CHM 151 Exam 2 100 Pts Spring 2004 Name: Key White

1. The value of $\Delta H°$ for the reaction below is -126 kJ. How much heat (in kJ) is evolved when 2.00 mol of NaOH is formed in the reaction?

$$2Na_2O_2(s) + 2H_2O(l) \rightarrow 4NaOH(s) + O_2(g)$$

a) 252
b) 63
c) 3.9
d) 7.8
e) -126

$$\frac{2.00 \text{ mol NaOH}}{4 \text{ mol NaOH}} \left| \frac{126 \text{ kJ}}{} \right. = 63 \text{ kJ}$$

2. What are the spectator ions in the reaction between KOH(aq) and HNO_3(aq)?
a) K^+ and H^+
b) H^+ and OH^-
c) K^+ and NO^-_3
d) H^+ and NO^-_3
e) OH^- only

$K^+ + OH^- + H^+ + NO_3^- \rightarrow HOH(l) + K^+ + NO_3^-$

3. Which of the following is an exothermic process?
a) ice melting
b) water evaporating
c) heating soup
d) condensation of water vapor
e) Ammonium thiocyanate and barium hydroxide are mixed at 25°C: the temperature drops.

4. The first law of thermodynamics states that _____.
a) all spontaneous processes are accompanied by an increase in disorder
b) energy is conserved during any process
c) the entropy of a pure, crystalline substance at absolute zero is zero
d) the amount of work done during a change is independent of the pathway of that change
e) none of these

5. $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s) \quad \Delta H° = -3351$ kJ

The reaction shown above is _____ and therefore heat is _____ by the reaction.
a) endothermic, evolved
b) endothermic, absorbed
c) exothermic, evolved
d) exothermic, absorbed

6.

Substance	$\Delta H°_f$ (kJ/mol)
$H_2O(l)$	-286
$NO(g)$	90
$NO_2(g)$	34
$HNO_3(aq)$	-207
$NH_3(g)$	-46

Calculate $\Delta H_{rxn}°$ (in kJ) for the reaction:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

a) -1172
b) -150
c) -1540
d) -1892
e) The $\Delta H°_f$ of $O_2(g)$ is needed for the calculation.

$\Delta H = \sum \Delta H_{prod} - \sum \Delta H_{react}$

$$\underbrace{[4(90) + 6(-286)]}_{4NO \quad 6H_2O} - \underbrace{[4(-46) + 5(0)]}_{4NH_3 \quad 5O_2} = -1172 \text{ kJ}$$

7. What is the concentration (M) of NaCl in a solution made by mixing 25.0 mL of 0.100 M NaCl with 50.0 mL of 0.100 M NaCl?

a) 0.100 — SAme conc.
b) 0.0500
c) 0.0333
d) 0.0250
e) 125

8. A strong electrolyte is one that _____ completely in solution.

a) reacts
b) dissolves
c) decomposes
d) disappears
e) ionizes

9. The value of $\Delta H°$ for the reaction below is -790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is _____ kJ.

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$$

a) 23
b) -23
c) -12
d) 12
e) -790

$$\frac{0.95\,g\,S}{32.06\,g} \left| \frac{1\,mol}{2\,mols} \right| \frac{-790\,kJ}{} = -11.7$$

10. Which hydroxides are strong bases?

1. $Sr(OH)_2$
2. KOH
3. NaOH
4. $Ba(OH)_2$

a) 2 & 4
b) 2 & 3
c) 2, 3, & 4
d) 1, 2, 3, & 4
e) none of these is a strong base

11. A chemical reaction that absorbs heat from the surroundings is said to be Endo and has a + value of ΔH at constant pressure.

a) endothermic, positive
b) endothermic, negative
c) exothermic, negative
d) exothermic, positive
e) exothermic, neutral

12. Consider the following thermochemical equations:

#1 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ $\Delta H° = -28.0$ kJ

#2 $3Fe + 4CO_2 \rightarrow 4CO + Fe_3O_4$ $\Delta H° = +12.5$ kJ

Calculate the value of $\Delta H°$ (in kJ) for:

$$3Fe_2O_3 + CO \rightarrow CO_2 + 2Fe_3O_4$$

a) -59.0
b) 40.5
c) -15.5
d) -109
e) +109

$3Fe_2O_3$: #1 x3 — $3Fe_2O_3 + 1CO \rightarrow 2Fe + 1CO_2$ ΔH (kJ) -84.0

CO : skip

CO_2 : skip

$2Fe_3O_4$: #2 x2 — $6Fe + 4CO_2 \rightarrow 4CO + 2Fe_3O_4$ 25.0

$3Fe_3O_2 + CO \rightarrow CO_2 + 2Fe_3O_4$ -59.0 kJ

13. How many grams of NaOH (MW = 40.0) are there in 500.0 mL of a 0.175 M NaOH solution?
a) 2.19×10^{-3}
b) 114
c) 14.0
d) 3.50
e) 3.50×10^{3}

$$\frac{500.0\ \text{mL} \mid 0.175\ \text{mol} \mid \text{NaOH} \mid 40.0\ \text{g}}{1000\ \text{mL} \mid \text{mol}} = 3.50\ \text{g NaOH}$$

