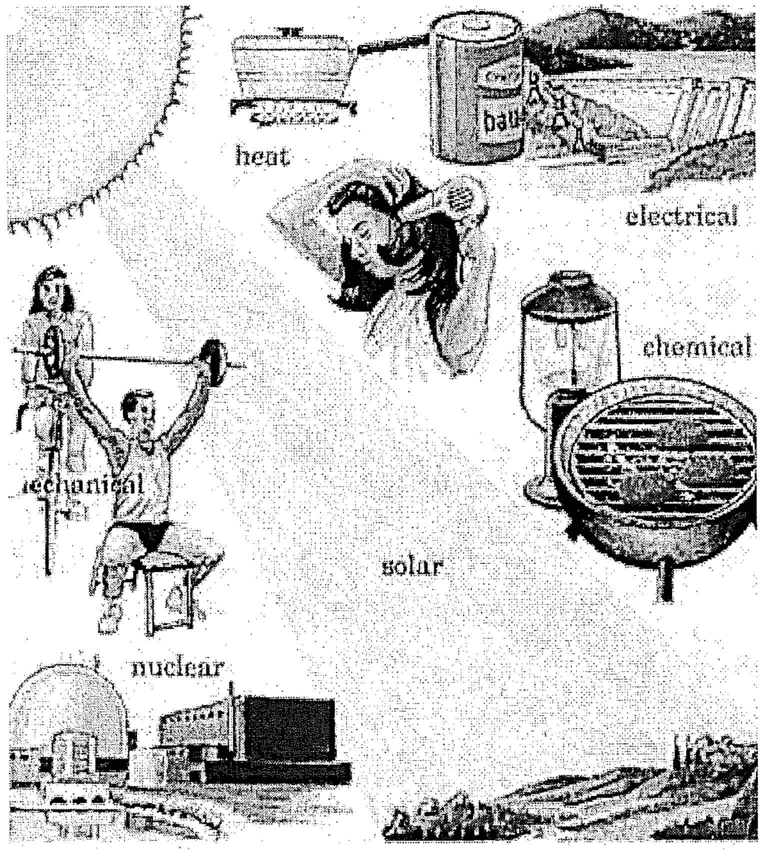
IPC



Unit 10

Energy Forms

Energy Conversions

Heat Energy

Name Key

Integrated Physics and Chemistry
Unit 10 Energy - Forms, Conversions & Heat

Date	What We're Doing	Homework
FEB 7 MON	Forms of energy & energy conversion notes, Vocabulary	
FEB 8 TUE	Nature of energy, Divisions of physics, Examining energy worksheets	
FEB 9 WED	Energy transformation game, Illustrate an original example of the Law of Conservation of Energy	
FEB 10 THU	Heat energy notes (slides 1-8), Heat on the move, The heat is on worksheets	Unit 9 retest after school
FEB 11 FRI	Comparing insulating materials question and graph, A form of energy worksheets	
FEB 14 MON	Finish notes (slides 9-12), Measuring heat, Specific heat worksheet	
FEB 15 TUE	We got the heat lab	
FEB 16 WED	Quiz, TAKS review problems	
FEB 17 THU	½ day, Go over TAKS review problems, Test review	
FEB 18-FEB 21 FRI-MON	NO SCHOOL	
FEB 22 TUE	Unit 10 test	
FEB 24 THU	Unit 10 RETEST - After school only	

- Investigate the law of conservation of energy.
- Investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as in weather, living, and mechanical systems.
- Analyze energy changes that accompany chemical reactions such as those occurring in heat packs, cold packs, and glow sticks and classify them as exothermic or endothermic reactions.

Name: ______________________________ Class: __________ Date: _____________

IPC Forms of Energy & Energy Conversion Notes

Slide 1 – What is ENERGY?

1. In Science ENERGY is the ability to do work and cause change.

Slide 2 – Why do we need energy?

2. Some examples how we need energy in our daily lives.
   - Reading a book
   - Running around the school
   - Riding a bike
   - Even resting needs energy

Slide 3 – Why do we need energy? Continued

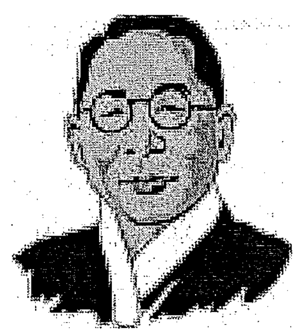
3. Everything that happens in the world involves movement and for something to move, energy is required.
4. If something takes energy in, then it also gives energy it out.

5. Think about it…a light bulb can get ENERGY IN from the electrical outlet and the bulb gives ENERGY OUT as light and heat.

Slide 4 – Seven Forms of Energy

6. The forms of Energy

   1. ***M***echanical
   2. ***R***adiant (Light)
   3. **C**hemical
   4. ***H***eat (Thermal)
   5. ***E***lectric
   6. ***N***uclear
   7. **S**ound



Slide 5 – Mechanical Energy

7. Mechanical Energy is energy of moving objects.
Mechanical Energy = kinetic energy + potential energy in the system

Examples of Mechanical Energy include:
- Windmill used to make electricity
- Paddle used to turn water to move boat.
- Peddling bicycle to move forward

Slide 6 – Radiant Energy

8. Made up of waves called electromagnetic waves.

Examples of Radiant Energy include:
- Light
- Ultraviolet light
- X rays
- Infrared radiation (heat)
- Radio waves
- Microwaves
- Radar

Slide 7 – Chemical Energy

9. Chemical Energy is the energy stored or released during a chemical reaction or energy stored in molecules.

Examples of Chemical Energy include:
- Acid battery
- Petrochemicals
- Carbohydrates

Slide 8 – Heat Energy

10. Heat Energy results from the movement of particles and also produces light in some instances.

Examples of Heat Energy include:
- The sun
- Boiling water
- Fire

11. A beaker of hot water has more heat energy than the beaker of cold water because the molecules are moving faster in the hot water.

Slide 9 – Electrical Energy

12. Electrical Energy is when an electrical current flows in a circuit to provide energy to an appliance.

    Examples of Electrical Energy include:
    - Using a hair dryer
    - A refrigerator cooling food
    - The energy your computer uses

Slide 10 – Nuclear Energy

13. Nuclear Energy is from the nucleus of the atom.
    Nuclear Fission splits 1 atom into 2.
    Nuclear Fusion combines 2 nuclei to make 1.
    Heat from the reaction makes steam to turn the turbine which generates electricity.

Slide 11 – Sound Energy

14. Energy produced by sound vibrations as they travel through a medium.
    Examples of Sound Energy include:
    - Music
    - Traffic noise
    - Talking

Slide 12 – Guided Practice

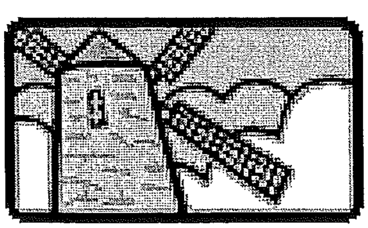
15. List and give examples of the 7 Forms of Energy in your daily life.

    i. computer
    ii. hair dryer
    iii. calculator
    iv. cell phone
    v. driving car
    vi. cooking

Slide 13 – Law of Conservation of Energy

16. Energy can not be created OR destroyed – it can only change from one form of energy to another.

17. When energy changes from one form to another, it is called:



1. Energy Conversions
   OR
2. Energy Transformations

Slide 14 – Energy Conversions/Transformations

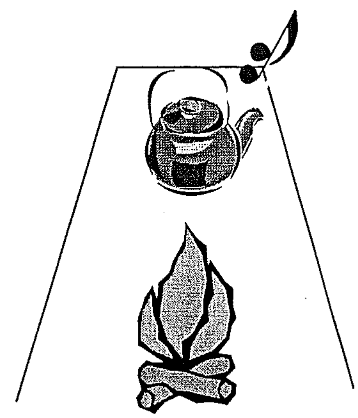
18. Let's look at the example: A camper is using a wood fire to heat a pot of water for coffee. The pot has a whistle that lets the camper know when the water boils.

    The types of energy involved:

    a. Chemical energy from the wood is changed to Heat energy.

    b. Heat energy is changed to Mechanical energy as the water boils and changes to steam to make the whistle vibrate.

    c. The whistle changes the Mechanical energy into Radiant energy (sound).



Slide 15 – Energy Transformations Examples

19. Identify the types of energy transformations involved in the following scenarios.

    Example 1: In western states, many homes generate electricity from windmills. In a particular home, a young boy is using the electricity to run a toy electric train.

1. Radiant → Mechanical ⇒ Sun can effect weather + wind patterns and wind turns windmill blade

2. Mechanical → Electrical ⇒ blade turning powers generator + creates electricity

    Example 2: A bicyclist is riding at night. He switches on his bike's generator so that his headlight comes on. The harder he pedals, the brighter his headlight glows.

