCl}}\right) = 2.53\ g$$

$$\text{percent yield} = \frac{1.50\ g}{2.53\ g} \times 100\% = 59.3\%$$

3. Complete the following: (10 points)

$$4\ NH_{3\,(g)} + 3\ O_{2\,(g)} \longrightarrow 2\ N_{2\,(g)} + 6\ H_2O_{(\ell)}$$

Calcium chloride reacts with potassium carbonate to yield calcium carbonate and potassium chloride. (Use solubility rules to predict the state of each material.)

$CaCl_{2\,(aq)} + K_2CO_{3\,(aq)} \longrightarrow CaCO_{3\,(s)} + 2KCl_{(aq)}$

4. When a 5.00 g sample of KCl is dissolved in water in a calorimeter that has a total heat capacity of 3.04 $kJ \bullet K^{-1}$, the temperature decreases by 0.380 K. Calculate the molar heat of solution of KCl. (5 points)

   molar heat of solution = $\left(\frac{3.04\ kJ}{K}\right)(0.380\ K)\left(\frac{1}{5.00\ g_{KCl}}\right)\left(\frac{74.56\ g_{KCl}}{mol_{KCl}}\right) = 17.2\ kJ/mol$ (Homework 5.13)

5. Is the following reaction endothermic or exothermic? Explain. (5 points)

   $CH_{4\,(g)} + 2\ O_{2\,(g)} \longrightarrow CO_{2\,(g)} + 2\ H_2O_{(\ell)}$

   It is exothermic because this is a combustion reaction (see MC # 4). Burning releases heat from the system into the environment.

6. A system gains 782 kJ of heat, resulting in a change in internal energy of the system equal to +251 kJ. How much work is done? (5 points)

   work = 251 kJ − 782 kJ = −531 kJ (Homework 5.9)

7. From the following data: (14 points)

   $4\ NH_{3\,(g)} + 5\ O_{2\,(g)} \rightarrow 4\ NO_{(g)} + 6\ H_2O_{(g)}\quad \Delta H^{o}_{rxn} = -904.0\ kJ$

   a) Is the reaction endothermic or exothermic?
   b) How much energy would be absorbed or released if 13.75 g of nitrogen monoxide formed?
   c) If an unknown quantity of ammonia is burned with a heat change of -425 kJ, what mass of ammonia burned?

   a) exothermic

   b) energy = $\left(\frac{-904.0\ kJ}{4\ mol_{NO}}\right)\left(\frac{1\ mol_{NO}}{30.01\ g_{NO}}\right)(13.75\ gNO) = 103.6\ kJ$

   c) $mass_{NH3} = (425\ kJ)\left(\frac{4\ mol_{NH3}}{904.0\ kJ}\right)\left(\frac{17.03\ g_{NH3}}{1\ mol_{NH3}}\right) = 32.0\ g_{NH3}$