14. Which of the following are strong acids?
1. HI
2. HNO_3
3. HF
4. HBr

a) 3 & 4
b) 1, 2, 3, & 4
c) 1, 3, & 4
d) 2, 3, & 4
e) 1, 2, & 4

15. Which one of the following is a weak acid?
a) HNO_3
b) HCl
c) HI
d) HF
e) $HClO_4$

16. What volume (mL) of a concentrated solution of sodium hydroxide (6.00 M) must be diluted to 200 mL to make a 0.88 M solution of sodium hydroxide?
a) 2.64
b) 176
c) 26.4
d) 29.3
e) 50.0

$$M_1V_1 = M_2V_2$$
$$(6.00\ M)(V_1) = (0.88\ M)(200\ mL)$$
$$V_1 = 29.3\ mL$$

17. When a sample of aluminum absorbed 9.86 J of heat, its temperature increased from 23.2°C to 30.5°C. Since the specific heat of aluminum is 0.90 J/g-K, the mass of the sample was _____ g.
a) 72
b) 1.5
c) 65
d) 8.1
e) 6.6

$$\frac{g \cdot K \mid 9.86\ J \mid}{0.90\ J \mid 7.3\ K} = 1.5\ g$$

18. Which one of the following processes is endothermic?
a) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ combustion = Exo
b) $H_2O(g) \rightarrow H_2O(l)$ condensation = Exo
c) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ combustion = Exo
d) $H_2O(s) \rightarrow H_2O(l)$ melting = Endo
e) $2Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2Fe(l)$ liquid = Exo

19. An aqueous ethanol solution (400 mL) was diluted to 4.00 L, giving a concentration of 0.0400 M. The concentration of the original solution was _____ M.
a) 0.400
b) 0.200
c) 2.00
d) 1.60
e) 4.00

$$M_1V_1 = M_2V_2$$
$$M_1(0.400\ L) = (0.0400\ M)(4.00\ L)$$
$$M_1 = 0.400\ M$$

20. When 72 g of a metal at 97.0°C is added to 100.0 g of water at 25.0°C, the final temperature is 29.1°C. What is the heat capacity (in J/g-K) of the metal? The specific heat of $H_2O(l)$ is 4.18 J/g-K.

Heat lost Metal = Heat gained H_2O

a) 0.46
b) 2.8
c) 0.35
d) 2.0
e) 4.18

Heat (H_2O) : $\frac{4.18\ J}{g\ K} \mid \frac{100.0\ g}{} \mid \frac{4.1\ K}{} = 1713.8\ J$

Sp. Ht metal : $\frac{1713.8\ J}{72\ g} \mid \frac{}{67.9\ K} = 0.35\ \frac{J}{g\ K}$

21. When aqueous solutions of $AgNO_3$ and NaI are mixed, AgI precipitates. The balanced net ionic equation is _____.

a) $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$
b) $Ag^+(aq) + NO_3^-(aq) \rightarrow AgNO_3(s)$
c) $Ag^+(aq) + NO_3^-(aq) \rightarrow AgNO_3(aq)$
d) $AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$
e) $AgNO_3(aq) + NaI(aq) \rightarrow AgI(aq) + NaNO_3(s)$

$Ag^+ + NO_3^- + Na^+ + I^- \rightarrow AgI(s) + Na^+ + NO_3^-$

$Ag^+ + I^- \rightarrow AgI(s)$

22. What is the concentration (M) of sodium ions in 4.57 L of a 0.847 M Na_3P solution?

a) 0.847
b) 3.87
c) 0.185
d) 2.54
e) 0.282

$3 \times 0.847 = 2.54\ M\ Na^+$

23. Calculate the concentration (M) of arsenic acid (H_3AsO_4) in a solution if 25.00 mL of that solution required 35.21 mL of 0.1894 M KOH for neutralization.

a) 0.2668
b) 0.8003
c) 0.08892
d) 0.1345
e) 0.1894

$H_3AsO_4 + 3KOH \rightarrow 3H_2O + K_3AsO_4$

25.00 mL | 35.21 mL
? mol/L | 0.1894 M

$\frac{35.21\ mL\ KOH}{25.00 \times 10^{-3}\ L\ H_3AsO_4} \mid \frac{0.1894\ mol\ KOH}{1000\ mL\ KOH} \mid \frac{1\ mol\ H_3AsO_4}{3\ mol\ KOH} = 0.08892\ \frac{mol\ H_3AsO_4}{L}$

24. What volume (mL) of 0.135 M NaOH is required to neutralize 13.7 mL of 0.129 M HCl?

a) 13.1
b) 0.24
c) 14.3
d) 0.076
e) 6.55

$NaOH + HCl \rightarrow H_2O + NaCl$

0.135 M | 0.129 M
? mL | 13.7 mL

$\frac{13.7\ mL\ HCl}{} \mid \frac{0.129\ mol\ HCl}{1000\ mL\ HCl} \mid \frac{1\ mol\ NaOH}{1\ mol\ HCl} \mid \frac{1000\ mL\ NaOH}{0.135\ mol\ NaOH} = 13.1\ mL\ NaOH$

25. What is the concentration (M) of CH_3OH in a solution prepared by dissolving 11.7 g of CH_3OH in sufficient water to give 230 mL of solution?

a) 11.9
b) 1.59×10^{-3}
c) 0.0841
d) 1.59
e) 11.9×10^{-3}

$\frac{11.7\ g\ CH_3OH}{} \mid \frac{mol}{32.04\ g} \mid \frac{}{0.230\ L} = 1.59\ \frac{mol}{L}$