1. Chemical → Mechanical ⇒ muscle energy allows him to push pedals

2. Mechanical → Electrical ⇒ Pedaling powers generator

3. Electrical → Radiant ⇒ Electricity creates light

Name ______________________ Class ____________ Date ________

Nature of Energy

KEY CONCEPTS

▲ Energy can be defined as the ability to do work.

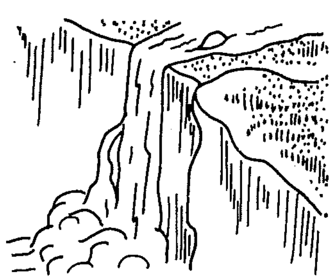
Building Vocabulary Skills: Understanding Definitions

Use your understanding of the term **energy** to complete the following sentences.

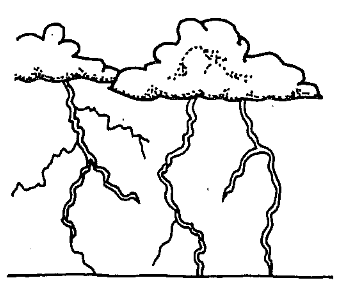
1. Energy appears in many forms.
2. Energy is the ability to do work.
3. Energy is measured in Calories or joules.
4. Energy associated with motion is called mechanical energy.
5. An object gains energy when temperature increases.
6. The internal motion of atoms is called heat.
7. Nuclear energy is released when atoms join or split.
8. Light and electricity are forms of radiant energy.
9. When atomic bonds are broken, chemical energy is released.
10. Music is a type of sound energy.

Forms of Energy: Understanding the Main Ideas

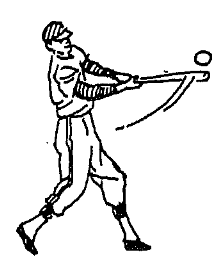
Identify which of the 7 main forms of energy is present in each situation. There may be more than one form.



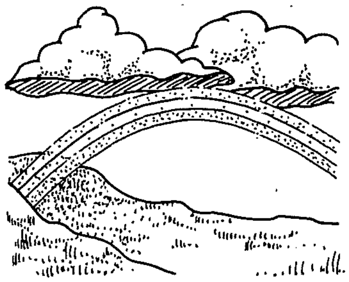
1. Mechanical



2. electrical radiant

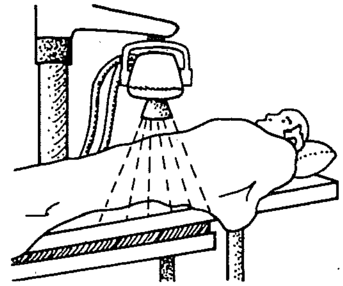


3. Mechanical sound

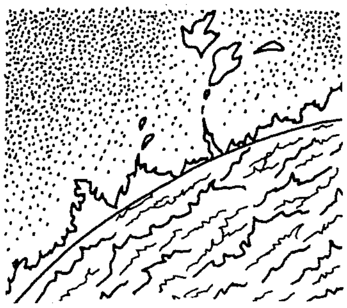


4. radiant

5. sound, mechanical

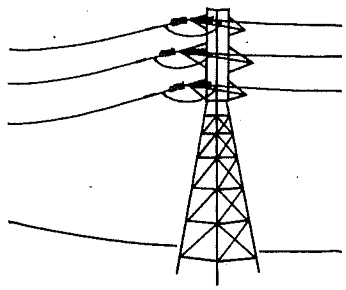


6. nuclear

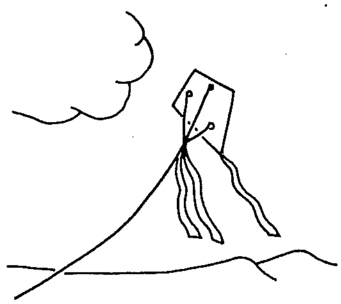


sun →

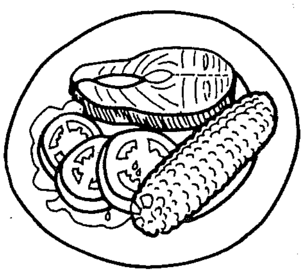
7. nuclear, heat radiant



8. electric

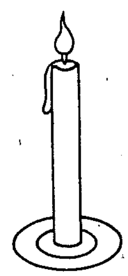


9. mechanical



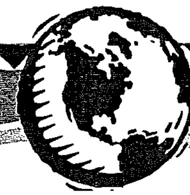
10. chemical

11. heat, electric



12. chemical, radiant

Name______________________________ Date______________



everyday physical science

THE DIVISIONS OF PHYSICS

Physics is the science that deals with matter and energy and how they interact. It involves the study of electricity, heat, light, magnetism, mechanics, and sound. Look at the items relating to physics below. Use the following letters to designate the field of physics each item relates to:

M mechanics, the motion of solids, liquids, and gases	R light energy - radiant
E electricity ~~and magnetism~~	**S** sound energy
H heat energy	**N** nuclear energy
	C - chemical energy

Note: More than one letter may be assigned to an example.

1. E electric motor
2. S drums
3. N atomic reaction
4. H R fireplace
5. C R firefly
6. M C skiing
7. M C swimming
8. M S playing a flute
9. S echo
10. M chain reaction
11. M falling off a ladder
12. C R burning candle
13. E S doorbell
14. M pushing a wheelbarrow
15. E refrigerator magnets
16. S R M explosion
17. S thunder
18. E R lightning
19. E R computer
20. E S telephone
21. M C horse race
22. E R sunlamp
23. M H sanding a floor
24. M S earthquake
25. M H boiling water
26. M S tornado
27. M swinging on a vine
28. E compass
29. N R our Sun, a star
30. M the planets
31. M baseball in flight
32. M C S flying an airplane
33. M S H volcano
34. M swinging bridge

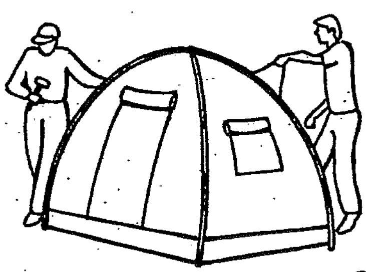
Examining Energy

The law of conservation of energy states that the amount of energy that exists in the universe always remains the same. Energy can, however, change from one form to another. Think about what happens to the electrical energy used to turn on a lamp. It changes to light energy and heat energy as the lightbulb gives off light and becomes hot. There are many forms of energy:

- **Mechanical energy** makes things move.
- **Heat energy** causes an increase in temperature.
- **Light energy** makes things visible.
- **Electrical energy** usually results from the flow of tiny particles called electrons. Electrical energy flows through materials such as iron, steel, and copper wire.
- **Chemical energy** is stored in a substance and released during a chemical reaction. During a chemical reaction, a new substance is produced.
- **Nuclear energy** is released when we change the nucleus of very small particles of matter called atoms. Nuclear energy is also called atomic energy. Nuclear energy is a powerful but potentially dangerous form of energy.
- **Radiant energy** is made up of heat energy and light energy. Solar energy, the energy from the sun, is a form of radiant energy. It is produced by nuclear energy.

Fill each blank with the appropriate type of energy described above.

During their spring campout, a group of campers called the Falcons used many

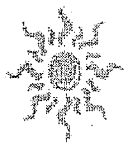
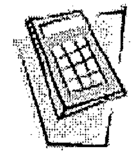
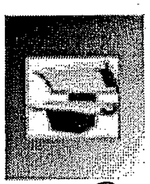
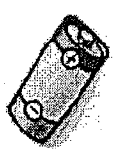
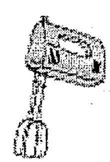
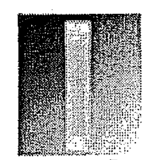


different forms of energy. They started out by pitching their tents. This required a lot of (1.) Mechanical energy. After the tents were up, it was time for lunch. Since there were no outlets to provide (2.) electric energy, the boys decided to use aluminum foil to create an oven which captured (3.) radiant /solar energy from the sun. They used the (4.) heat energy from the sunlight to warm their food. After they ate, their bodies used (5.) Chemical energy to digest the food. Then the campers used (6.) Mechanical energy to take a long hike. It began to grow dark before the campers reached their tents, so they turned on their flashlights. The (7.) Chemical energy in the batteries changed into the (8.) light energy which the campers used to see the trail in the dark.

9. Find out more about nuclear energy. What is its most common use?
Heat from nuclear energy created in nuclear reactors is used to produce electricity.

Energy Transformation Game

Answers can vary!

