ANSWER KEY (the answers are bolded)

CHEM 111 Fall 2010 **Practice Exam 2**

1. Which of the following ions is most likely to form an insoluble sulfate?
   a) K^+
   b) Li^+
   c) Ca^{2+}
   d) S^{2-}
   e) Cl^-

2. Identify the spectator ion(s) in the following reaction.
   $Cu(OH)_2(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Cu^{2+}(aq) + 2Cl^-(aq) + 2H_2O(l)$
   a) Cu^{2+} and Cl^-
   b) H^+ and Cl^-
   c) $Cu(OH)_2$
   d) Cl^-
   e) Cu^{2+}

3. A bright yellow precipitate is expected when an aqueous solution of potassium iodide is added to an aqueous solution of
   a) sodium sulfate.
   b) iron(II) chloride.
   c) calcium nitrate.
   d) barium hydroxide.
   e) lead nitrate.

4. What is the oxidation number of P in $NH_4H_2PO_4$?
   a) –3
   b) 0
   c) +1
   d) +3
   e) +5

5. Given:
   $4AlCl_3(s) + 3O_2(g) \rightarrow 2Al_2O_3(s) + 6Cl_2(g)$; $\Delta H = -529.0$ kJ

   determine ΔH for the following thermochemical equation.

   $Cl_2(g) + \frac{1}{3}Al_2O_3(s) \rightarrow \frac{2}{3}AlCl_3(s) + \frac{1}{2}O_2(g)$

   a) +529.0 kJ
   b) +88.2 kJ
   c) +176.3 kJ
   d) +264.5 kJ
   e) –176.3 kJ

(Notice that the reaction has been reversed so the sign changes, and the reaction multiplied by a factor 1/6)

6. What is the quantity of heat evolved at constant pressure when 60.9 g $H_2O(l)$ is formed from the combustion of $H_2(g)$ and $O_2(g)$?
$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$; $\Delta H° = -285.8$ kJ

a) 285.8 kJ
b) 1.74×10^4 kJ
c) 9.66×10^2 kJ
d) 1.18×10^{-2} kJ
e) 84.5 kJ

7. Given:
$60C(s) \rightarrow C_{60}(s)$; $\Delta H = 2320$ kJ

what is ΔH for the following thermochemical equation?

$\frac{1}{60} C_{60}(s) \rightarrow C(s)$

a) –38.7 kJ
b) +38.7 kJ
c) –2320 kJ
d) +2320 kJ
e) –139 MJ

8. Which of the following statements is <u>false</u> concerning the reaction of hydrogen gas and oxygen gas given below?
$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$; $\Delta H = -285.8$ kJ

a) If the equation is multiplied by 2, ΔH becomes –571.6 kJ.
b) If the equation is reversed, ΔH becomes +285.8 kJ.
c) Per mole of O_2, the change in enthalpy is –571.6 kJ.
d) The value –571.6 kJ pertains to 1 mol of liquid water.
e) For the reaction $H_2(g) + ½O_2(g) \rightarrow H_2O(g)$, ΔH is not equal to –285.8 kJ.

(Notice that option (e) is CORRECT given that the water is in gaseous state rather that the given liquid state)

9. What is the change in enthalpy when 3.00 mol of sulfur trioxide decomposes to sulfur dioxide and oxygen gas?
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$; $\Delta H° = 198$ kJ

a) –198 kJ
b) –297 kJ
c) 594 kJ
d) 297 kJ
e) 198 kJ

(Realize that decomposition of Sulfur trioxide will be the reverse of the given rxn, and the mole ratio is 3/2)

10. What is the change in enthalpy at 25°C and 1 atm for the production of 5.00 mol SnO(*s*)?
$Sn(s) + SnO_2(s) \rightarrow 2SnO(s)$; $\Delta H° = 16.2$ kJ
    a) 3.24 kJ
    b) –16.2 kJ
    c) –40.5 kJ
    d) 40.5 kJ
    e) 16.2 kJ

11. How much heat is gained by nickel when 29.2 g of nickel is warmed from 18.3°C to 69.6°C? The specific heat of nickel is 0.443 J/(g · °C).
    a) 2.37×10^2 J
    b) 9.00×10^2 J
    c) 22.7 J
    d) 6.64×10^2 J
    e) 30.8 J

12. What is $\Delta H°$ for the following reaction?
$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l)$

Substance	$\Delta H°_f$ (kJ/mol)
$C_2H_2(g)$	+226.7
$CO_2(g)$	–393.5
$H_2O(l)$	–285.8

    a) +1692.2 kJ
    b) –2599.0 kJ
    c) +2599.0 kJ
    d) –1692.2 kJ
    e) –452.6 kJ

