12' 23,30

DO NOT DO

4,9 °C = Ag = 950000 J = 1000 g · 0.237 · ΔT

2,454°C = Cu = 950000 J = 1000 g · 0.387 · ΔT

1,061°C = Al = 950000 J = 1000 g · 0.895 · ΔT

Name KEY

Class _____ Date _____

Chapter 16 Test

Thermodynamics

Part I

Select the response that best completes each statement or answers each question. Write the letter of each answer in the space provided on the left.

A 1. The temperature of a sample of a substance depends on the _____.
   a. average kinetic energy of the particles
   b. mass of the sample
   c. amount of heat the sample contains
   d. sum of kinetic energy + potential energy in the sample

D 2. If 100 mL of water at 50°C are put over a low flame for two minutes, _____.
   a. the average velocity of the particles increases
   b. the total heat energy of the sample increases
   c. the temperature increases
   d. all of the above occur

C 3. The total energy of a sample of a substance depends on its _____.
   a. mass only
   b. temperature only
   c. temperature and mass
   d. temperature and density

D 4. Which of the following does NOT affect the amount of heat energy transferred by a substance?
   a. the capacity of the substance to absorb heat
   b. the change in temperature
   c. the mass of the substance
   d. the initial temperature of the substance

D 5. Which of the following is NOT involved in the calculation of heat absorbed as a substance melts?
   a. mass of the sample
   b. specific heat
   c. change in temperature
   d. density of the sample

$q = m \cdot c \cdot \Delta T$

Refer to the data below to answer questions 6–12. Show your work.

Substance	Specific Heat (J/g°C)	Heat of Fusion (J/g)	Heat of Vaporization (J/g)
water (l)	4.18	334	2260
water (s)	2.06	334	2260
ethanol	2.45	109	879
aluminum	0.895	376	11,370
copper	0.387	205	4726
silver	0.233	88	2300
granite	0.803	____	____

6. Three 1.0-kg samples of metals at room temperature are heated. The metals are silver, copper, and aluminum. If 950 kJ are available, which metal will show the greatest increase in temperature? Explain your answer.

Silver would show the greatest change in temperature because it has the lowest heat capacity.

7. How much heat is absorbed as a 95.0-gram sample of water is heated from 10.5 °C to 48.2 °C?

$q = 95\,g \cdot 4.184\,(48.2 - 10.5)$ $q = 14984.9\,J$

8. A granite wall used to store heat in a solar heated house has a mass of 950 kg. During the day, the temperature of the wall reaches 24 °C. How much heat will be released if the wall cools to 17 °C during the night?

$q = 950000\,g \cdot 0.803\,(17 - 24)$ $q = -5,339,950\,J$

9. How much heat energy is required to melt 550.0 g of copper that has already been heated to its melting point?

$q = 550\,g \cdot 205$ $q = 112,750\,J$

10. How much heat is released as a 75.0 g sample of ethanol gas at the boiling point condenses to a liquid?

$q = 75\,g \cdot -879\,J/g$ $q = -65,925\,J$

11. To determine the specific heat of an unknown metal with a calorimeter, (a) what temperatures must you determine? (b) What masses must you find? (c) What physical constant must you use?

Temperatures
1. _____
2. _____
3. _____

Masses
1. _____
2. _____

Physical Constant: _____

m	4000 g	1000 g	1000 g
c	2.09	4.184	0.0
T_i	0	0	
T_f	0	100	

$q_{water} = 1000 \cdot 4.184 (100) = 418400$ J

$q_{vapor} = 1000\,g \cdot 2260\,J/g = 2,260,000$ J

Critical Thinking

12. How much energy is required to change 1.00 kg of ice at 0°C to steam at 100° C?

$q_{total} = q_{melt} + q_{water} + q_{vapor}$

$q_{total} = 3012400$ J

Part II

Fill in the correct answer for the following questions.

13. In a(n) exothermic reaction, the system transfers heat to the surroundings.

14. In a(n) endothermic reaction, the surroundings transfer heat to the system.

15. The measure of the heat change that accompanies a reaction is called enthalpy.

16. If the sign for ΔH for a reaction is negative, the reaction is classified as exothermic.

17. If two reactions are endothermic, the value of ΔH for the one with the greater energy transfer has a value that is greater than the value of ΔH for the reaction with the smaller energy transfer.