Sun  N → R or H	Windmill  M → E	Microwave  E → H or R	Solar Calculator  R → E	Crane  C → M	Satellite Dish  R → E	Siren  E → S
Tanning Bed  E → R	Nuclear Power Plant  N → E or H	Hot-air Balloon  H → M	Magnifying Glass  R → H	Candle  C → H or R	Electric Guitar  E → S	Firecracker  C → R or S
Battery  C → E	Piano  C → S	Light Bulb  E → H or R	Mixer  E → M	Iron  E → H	Lightstick  C → R	Bicycle  C → M
Television  E → R	Person Eating  M → C	Plant  R → C				

M = Mechanical
R = Radiant (Light)
C = Chemical
H = Heat (Thermal)
E = Electrical
N = Nuclear
S = Sound

Illustrate and color your own Law of Conservation of Energy example below using an energy conversion. Describe how energy does not appear or disappear in your example but changes from one form into another.

Name: ______________________________ Class:_______ Date: __________

IPC – Heat Energy Notes

Slides 2-8 – Thermal Energy Conversions

There are 3 types of Thermal Energy Conversions:

I. Conduction

- Transfer of thermal energy by direct contact
- **Always** from a solid hot object to a solid cold object
- Example: A metal spoon inside a saucepan gets hot while a saucepan is getting heated.

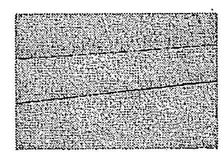
Question: If you were the chef in the picture and had to stir the contents for 20 minutes non-stop while on high heat – which type of spoon would you want to use? Why?

Conductors

- Transfer heat easily
- More tightly packed the particles, the better it is as a conductor
- Most often Metals - metal spoon, metal pan, copper, iron, steel, silver

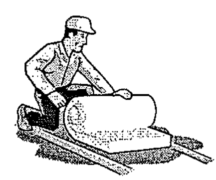
Insulators

- Do not allow heat to move easily through them
- Wood, plastic, glass, fiberglass, air, styrofoam
- Double pane windows (air between 2 panes of glass)



Insulation

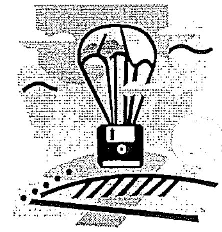
- R-value - rates insulation (higher number best)
  R-1 R-16 R-20



Energy Vocabulary

- Absorbers - take in the energy
- Reflectors - reflect the energy
- Emitters - good absorbers that release energy later
  - dark and dull materials absorb
  - light and shiny materials reflect

II. Convection



- Transfer of thermal energy in fluids – anything that flows
- **Always** between liquids and gases
- Example: hot air balloon, wind, ocean & air currents, home heating, all the soup in a pot becoming warm
- Warmer fluids (less dense) rise, buoyant convection
- Cooler fluids (more dense) sink
- Wearing sweater keeps the heat from being taken away from the body

III. Radiation

- Transfer of thermal energy through waves.
- Electromagnetic waves - light, ultraviolet rays, x-rays, infrared rays
- Travels though gas and no air (vacuum) (outer space)
- Colors reflect waves differently.
    - Black absorbs, White reflects
- Example: sun's energy, microwaves and radio waves, infrared light bulbs, person warmed by a fire .

Slide 9 – Specific Heat

- The amount of energy needed to raise 1 gram of a substance 1°C in temperature.
- The property of a substance that tells us how much the temperature goes up when a given amount of heat is added
- The lower the specific heat number the quicker it heats up or cools down
- Water has a high specific heat, metals have a low specific heat
- Specific heat of water is 1.00 cal/g·C°
    - If in Joules it is 4.2 J/g·C°

Slide 10 The formula for calculating Specific Heat is...

Heat gained or lost = Mass X Change in Temperature X Specific Heat

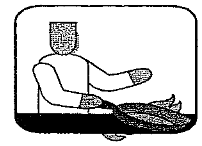
OR

$$Q = (m)(\Delta T)(Cp)$$

SYMBOL	STANDS FOR	UNITS
Q	Heat gained or lost	Calorie, joule or BTU
m	mass	grams
ΔT	Change in temperature in °C (final - initial)	°C
C*p*	Specific Heat	(cal/g°C) or (J/g·C°)

Slide 11 – Calculating Specific Heat

Example: If the specific heat of copper (Cu) is 0.09cal/g°C, how much heat is needed to raise the temperature of 5 grams of copper by 10°C?



Cp=.09 cal/g°C M=5g ΔT=10°C Q=?	Formula	Substitute	Answer
	Q=(M)(ΔT)(Cp)	Q=(5)(10)(.09)	Q=4.5 cal

Slide 12 – Specific Heat Guided Practice Problems

Problem 1: A 500 gram piece of Iron (Fe) changes from 7°C when heat is added. How much heat energy is produced this change in temperature. The specific heat of Iron (Fe) is 0.11cal/g°C.

Cp=.11 cal/g°C m=500g ΔT=7°C Q=?	Formula	Substitute	Answer
	Q=(m)(ΔT)(Cp)	Q=(500)(7)(.11)	Q=385 Cal

Problem 2: If it takes 105 calories to warm 100g of Aluminum (Al) from 20°C to 25°C, what is the specific heat of Aluminum (Al)?

Cp=? m=100g ΔT=5° Q=105 cal	Formula	Substitute	Answer
	Q=(M)(ΔT)(Cp) $\frac{Q}{(M)(\Delta T)}$ = Cp	$\frac{105}{100 \times 5}$ =	Cp=.21 cal/g°C

Heat on the Move

Heat energy comes from the movement of atoms and molecules that make up matter. When they vibrate and bump one another, they generate friction. **Friction** is a force that tries to keep objects from sliding across each other. The friction between the moving atoms and molecules generates heat. (You experience friction and the heat it creates when you rub your hands together on a cold day.)

Heat travels in three ways: conduction, convection, and radiation. During **conduction**, heat energy travels by direct contact. A heat source sends heat from molecule to molecule within a solid. **Conductors** are materials, such as iron and copper, that allow heat to flow through them easily. Materials such as wood and rubber, which do not allow an easy flow of heat, are called **insulators**.

Convection is another way in which heat energy is transferred. A heat source sends heat currents in a fluid motion throughout a liquid or gas. The heated liquid or gas is lighter because its molecules are farther apart, and it moves upward, away from the heat source. As the air or liquid cools, it moves back down and is heated again. The cycle continues. These movements are called **convection currents**.

Radiation is heat energy that travels in waves. These waves are called infrared rays. Radiation does not depend on the movement of atoms or molecules, so it can travel through a vacuum, a space that has no matter in it.

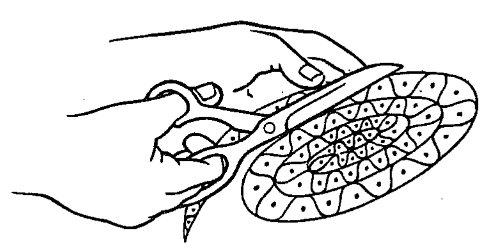
Write letters in the blanks to match each description with the correct word. (Some letters will be used more than once.)

1. E This type of object does not transfer heat easily.
2. C The sun warms you.
3. A the transfer of heat energy by direct contact
4. D This type of object transfers heat easily.
5. C the transfer of heat by rays
6. A You burn your finger on a hot stove.
7. B This causes air near the ceiling to be cooler than air near the floor.
8. A The end of a spoon left in hot water becomes hot.
9. B A space heater heats air then blows it across the room.
10. C Sunlight warms the earth.

A. conduction
B. convection
C. radiation
D. conductor
E. insulator

Follow the directions below to prove the existence of convection currents.

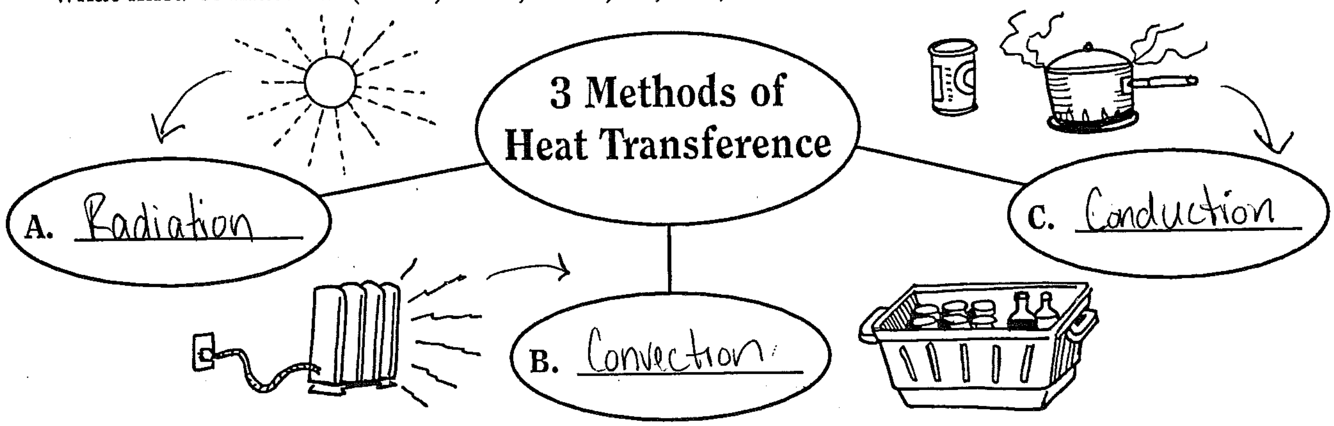
A. Cut a large circle from thin cardboard. Draw a spiral that eventually reaches the circle's center. The lines should be approximately $\frac{1}{2}$" apart. Use bright colors to decorate the spiral.
B. Cut along the spiral, then carefully make a tiny hole in the center of the circle. Push a piece of string through the hole, and tie a knot underneath.
C. Hang the spiral over a heater or a warm lamp to watch the convection process. The rising air (convection currents) makes the spiral turn.