13. Given:
$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$; $\Delta H = –26.8$ kJ
$FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g)$; $\Delta H = –16.5$ kJ
determine ΔH for the following thermochemical equation.
$Fe_2O_3(s) + CO(g) \rightarrow 2FeO(s) + CO_2(g)$

a) –43.3 kJ
b) –10.3 kJ
c) 6.2 kJ
d) 10.3 kJ
e) 22.7 kJ

14. Which substance has a standard enthalpy of formation equal to zero at 25°C?
a) $C_2H_6(g)$
b) $C_2H_6(l)$
c) $Br_2(s)$
d) $Br_2(l)$
e) $Br_2(g)$

15. A 63.2-g sample of cobalt (s = 0.421 J/(g · °C)), initially at 187.3°C, is placed in an insulated vessel containing 222.4 g of water (s = 4.18 J/(g · °C)), initially at 11.8°C. Once equilibrium is reached, what is the final temperature of the metal–water mixture? Neglect the heat capacity of the vessel.
a) 16.7°C
b) 99.6°C
c) 6.6°C
d) 50.6°C
e) 27.9°C

WORK OUT PROBLEMS

16. For the following reaction:

$$Ba(OH)_2(aq) + HCl\ (aq) \rightarrow BaCl_2(aq) + H_2O(l)$$

a. Name each reactant and product from above.
Barium hydroxide *Barium chloride*

Hydrochloric acid *Water*

b. Write a balanced complete ionic equation.

$$Ba^{2+}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \longrightarrow Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2H_2O_{(l)}$$

c. Write a balanced net ionic equation.

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

d. If 125 mL of 0.33 *M* $Ba(OH)_2$ is present, what is the minimum amount, in L, of 0.21 *M* HCl that must be added to neutralize the $Ba(OH)_2$?

Get the number of mole of $Ba(OH)_2$ = 0.125 x 0.33 = 0.04125 moles
From the balanced rxn # moles of HCl used = 2 x 0.04125 = 0.0825
Therefore Vol of HCl = 0.0825/0.21 = 0.3928L = 392.8 mL of HCl

e. If phenolphthalein is added to the $Ba(OH)_2$ solution prepared in Part (d) above and this solution is then titrated with HCl, how will you know when the neutralization is complete (be explicit!)?

Color change from pink to colorless at end point.

17. An impure sample of benzoic acid (C_6H_5COOH, 122.12 g/mol) is titrated with 0.1278 *M* NaOH. A 0.503798-g sample requires 23.81 mL of titrant to reach the endpoint. What is the percent by mass of benzoic acid in the sample?

$C_6H_5COOH(aq) + NaOH(aq) \rightarrow NaC_6H_5COO(aq) + H_2O(l)$

Step by step solution

 # Moles of NaOH = 0.1278M x 0.02381L = 3.0429×10^{-3}

From the balanced equation #moles of NaOH= # moles of Benzoic acid

Therefore # moles of benzoic acid = 3.0429×10^{-3}

To convert these moles of benzoic acid to grams = 3.0429×10^{-3} mol x 122.12 g/mol

= 0.3716g of benzoic acid

Therefore the percent by mass of benzoic acid in sample = (0.3716g/0.503798g)100%

= 73.76%

(This problem was in your quiz, not well done, so it came around again)

18. Given:

$N_2(g) + \frac{3}{2} O_2(g) \rightarrow N_2O_3(s)$; $\Delta H = 83.7$ kJ

$N_2(g) + O_2(g) \rightarrow 2NO(g)$; $\Delta H = 180.4$ kJ

$\frac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g)$; $\Delta H = 33.2$ kJ

what is ΔH for the following reaction?

$N_2O_3(g) \rightarrow NO(g) + NO_2(g)$

NB

Realize that the first equation has been reversed (ΔH sign changes) and the second equation halved (ΔH halved) and then all summed up

$N_2O_3(s) \rightarrow N_2(g) + \frac{3}{2} O_2(g)$; $\Delta H = -83.7$ kJ

½ $N_2(g)$ + ½ $O_2(g) \rightarrow NO(g)$; $\Delta H = 90.2$ kJ

$\frac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g)$; $\Delta H = 33.2$ kJ

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$N_2O_3(g) \rightarrow NO(g) + NO_2(g)$; ***$\Delta H = 39.7$ KJ***