Name: _____

# Chapter 11: Thermochemistry– Heat and Chemical Change

Homework was checked against the key with wrong answers corrected.

Parent Signature: _____

Each numbered question is worth 1 point except as noted. Total possible = 32 points

**Section 11.1: The Flow of Energy--Heat**

1. When 435 J of heat is added to 3.4 g of olive oil at 21° C, the temperature increases to 85° C. What is the specific heat of olive oil?

2. A 1.55-g piece of stainless steel absorbs 141 J of heat when its temperature increases by 178℃. What is the specific heat of the stainless steel?

3. How much heat is required to raise the temperature of 250.0 g of mercury 52℃?

4. Define *energy* and explain how energy and *heat* are related.

5. Explain the difference between *heat capacity* and *specific heat*.

6. Will the specific heat of 50 g of a substance be the same as, or greater than, the specific heat of 10 g of the same substance? Explain.

7. On a sunny day, why does the concrete deck around an outdoor swimming pool become hot, while the water stays cool?

8. Using *calories*, calculate how much heat 32.0 g of water absorbs when it is heated from 25.0℃ to 80.0℃. How many joules is this?

9. A chunk of silver has a heat capacity of 42.8 J/℃. If the silver has a mass of 181 g, calculate the specific heat of silver.

10. How many kilojoules of heat are absorbed when 1.00 L of water is heated from 18℃ to 85℃?

**Section 11.2: Measuring and Expressing Heat Changes**

11. A student mixed 50.0 mL of an aqueous solution containing 0.50 mol HCl at 22.5℃ with 50.0 mL of another aqueous solution containing 0.50 mol NaOH at 22.5℃ in a foam cup calorimeter. The temperature of the resulting solution increased to 26.0℃. How much heat in kilojoules (kJ) was released by this reaction?

12. A small pebble is heated and placed in a foam cup calorimeter containing 25.0 mL of water at 25.0℃. The water reaches a maximum temperature of 26.4℃. How many joules of heat were released by the pebble?

13. When carbon disulfide is formed from its elements, heat is absorbed. Calculate the amount of heat (in kJ) absorbed when 5.66 g of carbon disulfide is formed.

$C(s) + 2\ S(s) \rightarrow CS_2(l)$ $\quad \Delta H = 89.3$ kJ

14. The production of iron and carbon dioxide from iron(III) oxide and carbon monoxide is an exothermic reaction. How many kilojoules of heat are produced when 3.40 mol $Fe_2O_3$ reacts with an excess of CO?

$Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g) + 26.3$ kJ

15. When 2 mol of solid magnesium (Mg) combines with 1 mole of oxygen gas ($O_2$), 2 mol of solid magnesium oxide (MgO) is formed and 1204 kJ of heat is released. Write the thermochemical equation for this combustion reaction.

16. Gasohol contains ethanol ($C_2H_5OH$) (l), which when burned reacts with oxygen to produce $CO_2$(g) and $H_2O$(g). How much heat is released when 12.5 g of ethanol burns?

$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g)$ $\quad \Delta H = -1235$ kJ

17. Explain the term *heat of reaction*.

18. Hydrogen gas and fluorine gas react to produce hydrogen fluoride. Calculate the heat change (in kJ) for the conversion of 15.0 g of hydrogen gas to hydrogen fluoride gas at constant pressure.

$H_2(g) + F_2(g) \rightarrow 2\ HF(g)$ $\quad \Delta H = -536$ kJ

19. Why is it important to give the physical state of a substance in thermochemical reaction?

**Section 11.3: Heat in Changes of State**

20. How many grams of ice at 0℃ and 101.3 kPa could be melted by the addition of 0.400 kJ of heat?

21. How many kilojoules of heat are required to melt a 10.0 g popsicle at 0℃ and 101.3 kPa? Assume the popsicle has the same molar mass and heat capacity as water.

22. How much heat (in kJ) is absorbed when 63.7 g $H_2O(l)$ at 100℃ is converted to steam at 100℃?

23. How many kilojoules of heat are absorbed when 0.46 g of chloroethane ($C_2H_5Cl$, bp 12.3℃) vaporizes at its boiling point? The molar heat of vaporization of chloroethane is 26.4 kJ/ mol.

24. How much heat (in kJ) is released when 0.677 mol NaOH(s) is dissolved in water?

25. How many moles of $NH_4NO_3(s)$ must be dissolved in water so that 88.0 kJ of heat is released from the water?

**Section Review 11.3**

26. Identify each heat change by name and classify each change as exothermic or endothermic. (2.5)

a. 1 mol $C_3H_8(l) \rightarrow$ 1 mol $C_3H_8(g)$

b. 1 mol NaCl(s) + 3.88 kJ/ mol → 1 mol NaCl(aq)

c. 1 mol $NaCl(s) \rightarrow$ 1 mol $NaCl(l)$

d. 1 mol $NH_3(g) \rightarrow$ 1 mol $NH_3(l)$

e. 1 mol $Hg(l) \rightarrow$ 1 mol $Hg(s)$

27. Heavy water, in which the hydrogens are hydrogen-2 instead of the more common hydrogen-1, is called deuterium oxide ($D_2O$). Solid $D_2O$ melts at 3.78℃. The molar heat of fusion of $D_2O(s)$ is 6.34 kJ/ mol. How much heat is released when 8.46 g $D_2O(l)$ solidifies at its melting point?

28. Why is a burn from steam potentially far more serious than a burn from very hot water?

29. Why does an ice cube melt at room temperature? (0.5)

**Chapter 11 Review**

71. The molar heat of vaporization of ethanol ($C_2H_5OH$) (l) is 43.5 kJ/ mol. Calculate the heat required to vaporize 25.0 g of ethanol at its boiling point. 11.3

73. The combustion of ethane ($C_2H_4$) is an exothermic reaction. Calculate the amount of heat liberated when 4.79g $C_2H_4$ reacts with excess oxygen. 11.2

$C_2H_4(g)$ 3 $O_2(g) \rightarrow$ 2 $CO_2(g)$ + 2 $H_2O(l)$ $\quad \Delta H = -1.39 \times 10^3$ kJ