THE HEAT IS ON

You reach out to stir the soup and the spoon burns your hand. Your can of soda was icy cold just half an hour ago, but now it's lukewarm. The basement of your house is cool, even on a sweltering hot day. You're sweating in your black shirt on a sunny day, but your friend is comfortable in her white shirt. You ski outside all day on a sub-zero, blizzardy day. You're warm in your living room even though you're 20 feet across the room from the heater. All these things are true because of the amazing talent of heat energy (it can be transferred) and the equally amazing talents of some materials that put up resistance to heat transfer. Use your knowledge about heat energy to do these two tasks:

I. Fill in the diagram below, and write a brief explanation for each method. Be sure to mention what kind of material (metal, wood, water, air, etc.) that method works in.



II. Give explanations that answer these questions. Use the back of the page if you need to.

1. How does heat get from the stove burner into your soup?
2. How does a cooler keep drinks cold on a hot day?
3. When two cars sit in the sun all day, the one with the black roof gets hotter than the one with the white, shiny roof. Why?
4. How does the heat from the sun, thousands of miles away, reach your body?
5. Why is the metal spoon in your cup of hot chocolate hot?
6. Why doesn't a plastic spoon in hot chocolate feel hot?
7. Why is your house warm on a cold day, even if you haven't turned on the heat?
8. When you turn on a heater, how does the warmth get to you?
9. Why are you warmer with several layers of clothes than with one heavy jacket?
10. Why do some cooking pots have wooden handles?
11. How does a cold can of soda become warm on a hot day?
12. How does a microwave oven get your food hot?
13. How can a solar heating system heat your water on a day when there's no sun?
14. How is a refrigerator an example of a heat mover?
15. How can temperature (heat) be pollution?
16. Why does clean snow melt more slowly than dirty snow?
17. Why is the attic of a house always warmer than the basement?

Name ______________________________

II. Answers will vary somewhat.
1. Conduction and convection: Heat from
the burner warms the pan by conduc-
1. tion. The liquid soup is warmed by
convection currents.
2. The cooler has insulating material—
something that is a poor conductor and
2. does not allow thermal energy to
transfer well.
3. Black absorbs radiant energy from the
3. sun. White or shiny objects reflect the
sun's energy.
4. by radiation
4. 5. Metal is a good conductor of heat. The
heat energy moves from the hot liquid
through the spoon by conduction.
5. 6. Plastic is a poor conductor of heat
energy.
7. Houses are usually insulated with mate-
rials that do not transfer thermal
6. energy well. Heat usually flows from
warmest spot to cooler spots. The insu-
lating materials hold the heat into the
7. house.
8. The warmth travels through the air by
convection.
8. 9. When you wear layers, air is trapped
between the layers. Your body heat
warms these many pockets of air, and
they add extra insulation to keep in
9. your body heat.
10. Wood is a poor conductor of heat; this
is a protection to keep hands from
10. burning.
11. Conduction and convection: Heat
energy outside the can warms the metal
11. can (a good conductor) by conduction.
Warmth from the surface of the can
then transfers through the liquid by
12. convection.
12. Microwaves carry radiant energy to the
food. This causes the molecules in the
food to vibrate rapidly and produce
13. thermal energy (heat).
13. A solar heating system includes
containers that store the heat collected
14. on a sunny day. This heat is stored in
such materials as hot water or stones.
14. A refrigerator is a heat mover because it
15. removes heat from the food inside a
cool space and puts the heat out into
the room at a higher temperature
16. (warm air comes out of the back of the
refrigerator).
15. Extra heat in the environment is called
thermal pollution because it can raise
17. the temperature of the environment
and change the ecosystem, causing
danger to some life forms.
16. Dirt in the snow is dark in color and
absorbs radiant energy from the sun.
This causes the snow to melt. Clean
snow reflects more of the sun's heat
energy away.
17. Air is heated by convection. Warm air is
always less dense and lighter. Heavier,
denser, cooler air sinks and pushes
warmer air upward.

Name ______________________ Class __________ Date ________

ACTIVITY ■ What Is Heat?

Comparing Insulating Materials

A student is conducting an experiment with three different materials to determine which material is the best insulator. The student fills a beaker with 250 mL of boiling water. Then she wraps a 2-cm-thick layer of Insulator A around the beaker. The student measures and records the temperature of the water every 30 minutes over a period of 2 hours. She repeats this procedure with two other insulating materials, Insulator B and Insulator C. The data obtained by the student are shown in the data table. Use these data to answer the questions that follow.

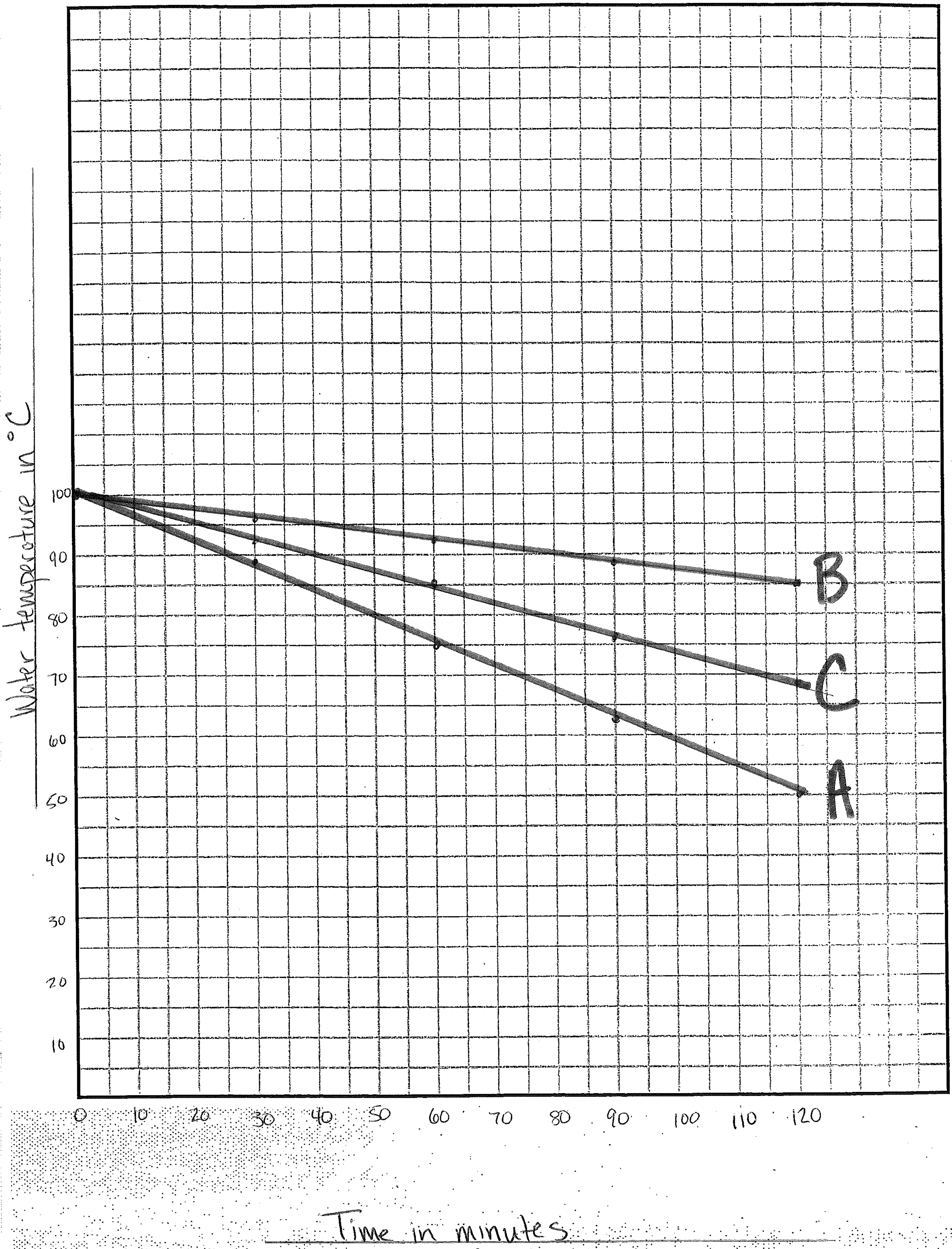
Time (min)	Water Temperature (°C)		
	Insulator A	*Insulator B*	*Insulator C*
0	100	100	100
30	88	96	92
60	75	93	85
90	63	88	76
120	50	85	68

1. Plot the data on a graph. Plot time in minutes on the horizontal axis and water temperature in degrees Celsius on the vertical axis. Use different-colored pencils to connect the data points for each insulator.

