4th
Thurs

Physics
Chapter 12 Pretest
Mr. Roy

Name Key
Date ______
Period ______

Thermal Energy

Understanding Physics Concepts

Write the term that correctly completes the statement. Use each term once.

Celsius
entropy
heat
heat of vaporization
Kelvin
kinetic
mechanical
potential
conduction
specific heat
temperature
thermal equilibrium
radiation
convection
work

1. thermal equilibrium If two objects touch each other and the temperatures of both objects remain the same, they are in ______.
2. temperature Energy that travels spontaneously from a warm object to a cold object is called ______.
3. heat ______ is a measure of the average kinetic energy of a substance.
4. radiation Heat travels through a vacuum by ______.
5. Convection ______ occurs in fluids that are warmer at the bottom.
6. Conduction Heat travels best through a solid by ______.
7. specific heat The heat needed to raise the temperature of 1 kg of a substance 1 K is called its ______.
8. heat of vaporization The energy released when 1 kg of steam condenses is the ______ of water.
9. Kelvin The freezing point of water on the ______ scale is 273 degrees.
10. Kinetic A substance melts when the ______ energy of its atoms or molecules is increased.
11. Potential A decrease in temperature is a result of a decrease in the ______ energy of the atoms or molecules.
12. Entropy In an engine, the difference between the heat put in and the heat discharged will appear as ______.
13. Mechanical Heat engines convert thermal energy into ______ energy.
14. work A 100% efficient engine would produce no increase in ______.
15. Celsius On the ______ scale, the boiling point of water is 100 degrees.

Circle the letter that best completes the statement.

16. According to the second law of thermodynamics, natural processes go in the direction that _____ Increases the total entropy of the system.

a. increases or decreases
[✓ b.] increases
c. decreases
d. maintains or increases

17. The total increase in the thermal energy of a system is the heat added to it minus the _____ done by it.

a. entropy
[✓ b.] work
c. kinetic energy
d. temperature

18. A heat pump _____.

a. is used only to remove heat from the house in the summer
b. is used only to transfer heat from the outside air into the house in the winter
c. generates its own heat for the house during the winter
[✓ d.] transfers heat into and out of the house depending on the season

† 19. The form of heat transfer that takes place in a house heated by forced air is primarily _____.

[✓ a.] convection
b. conduction
c. radiation
d. work

20. Natural processes tend to move toward greater _____.

a. order
[✓ b.] disorder
c. total energy
d. thermal energy

Answer the following questions. Use complete sentences.

21. You drop 1 kg each of copper, aluminum, and iron, which have been heated to 450 K, into three pails that contain the same amount of water at room temperature.

a. How will the temperature of the water in the three pails compare when they reach thermal equilibrium? Why?

Each pail will have a T_f above 450K, but they will be different because they have different specific heat constants

b. How will the temperature increase of the water with the aluminum compare to the temperature increase of the water with the iron?

The ΔT caused by the aluminum will be than the ΔT caused by the iron.

3. A 1.0-kg block of aluminum is at a temperature of 50°C. How much thermal energy will it lose when its temperature is reduced by half?

$T_f = 25.0$ $T_o = 50$ $C = 897 J/kg\text{-}°C$

$\Delta T = 25 - 50 = -25$

$Q = MC\Delta T$; $Q = (1.0)(897)(-25) = -22425 J = -2.2 \times 10^4 J$

4. How much heat must be added to a 250-g aluminum pan to raise its temperature from 20°C to 85°C? The specific heat of aluminum is 897 J/kg · K.

$M = .250 kg$

$\Delta T = 85 - 20 = 65$

$C = 897$

$Q = (.250)(897)(65) = 14576 J = 1.5 \times 10^4 J$

5. A 250-g block of ice is removed from the refrigerator at −8.0°C. How much heat does the ice absorb as it warms to room temperature (22°C)? The heat of fusion of water is 3.34 × 10⁵ J/kg.

$M = .250 kg$

$C_{ice} = 2060$

$C_{H_2O} = 4180$

$Q = MC\Delta T + ML_f + MC\Delta T$

$Q = (.250)(2060)(8) + (.250)(3.34 \times 10^5) + (.250)(4180)(22)$

$Q = 4120 + 83500 + 22990 = 110610 J$

$Q = 1.1 \times 10^5 J$

6. Why are the Fahrenheit and Celsius temperature scales different? What was the basis for each scale?

The increment size per degree are different due the values assigned in each scale for the freezing and boiling points of water.

3. You pour 150 g of hot water at 86°C into a 250-g glass cup at 22°C. They come to thermal equilibrium quickly, so you can ignore any loss of energy to the surroundings. What is the final temperature?

$Q_{loss} = -Q_{gain}$

$m_1 = .150 kg$ $C_1 = 4180$

$T_{o_1} = 86°$

$M_2 = .250 kg$ $C_2 = 840$

$T_{o_2} = 22°c$

$(.250)(840)(T_f - 22) = -(.150)(4180)(T_f - 86)$

$210 T_f - 4620 = -627 T_f + 53922$

$837 T_f = 58542$

$T_f = 69.9°c$

4. A 1.00-kg block of ice at 0°C is melted and converted to water at 0°C. What is its change in entropy?

$\Delta S = \frac{Q}{T}$

$Q = ML_f = (1.00)(3.34 \times 10^5) = 3.34 \times 10^5 J$

$T = 0°C = -273 K$

$\Delta S = \frac{3.34 \times 10^5}{-273} = -1223.4 J/K$

5. A window air conditioner is put on the floor of a room and is plugged in and turned on. What will happen to the temperature in the room?

It will not change. The heat tranfer brought about by the work of the air Conditioner is staying in the room.

6. A mass of 10.0 kg of iron is heated from 20.0°C to 60.0°C. $C = 450\ J/kg\text{-}°C$

a. How much heat is added to the system?

$$Q = (10.0)(450)(40) = 1.8 \times 10^5\ J$$

b. If the iron were placed in a large container of boiling water, what would happen to the water?

Energy from the water would be transferred to the iron until thermal equilibrium occurred.

c. If the iron were placed in a depression in a large block of ice, how much ice would melt? Assume that no energy is lost to the surroundings.

$$m = \frac{Q}{L_f} = \frac{1.8 \times 10^5}{3.34 \times 10^5} = .54\ kg$$ of ice would melt

7. A copper wire has a mass of 165.0 g. An electric current runs through the wire for a short time, and its temperature rises from 21.0°C to 39.0°C. What minimum quantity of heat is generated by the electric current? $Q = (.165)(385)(18) = 1143\ J$

8. A 10.0-g ice cube at 0.0°C is added to a cup that contains 200.0 g of water at 90.0°C.

a. How much energy is needed to melt the ice cube?

$$Q = (.010)(3.34 \times 10^5) = 3.34 \times 10^3\ J$$

b. What is the temperature of the water after the ice cube has melted? Assume that no thermal energy transfer occurs other than the energy used to melt the ice cube.

$$Q_{H_2O} = (.200)(4180)(T_f - 90) = -Q_{ice\ melt}$$

$$836\ T_f - 75240 = -3.34 \times 10^3$$

$$836\ T_f = 71900$$

$$T_f = 86\ °C$$

c. What will be the final temperature of the system after it reaches thermal equilibrium?

$$Q_{gain} = -Q_{loss}$$

$$(3.34 \times 10^3) + (.010)(4180)(T_f - 0) = -(.200)(4180)(T_f - 90)$$

$$(3.34 \times 10^3) + 41.8\ T_f = -836\ T_f + 75240$$

$$877.8\ T_f = 71900$$

$$T_f = 81.9°C$$