18. According the Hess's law, the enthalpy change in forming a certain product in one step is equal to the enthalpy change in forming the same product in several steps.

19. An equation that shows the standard enthalpy of formation is written to indicate the formation of one mole(s) of product.

Write the correct answer in the space provided. Show your work.

20. Calculate ΔH for the reaction $NO(g) + \frac{1}{2}O_2(g) \rightarrow NO_2(g)$ given

$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g)\ \Delta H = +21.6$ kcal

$\frac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g)\ \Delta H = +8.1$ kcal

$NO \rightarrow \frac{1}{2}O_2 + \frac{1}{2}N_2 \quad \Delta H = -21.6$ kcal

$\frac{1}{2}N_2 + O_2 \rightarrow NO_2 \quad \Delta H = 8.1$ kcal

$NO + \frac{1}{2}O_2 \rightarrow NO_2$

$\Delta H = -13.5$ kcal

Write the equation that shows the standard enthalpy of formation for nitrogen dioxide, NO_2.

Refer to the figure below to answer question 22.

Substance	Formula	ΔH (kJ/mol)
water	$H_2O(l)$	−285.8
water	$H_2O(g)$	−241.8
carbon dioxide	CO_2	−393.5
methanol	CH_3OH	+638

22. Calculate ΔH for the burning of methanol. The products of complete burning of methanol are carbon dioxide and water vapor. Show your work.

$10\,CH_3OH + 5O_2 \rightarrow 10CO_2 + 2H_2O(g)$

638 ∅ −393.5 −241.8

−3935 6380

$\Delta H = [2(-241.8) + 10(-393.5)] - [10(638)]$

−483.6

$\Delta H = -10,798.6$ kJ

Critical Thinking

23. In the presence of oxygen, living things break down glucose to release energy during photosynthesis. The products of this reaction are carbon dioxide and water vapor. Some living things, such as yeasts, are able to break down glucose without using oxygen. This process, called fermentation, produces ethanol and carbon dioxide. Which process releases more energy? Show your calculations.

Substance	ΔH_f° (kJ/mole)
$C_6H_{12}O_6(s)$	−1268
$CO_2(g)$	−393.5
$H_2O(g)$	−241.8
C_2H_5OH	−277

Part III

Select the response that best completes each statement or answers each question. Write the letter of each answer in the space provided on the left.

C 24. Entropy is a measure of the _____ in a system.

a. average kinetic energy
b. temperature
c. disorder
d. heat

B 25. Which of the following does NOT represent an increase in entropy?

a. a solid changing to a liquid
b. a gas changing to a liquid
c. a solute dissolving in a solvent
d. water being heated

A 26. The characteristics that make a reaction most likely to be spontaneous are _____.

a. $-\Delta H, +\Delta S$
b. $-\Delta H, -\Delta S$
c. $+\Delta H, +\Delta S$
d. $+\Delta H, -\Delta S$

D 27. Which of the following affect(s) total free energy?

a. enthalpy
b. entropy
c. temperature
d. all of the above

C 28. The decomposition of hydrogen peroxide, H_2O_2, is a spontaneous reaction. From this, you can infer that _____.

a. ΔH for this reaction is positive
b. ΔS for this reaction is negative
c. the reverse reaction is nonspontaneous
d. All of the above are true.

Critical Thinking

29. Explain how temperature determines whether a reaction is spontaneous, if both ΔH and ΔS are positive.

Temperature must be high so $-T\Delta S$ will be greater than ΔH resulting in a $-\Delta G$ in the equation $\Delta G = \Delta H - T\Delta S$. A $-\Delta G$ indicates a spontaneous reaction.

Laboratory Investigation

30. Sometimes, clouds are "seeded" to produce rain. In this process, crystals are dropped into a cloud, and water vapor collects on the crystals, forming droplets that fall as rain. How does cloud seeding affect the entropy of the cloud system? Would you expect this change to be exothermic or endothermic? Explain your answer.