2. Which material would make the best insulator? Explain your answer.

   Insulator B - it allows less heat loss than the other two materials

3. Why is a good insulator important for conserving energy in homes during the winter? During the summer? During the winter insulation keeps heat from easily escaping from a house. During the summer, insulation keeps heat from easily entering a house.



Water temperature in °C
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
120
B
C
A
Time in minutes

Name ______________________ Class ____________ Date ________

Heat: A Form of Energy

KEY CONCEPTS

- ▲ Heat is a form of energy caused by the internal motion of molecules of matter.
- ▲ Heat energy is transferred by conduction, convection, and radiation.

Building Vocabulary Skills: Applying Definitions

Part 1

Decide which of the following statements correctly describes heat. If the statement describes heat correctly, write T before the number. If the statement does not describe heat correctly, write F

F 1. Heat is an invisible, weightless fluid.

F 2. Heat is a substance called caloric.

F 3. Heat is made up of molecules.

T 4. Heat moves from a warmer object to a colder object.

F 5. Heat can be transferred in only one way.

T 6. Heat is a form of energy.

T 7. Heat is caused by the internal motion of molecules of matter.

T 8. Motion produces heat.

F 9. Cold molecules move faster than warm molecules.

F 10. The hotter a substance is, the less energy its molecules have.

Part 2

Decide which of the following materials are conductors and which are insulators. If the material is a conductor, write C before the number. If the material is an insulator, write I.

I 1. air

C 2. copper wire

I 3. rubber

I 4. glass

C 5. aluminum

C 6. silver

C 7. iron

I 8. wood

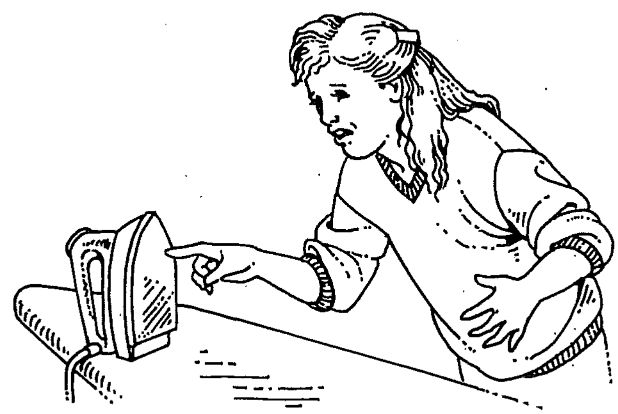
I 9. plastic

I 10. down

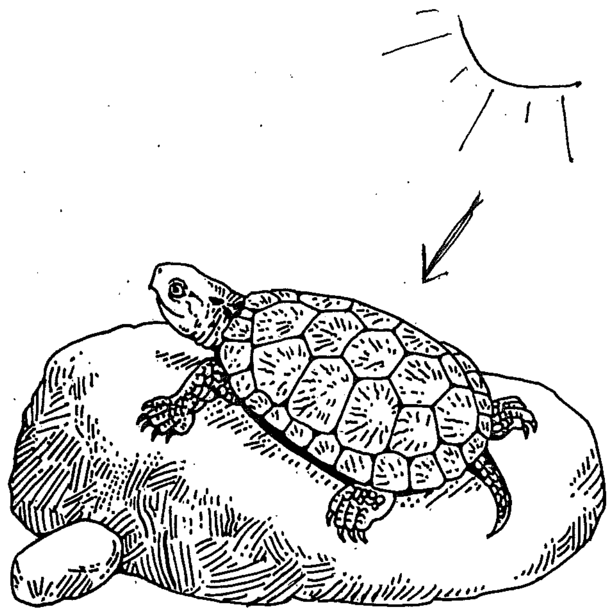
Heat Transfer: Understanding the Main Ideas

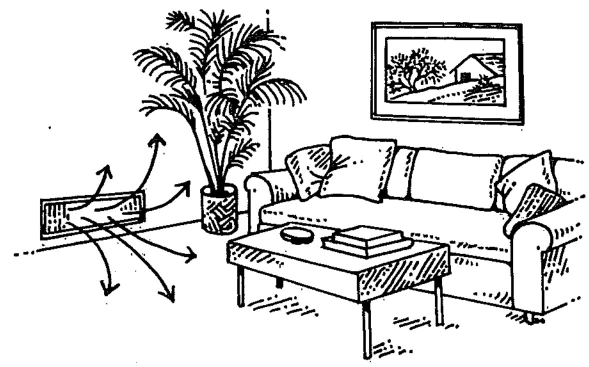
Identify the forms of heat transfer that take place in each illustration. Some illustrations may show more than one form of heat transfer.

1. Radiation



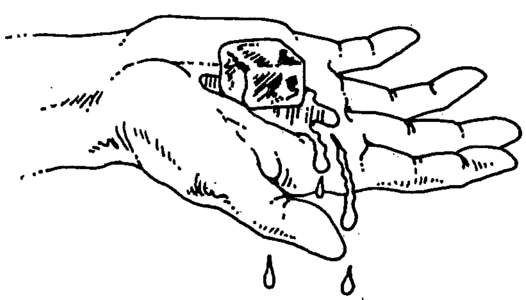
2. Conduction





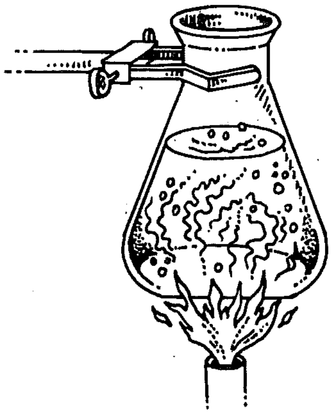
3. Radiation + Conduction

4. Convection

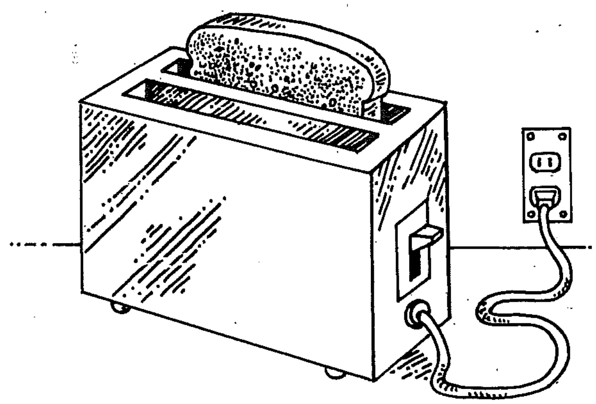


5. Conduction

6. Convection



7. Conduction + Convection



8. Conduction or Radiation

Name ______________________ Class ____________ Date ________

Measuring Heat

KEY CONCEPTS

▲ An increase in temperature indicates that heat is being added. A decrease in temperature indicates that heat is being removed.

Building Vocabulary Skills: Using Terms

Complete the following paragraphs by filling in the correct terms. Some terms will be used more than once.

Heat is measured in units called calories. One calorie is the amount of heat needed to raise the temperature of 1 gram of water 1 degree Celsius. Another unit that can be used to measure heat is the joule.

The ability of a substance to absorb heat energy is called its specific heat. The specific heat of a substance is the number of calories needed to raise the temperature of 1 gram of that substance 1 degree Celsius. A substance with a high specific heat tends to heat up slowly, while a substance with a low specific heat tends to heat up quickly.

The amount of heat gained or lost by a substance is equal to the product of its mass times the change in temperature times its specific heat. Within a closed container, the heat lost by one substance must be equal to the heat gained by another substance. A device that makes use of this principle to measure the heat given off in chemical reactions is called a Calorimeter.

Heat energy does not always cause a change in the temperature of a substance. Instead, the heat energy can be stored. Stored energy is called chemical energy. Foods contain stored heat energy. The amount of heat that a food gives off is measured in calories. One kilo calorie is equal to 1000 calories.

Using Formulas: Understanding the Main Ideas

For each situation pictured below, calculate the missing quantity.

