Name _____ Section _____

Period 4 Activity Solutions: Transfer of Thermal Energy

4.1 How Does Temperature Differ from Thermal Energy?

a) **Temperature** Your instructor will demonstrate molecular motion at different temperatures.

1) What happens to molecular motion at higher temperatures?

2) Define temperature in terms of molecular motion.

b) **Thermal Energy**

1) What is thermal energy? How does thermal energy differ from temperature?

2) Which has more thermal energy – a cup of hot coffee or a bathtub full of warm water?

c) **Thermometers** Examine the four types of thermometers and explain what changing property each type of thermometer relies upon.

1) alcohol thermometers

2) bimetallic strip thermometers

3) liquid crystal thermometers

4) infrared thermometer

d) **Temperature Scales** Your instructor will discuss Fahrenheit, Celsius and Kelvin temperature scales.

1) Examine a thermometer with both Fahrenheit and Celsius scales. On the Celsius scale, how many degrees are between the freezing point and the boiling point of water? _____

2) On the Fahrenheit scale, how many degrees are between the freezing point and the boiling point of water? _____

3) Use the number of degrees between the freezing and boiling points of water to make a ratio of the number of Celsius degrees per Fahrenheit degrees.

4) Write an equation to convert degrees Fahrenheit into degrees Celsius. Use your ratio from part 3 plus the fact that the freezing temperature of water in the Celsius scale is 32 degrees lower than in the Fahrenheit scale.

5) Use your equation to convert 70 degrees Fahrenheit into Celsius degrees.

6) In the Kelvin scale, water boils at 373 Kelvin and freezes at 273 Kelvin.

   A change in how many degrees Celsius equals how much of a change in Kelvin?

7) Write an equation to convert degrees Celsius to Kelvin.

e) Group Discussion Question: Which temperature scale gives the greatest distinction between temperature degrees – Fahrenheit, Celsius, or Kelvin?

4.2 How Is Thermal Energy Transferred?

a) **Transferring Thermal Energy** What is the one essential condition for the spontaneous transfer of thermal energy between two objects?

b) **Conduction**

1) Before watching the demonstration, predict the order in which the steel balls will fall off of a metal rod when it is heated.

Prediction: _____

Answer: _____

2) What are the necessary conditions for heat transfer via conduction between two objects?

c) **Thermal Conductivity** Your instructor will discuss thermal conductivity

1) Before watching the demonstration, predict the order in which the steel balls will fall off of rods made of different metals.

Prediction: _____

Answer: _____

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2) Touch the glass, metal, and cork squares.

a) Do the squares feel as if they are at the same temperature? _____

b) Measure the temperature of the squares with an infrared thermometer. How do their temperatures compare?

c) Why do the squares feel as if they are at different temperatures?

d) **Convection** Watch the demonstrations of thermal energy transfer via convection

1) What are the necessary conditions for thermal energy transfer via convection?

2) Does convection involve a transfer of matter? _____

3) Does conduction involve a transfer of matter? _____

e) **Radiation** Place the flood light an equal distance from the two cans fitted with balloons.

1) Which balloon inflates first? _____ Why?

2) Why is the inside of a thermos silver-colored?

3) Does thermal energy transfer via radiation involve a transfer of matter? _____

4) Does thermal energy transfer via radiation require objects to be touching? _____

f) **Examples of thermal energy transfer** Place a small paper cup of water on the screen of the metal stand. Light the burner with a match and carefully move the burner under the paper cup.

1) Does the paper cup burn? _____ Why or why not?

2) What do you think would happen if the paper cup were full of pennies instead of water?

3) What forms of energy transfer are involved?

4.3 How Can Thermal Energy Transfer Be Minimized?

a) **Heat flow through a surface**

1) What factors determine how much heat flows through a surface, such as a glass window?

2) Write an equation for heat flow through a surface.

3) How much heat flows through a glass window that is 2 meters by 2 meters in area and 1.5 cm thick if the outside temperature is 10 ^{0}C and the inside temperature is 25 ^{0}C? (The thermal conductivity of glass is 0.84 J/s m ^{0}C)

b) **R-value of insulation** Examine a piece of home insulation. The R-value of a material is a ratio of two variables: the thermal conductivity of the material ***K*** and its thickness ***L***.

1) Use ratio reasoning to write an equation for ***R*** so that good insulating material has a larger R-value than poor insulating material.

2) Rewrite your equation for heat flow from part a.3, using R instead of L and K.

3) What would happen to the heat flow through a wall if you increased the thickness of the insulation from 2 inches to 6 inches?

c) **Changing temperatures and properties of matter**

1) Predict some properties of matter that you think change with changing temperature.

2) Watch the demonstrations of materials cooled with liquid nitrogen. List changes you see in the properties of matter cooled to low temperatures.