Q = m ΔT Cp

Q = heat gained / lost

Cp = specific heat

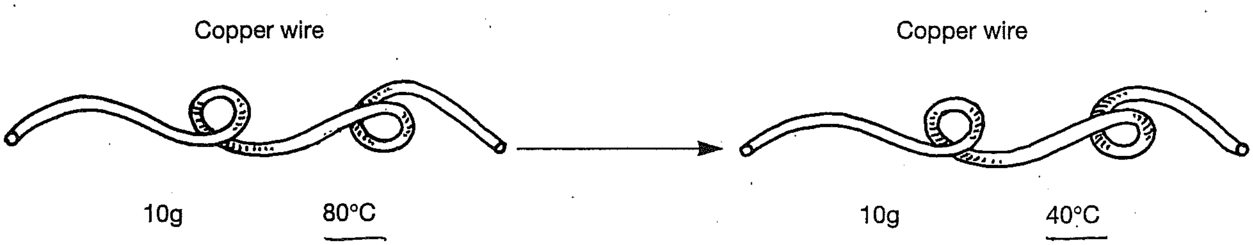
1.

Q = ?

m = 10g

ΔT = -40

Cp = .09



(Q) Heat lost = - 36 calories

Q = m × ΔT × Cp   10 × -40 × .09

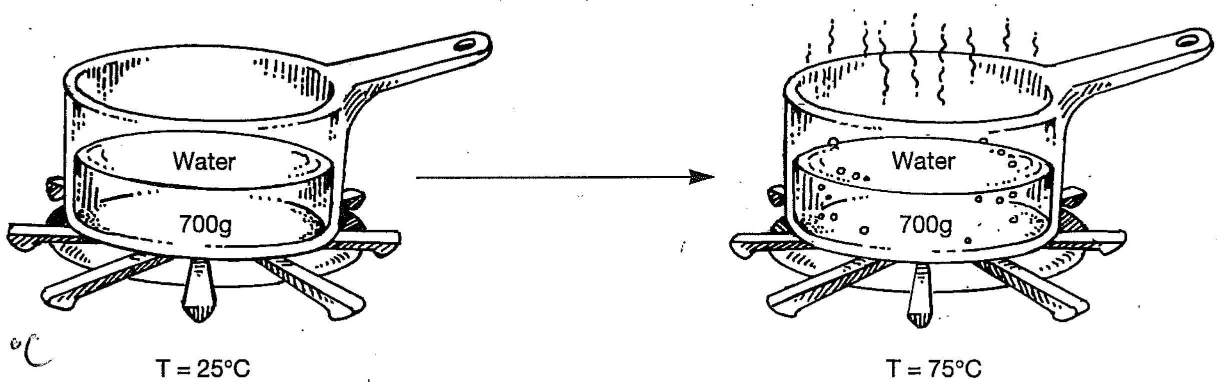
2.

Q = ?

M = 700

ΔT = 50

Cp = 1 cal/g °C



(Q) Heat gained = 35,000 calories

Q = m × ΔT × Cp   700 × 50 × 1

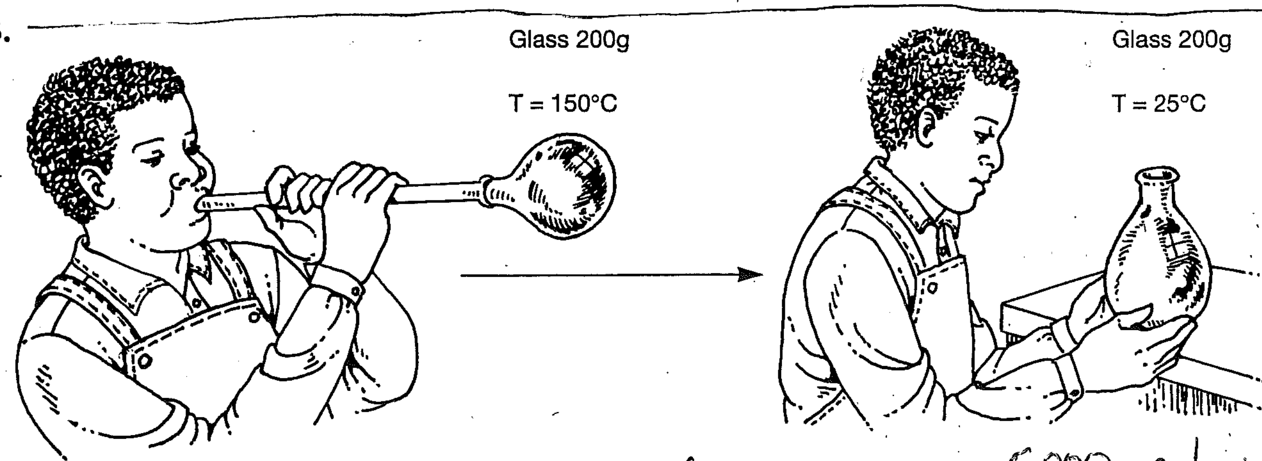
3.

Q = ?

m = 200

ΔT = -125

Cp = .2



(Q) Heat lost = - 5000 calories

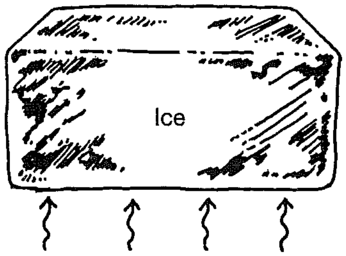
Q = m × ΔT × Cp   200 × -125 × .2

Name $Q = m \Delta T C_p$ Class ______ Date ______

4.

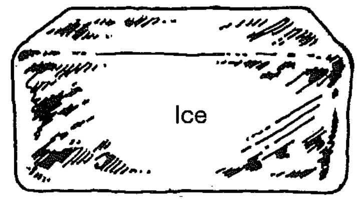
$Q = 5000$ Cal
$m = ?$
$\Delta T = 20$
$C_p = 1.0$

T = -20°C



+ 5000 calories →

T = 0°C



$m = \frac{Q}{\Delta T \times C_p} \Rightarrow \frac{5000}{20 \times 1}$

(m) Mass of ice = 250 g

5.

$Q = 900$ cal
$m = 50g$
$\Delta T =$
$C_p = .03$

Mercury

50g T = 20°C

+90 calories →

Mercury

50g

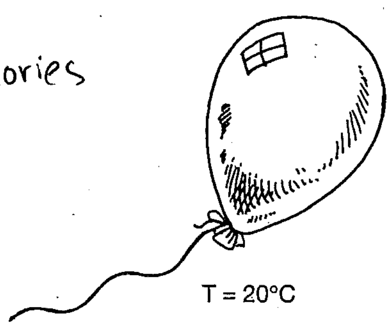
$\frac{Q}{m \times C_p} = \Delta T \Rightarrow \frac{90}{50 \times .03} \Rightarrow 60 + 20$

T = 80°C (mercury after)

6.

$Q = -2.5$ calories
$m = .5g$
$\Delta T =$
$C_p = .24$

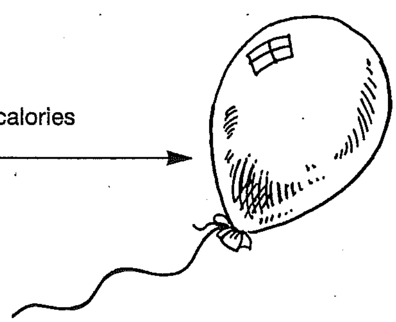
Air 0.5g



T = 20°C

-2.5 calories →

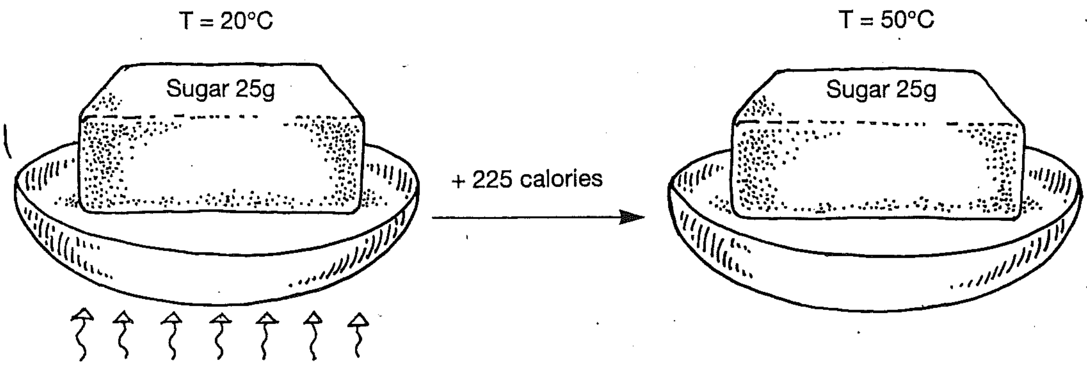
Air 0.5g



$\frac{Q}{m \times C_p} = \Delta T \quad \frac{-2.5}{.5 \times .24} \Rightarrow 21°C$

T = -1°C (air after)

7.

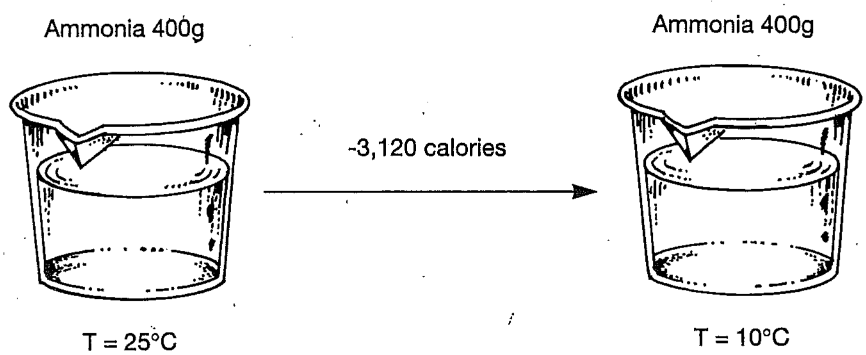


Q = 225 cal
m = 25g
ΔT = 30°C
Cp = ?

$Cp = \frac{Q}{m \times \Delta T}$ $\frac{225}{25 \times 30}$ ⇒

(Cp) Specific heat = .3 Cal/g°C

8.



Q = - 3,120 cal
m = 400g
ΔT = -15 °C
Cp = ?

(Cp) Specific heat = .52 cal/g°C

$Cp = \frac{Q}{M \times \Delta T}$ $\frac{-3120 \text{ cal}}{400 \times -15}$ ⇒

Specific Heat Worksheet Name: KEY

Q = m x ΔT x cp

Where q = heat energy, m = mass, T = temperature and C = specific heat. Remember, ΔT = (T_{final} – $T_{initial}$). Show all work and proper units.

1. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.

Q = 1086.5 J
m = 15.75 g
ΔT = 150°C
Cp = ?

.46 J/g°C

$\frac{1086.5}{15.75 \times 150}$

2. How many joules of heat are needed to raise the temperature of 10.0 g of aluminum from 22°C to 55°C, if the specific heat of aluminum is 0.90 J/g°C?

Q = ?
m = 10 g
ΔT = 33°C
Cp = 0.90 J/g°C

297 J

10 x 33 x .9

3. To what temperature will a 50.0 g piece of glass raise if it absorbs 5275 joules of heat and its specific heat capacity is 0.50 J/g°C? The initial temperature of the glass is 20.0°C.

Q = 5275 J
m = 50 g
ΔT = ?
Cp = 0.50 J/g°C

231 J/g°C

$\frac{Q}{m \times c}$ $\frac{5275}{50 \times .5}$ ⇒ 211 + 20°

4. Calculate the heat capacity of a piece of wood if 1500.0 g of the wood absorbs 6.75×10^4 joules of heat, and its temperature changes from 32°C to 57°C.

Q = 6.75×10^4 joules
m = 1500.0 g
ΔT = 25°C
Cp = ?

1.8 J/g°C

$\frac{6.75 \times 10^4}{1{,}500 \times 25}$

5. 100.0 g of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature.

Q = ?
m = 100 g
ΔT = 33 °C
Cp = 4.18 J/g°C

13,974 J

100 x 33 x 4.18

6. 25.0 g of mercury is heated from 25°C to 155°C, and absorbs 455 joules of heat in the process. Calculate the specific heat capacity of mercury.

Q = 455 joules
M = 25 g
ΔT = 130°C
Cp = ?

.14 J/g°C

$\frac{455}{25 \times 130}$

7. What is the specific heat capacity of silver metal if 55.00 g of the metal absorbs 47.3 calories of heat and the temperature rises 15.0°C?

Q = 47.3 calories
m = 55 g
ΔT = 15.0°C
Cp = ?

.06 Cal/g°C

$\frac{47.3}{55 \times 15}$

8. If a sample of chloroform is initially at 25°C, what is its final temperature if 150.0 g of chloroform absorbs 1.0 kilojoules of heat, and the specific heat of chloroform is 0.96 J/g°C?

Q = 1.0 kilojoules
m = 150 g
ΔT = ?
Cp = 0.96 J/g°C?

31.9 °C

$\frac{1000}{150 \times .96} \Rightarrow 25° + 6.9°$

INTEGRATED PHYSICS & CHEMISTRY
WE GOT THE HEAT LAB ACTIVITY – DEMONSTRATION
TEACHER PAGES

PURPOSE: To introduce the importance of convection, conduction, and radiation in describing energy transformations?

MATERIALS: Hot Plate, Glitter (small amount) 300mL of Distilled Water, 500mL beaker, Energy Cards (1 Set per Student Group – attached), and Whiteboard with Markers

PROCEDURE:

1. Remind the students that they have been studying the different ways that energy can be changed from one form to another. Tell students that now they will focus on exactly how those changes take place. Tell students to keep the following terms in mind: CONDUCTION, CONVECTION, and RADIATION.

2. Plug a hot plate into the wall. Make sure the hot plate is turned OFF (do not let the students see the hot plate dial). Pose the following question: How could someone tell if the hot plate is "on" or not?

   Likely response will be – by touching it.

   With a flourish, touch the hot plate (screaming theatrically is optional). Tell students that one way for energy to transfer is by direct contact – the atoms of your hand physically touch the atoms of the hot plate. This form of energy transfer is called "conduction," since the atoms of both objects are in direct contact. Ask students to think of other examples of conduction.

3. While the students are thinking of examples of conduction, turn the hot plate to its highest setting. Wait for a few minutes until the hot plate coils begin to glow. (If you have hot plates that do not have coils or the coils are not exposed, ask students how they would know when an electric stovetop burner is transferring energy.) Ask students if there are any other ways we can tell that the hot plate is transferring energy.

   Students will likely say that they can "see" that the plate is hot because it is glowing.

   Point out to students that light is a form of energy, and that energy can be transferred through light. This process if called radiation. Point out that radiation is not necessarily harmful and not always visible. The hotplate is actually radiating two different types of light (electromagnetic radiation): infrared radiation (heat) and visible radiation (light). Ask students if it is possible to detect the infrared radiation directly.

   Yes, by holding your hand near the heating coil.

   Ask students to generate additional examples of energy transfer through radiation.

   Answers will include: solar radiation (heat, light and UV), radiation from a campfire, radiation form a space heater, and also from a x-ray machine.

   Point out to students that is not necessary for your eyes to "touch" the hot plate to detect the transfer of energy.

   Turn OFF the hot plate.

4. Ask students to imagine a blazing campfire (you may want to use an alcohol burner or Bunsen burner as a visual. Pose the following question: Where would you place food so that it cooks the fastest, but does not "burn" (ie. Directly touch the fire?)

   Above the fire.

Ask students why food placed one foot above the fire cooks more quickly than food placed one foot to the side of the fire. Guide the students toward the idea that rising hot air carries the energy from the fire to the food. Tell students that when energy is transferred by a moving fluid, the process is called convection. Point out that convection always involves three things: a heat source, a moving fluid and a heat receiver.

Ask students to generate additional examples of convection.

Students may need prompting to come up with examples of convection, which include the buildup of thunderstorm clouds, a geyser, magma under the surface of the earth, and Great Red Spot of Jupiter.

5. Tell students that you are going to show them a demonstration of heat transfer where all three processes (convection, conduction and radiation) are present. Ask them to SILENTLY observe the phenomena. Then, have each student group use the Energy Cards and Energy Change Arrows to create a diagram explaining their observations. Students should write the name of the process (conduction, convection and radiation) directly on the Energy Change Arrow.

   For the demonstration, place 300mL of distilled water in a 500mL beaker. Add some glitter to the water. Place the filled beaker on a cool hot plate and turn on the hotplate to high. If possible, use an overhead projector to backlight the beaker for greater visibility.

6. Have each student group share their diagram with the rest of the class. Make sure all three types of energy transfer are detailed in the diagrams. Remind students to include the words convection, conduction and radiation in all future energy diagrams.

7. Check student understanding by asking the class the following questions (remind students to use the words convection, conduction, and radiation in their answers).

QUESTIONS:

1. Why is it important to keep the radiator of your car filled with radiator fluid or water?

   Because the water moves thermal energy from the engine to the radiator by convection.

2. Why do ice chests have foam sides instead of metal sides?

   Foam sides transfer energy less effectively than metal sides (conduction).

3. Why are some cooking pans made of steel, and other plans made of copper?

   Copper pans conduct heat very easily, so they cook food faster (conduction).

4. Why does your car cool faster when the air conditioner fan is on "high"?

   When the fan is on high, air moves rapidly throughout the car, quickly cooling by convection.

5. Why does a car radiator have a large surface area?

   A large surface area radiates heat more effectively (radiation) and also touches more "cool) outside air (conduction/convection).

6. Why are tinted windows a good way to keep your car cool?

   Because they keep out the energy carried by solar radiation.

7. Why do you hold your palms open when trying to heat your hand near a fire or other heat source?

To increase the surface area of your hands so more radiation can strike you..

8. Why is a cold shower a good way to cool down quickly?

When the cold water touches your skin, head is carried away by conduction..

9. Why is it warmer during the day than at night?

Energy from the sun travels to the Earth by radiation. When it is night, the solar radiation is striking the "other" side of the Earth. During the night, heat actually radiates from the Earth out into space.

Conservation of Energy Taks Problems Name: key

1. Because ancient Greeks lived close to water, they may have enjoyed a more constant climate than if they had lived inland. Water warms up and cools down more slowly than land. This is because of water's —

F boiling point
G specific heat
H melting point
J specific gravity

2. Which of the following is an example of solar energy being converted into chemical energy?

F Plants producing sugar during the day
G Water evaporating and condensing in the water cycle
H The sun unevenly heating Earth's surface
J Lava erupting from volcanoes for many days

$C_6H_{12}O_6$ +	$6O_2$ →	$6CO_2$ +	$6H_2O$
Glucose	Oxygen	Carbon dioxide	Water
3000 kJ	300 kJ	200 kJ	150 kJ

+ heat

3. Why is the sum of the products' energy in this reaction less than the sum of the reactants' energy?

A Energy is given off as heat.
B The products absorb available energy.
C Energy is trapped in the reactants.
D The reactants' energy is less than the melting point of glucose.

4. An inventor claims to have created an internal combustion engine that converts 100 kJ of chemical energy from diesel fuel to 140 kJ of mechanical energy. This claim violates the law of conservation of —

F momentum
G inertia
H energy
J mass

Solar Radiation and Earth

Effect	Amount of Energy per Second (terajoules)
Solar radiation reaching Earth	173,410
Radiation reflected back into space	52,000
Radiation heating atmosphere, landmasses, and oceans	81,000
Radiation producing winds and ocean currents	370
Radiation used in photosynthesis	40
Radiation resulting in evaporation of water	?

add up to

5. Assuming the chart contains all energy transformations in the Earth system, how much solar radiation goes toward evaporating water?
F 40,000 terajoules
G 92,410 terajoules
H 121,410 terajoules
J 133,410 terajoules

6. Fuel cells powered by plankton from the seabed can be used to operate instruments that monitor ocean currents and water temperature. These fuel cells get their energy by converting —
F chemical energy to electrical energy
G electrical energy to mechanical energy
H hydroelectric energy to geothermal energy
J mechanical energy to chemical energy

7. The transfer of heat by the movement of air currents in Earth's atmosphere is an example of
A conduction
B convection
C radiation
D fusion

Temperatures of Water in Different Containers

Container	Initial Temperature (°C)	Final Temperature (°C)
P	90	83
Q	90	76

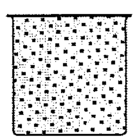
8. Container P and Container Q each were filled with 0.5 liter of water. The water was heated to 90°C. The table shows the temperatures after both containers were allowed to cool for 3 minutes. Compared to Container Q, Container P is a better —

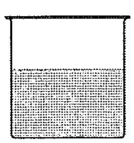
A conductor
B absorber
C radiator
D insulator

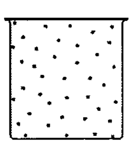
9. The moon's surface becomes hot during the long lunar day because the sun transfers heat to the moon. This heat transfer is accomplished almost entirely through the process of —

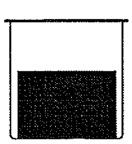
F convection
G refraction
H conduction
J radiation

10. In which container is the substance unable to transfer heat by convection?

F

Chlorine

G

Water

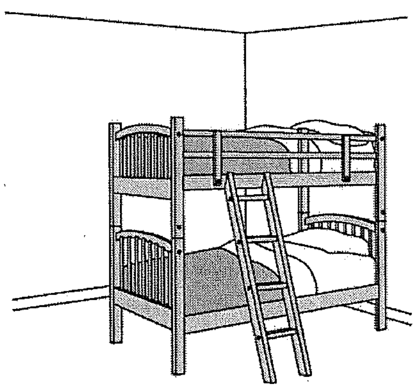
H

Air

J

solid

Aluminum

11. Heat convection occurs in gases and liquids. Heat convection does not occur in solids because solids are unable to —
A absorb heat by vibrating
B transfer heat by fluid motion
C emit radiation by reflecting light
D exchange heat by direct contact

12. A solar heater uses energy from the sun to heat water. The heater's panel is painted black to
F improve emission of infrared radiation
G reduce the heat loss by convection currents
H improve absorption of infrared radiation
J reduce the heater's conducting properties



13. In winter the air just above the top bunk of a bunk bed is warmer than the air just above the bottom bunk because warm air rises. Which of the following describes the method of heating that causes this difference in temperature?
F Radiation from the room
G Heat transfer through the walls
H Convection currents in the room
J Heat conduction through the bed

14. Which of these is the best example of heat transfer by radiation?
A A satellite is warmed by sunlight.
B Butter melts on warm bread.
C A ceiling fan cools a warm room.
D Puddles of water cool a warm tile floor.

15. A man who was sleeping wakes up because he hears the smoke alarm go off in his house. Before opening the bedroom door, the man feels the door to see whether it is warm. He is assuming that heat would be transferred through the door by —
A conduction
B convection
C radiation
D compression

Unit 10 Study Guide Name:___________________________________

1. Radiation is the transfer of energy in the form of particles.

2. In a forced-air heating system (furnace), the warm air circulates by convection. Think of a convection oven circulating hot air.

3. Dark/Dull materials absorb radiant energy. Light/Shiny objects reflect radiant energy.

4. Water has a higher specific heat, metals have a lower specific heat.

5. The lower the specific heat number the quicker it heats up or cools down.

6. In science, energy is the ability to do work and cause change.

7. The law of conservation of energy states that energy can be created OR destroyed and that it does not change from one form of energy to another.

8. A material that reduces the flow of heat by conduction, convection, and radiation is an insulator.

9. Good conductors are metals like aluminum, copper and silver.

10. The transfer of energy that does NOT require matter is radiation.

11. Energy from the Sun travels to Earth as radiant energy.

12. Convection occurs in liquids and gases.

13. Air and Styrofoam are good insulators.

14. If particles move more slowly, the object's temperature falls.

15. Know the 7 forms of energy: Mechanical, Radiant, Chemical, Heat, Electric, Nuclear and Sound (Mr. Chens)

16. When energy changes from one from one form to another it is called an energy conversion.

17-18. Two equations using the specific heat formula.

19. TAKS review question about the law of conservation of energy.

20. Plants convert the suns energy into chemical energy. This is an example of a solar to chemical energy conversion.

21. Liquids and gases transfer heat by convection. Solids do not.

22. A person eating food would undergo an energy conversion of mechanical (chewing) to chemical energy (breaking down food chemically).

23. A radio playing music would undergo an energy conversion of electrical (battery or wall plug) to sound (music).

24. A solar heater uses energy from the sun to heat water. The heater's panel is painted dull black to help absorb the sun's rays.

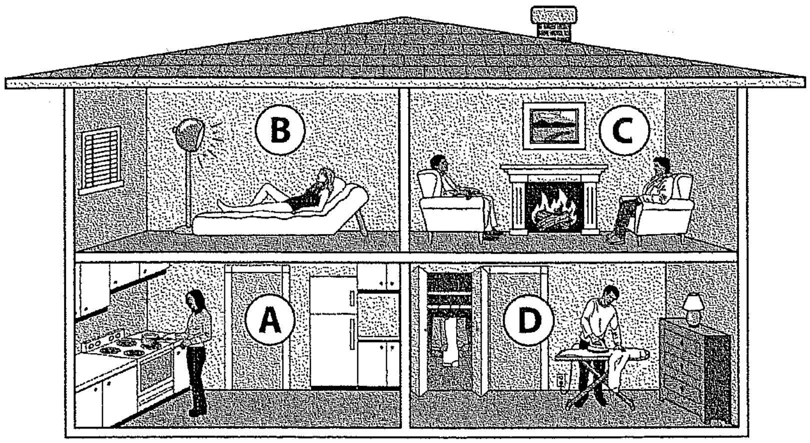
25. unit of temperature = °C

26. variable that stands for specific heat = C or Cp

27. variable for heat lost/gained = Q

28. units that measure mass = g

29. stands for change in temperature = ΔT



30. Room A: Woman cooking with pot in kitchen = Conduction

31. Room B: Sunbather in room = Radiation

32. Room C: Heat from fireplace = Convection

33. Room D: Man ironing clothes = Conduction

34. energy of motion = mechanical

35. suns rays = radiant

36. warm particles move faster, cold particles move slower = heat energy

37. energy stored in food = chemical

38. fusion or fission = nuclear energy

39. energy flowing through a circuit = electrical energy

40. music = sound energy