UNIT LEARNING PACKS

FOCUS IN ACTION

Grade 7 Science Focus

Unit C - Heat and Temperature

EDQUEST
MIDDLE SCHOOL SCIENCE RESOURCES

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'Focus in Action' UNIT LEARNING PACKS

These booklets are designed to provide Grade 7 students with all the resources needed to review or reinforce concepts, covered in the Alberta Science Curriculum, and included in the Grade 7 Science Final Exam in June. There are circumstances in which **an entire unit** may be missed and covering the concepts from that unit (for the final exam) can be difficult. This can happen for a number of reasons:

- Students – new to the school – register throughout the year (from other provinces, school jurisdictions or countries)
- Students may be ill or have surgery and often can miss one or more units
- Students have extended holidays throughout the year
- Transfers from another school, who have completed the units in a different order

For additional support, students are directed to the **Edquest Middle School Science Website** or, Scienceman Resource (www.scienceman.com/scienceinaction/pgs/hot_8u1.html)

Unit 3 – Heat and Temperature

- **Topic 1 Notes & Quiz**
- **Topic 2 Notes & Quiz**
- **Topic 3 Notes & Quiz**
- **Topic 4 Notes & Quiz**
- **Topic 5 Notes & Quiz**
- **Topic 6 Notes & Quiz**
- **Topic 7 Notes & Quiz**
- **Topic 8 Notes & Quiz**
- **Unit Summary**
- **Review Booklet**
  (Covered in class, prior to the Final Achievement Exam)
- **Unit Test**
- **Answer Key for Section Quizzes and Unit Test**

Additional support will be provided, in the form of practice Achievement Test Questions, during the course review in June. Multiple Choice Questions and Numerical Response Questions will be reviewed, as these are the types that will make up the Science 7 Final Exam

Handouts and other activities, to reinforce the concepts covered in this Unit, will be made available based on need. If you require further information or resources, email Edquest directly: edquest@gmail.com.

Finding Solutions to Problems, instead of Making Excuses

Student Instructions for use of this Learning Pack

The purpose of this Learning Unit Pack is to provide you with the resources that will help you cover the material from the curriculum that will be tested on the Final Exam in June.
Follow these steps to successfully complete this Unit Learning Pack:

Step 1 – Read the **Topic Notes**

Step 2 – Use a **highlighter** to identify the key words or phrases in the Topic Notes and reread the material again paying close attention to those words that you highlighted. If necessary, modify your highlights to make sure you understand the material in the notes.

Step 3 – Complete the **Topic Quiz**

Step 4 – Correct the Topic Quiz by **checking the answers** in the back of this Learning Pack.

Step 5 – Using your **textbook** and the **completed quiz**, find the page where the question and correct answer can be found and write it next to the question number in your Learning Pack.

Step 6 – **Repeat Steps 1-5** for each of the other Topics in this Unit.

Step 7 – Look over the **Unit Outline** to review the **Key Concepts** once you have completed all of the Topics.

Step 8 – Complete the **Unit Review**, using your **Learning Pack** and **Textbook**.

Step 9 – **Highlight** those sections of the Review that you had difficulty with and review those sections with your teacher prior to taking the Unit Test.

Step 10 – Take the **Unit Test** and correct it using the answer key provided in the back of the Learning Pack.

Step 11 – You should now be ready to answer any questions on the **Final Exam** related to this Unit.

Anything you still do not understand should be discussed with your teacher. Congratulations on your **Independent Study**, and Good Luck on the Final Exam. I hope you have made good use of this resource. Please provide feedback to your teacher, so that this resource can be improved.

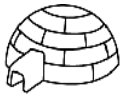
Additional support is available in the form of practice Achievement Test Questions. **Multiple Choice Questions** and **Numerical Response Questions** will be made available on request, as these are the types that will make up the **Science 7 Achievement Exam**.

Handouts and other activities, to reinforce the concepts covered in this Unit may be acquired by visiting the Edquest Middle School Science Resource Website

http://www.edquest.ca

Topic 1 - Using Energy from Heat

Examples of using Thermal energy for heating and cooking:

Open fires		Wood-burning fireplaces	
Pioneer stoves		Modern stoves	
Igloo		Sod House Soddies	
Modern Fireplace		Solar heating	

Technologies, like micro-sensors, have advanced the use of thermal energy in heating and cooking.

Topic 2 - Measuring Temperature

A relative idea about temperature is that it tells you how hot or cold something is. This can be done by using our senses:
- **Touch** (sensitive nerve endings on your skin can detect changes in temperature)
- **Sight** (the color of the material giving off heat)
Relative ways to determine the temperature are not always reliable or safe.

Thermometers
Thermometers are more reliable devices that measure temperature
The Italian scientist Galileo invented the first air thermometer around 1600 and it has, and will continue to be, improved upon.

Temperature Scales

Early thermometers (like the one Galileo invented) did not have any scale (markings with numbers) to determine precise temperature.
The 1st precise scale was developed by Anders Celsius in 1742. He used 'degree' as the unit of temperature. All of his standards for comparison to make his markings (on his scale) were based on the properties of water.
- 0^{o} was assigned the temperature at which ice melts at sea level
-100^{o} was assigned the temperature at which liquid water boils at sea level
-The region between (above and below, as well) these two extremes was separated into 100 equal units (degrees)
-The two fixed temperatures that Celsius chose can be used to calibrate a thermometer (p. 195)

Pressure also affects the freezing and boiling points of water. Extremely high pressure can cause ice to melt at a temperature below 0^{o} (Ice skaters actually glide on a thin layer of water). Low pressure enables water to boil at a temperature below 100^{o}. (On top of Mt. Everest, water boils at 69^{o})

Absolute zero is the coldest possible temperature - 273^{o} and is used by scientists. The Kelvin scale was developed by William Thomson - a.k.a. Lord Kelvin - and the markings on the scale are not called degrees, but are simply called Kelvins.
(0^{o} Celsius is equal to 273.15^{o} Kelvin)

The Right Device for the Job

Measuring extreme temperatures means using different devices to measure these extremes.

Thermometers used for this purpose have:
A **sensor** - a material which is affected by changes in some feature of the environment, such as temperature
A **signal** - provides information about the temperature, such as an electric current
A **responder** - which indicates the data with a pointer, light or other mechanism using the signal

Thermocouple

Two wires of different metals are twisted together. When heat is applied to one end an electric current is produced. (the amount of current depends on the temperature and the type of wires) This current can turn on and off a switch or valve.

The Bimetallic Strip

A bimetallic strip is made of two different metals joined (fused) together, often formed into a coil. When heat is applied to the end, one of the metals will expand faster than the other and the coil can operate a switch or valve just as the thermocouple does.

The Recording Thermometer

When a bimetallic coil strip is attached to a long arm lever, with a marker at the end and a drum that has graph paper, a recording thermometer can be made. This instrument works much the same as a seismograph.

The Infrared Thermogram

If an object is warmer than absolute zero it gives off infrared radiation (IR). The infrared radiation can be photographed with special films or detected by special sensors that display colored images. The brightness or color of the image indicates the temperature of the object.

Topic Review p. 201

Heat and Temperature Quiz
Topic 1 – Using Energy From Heat

1. This type of Thermal Energy source can be used to cook food, but they are hard to control, dangerous and messy.
   A. open fires
   B. fireplaces
   C. pioneer stove
   D. modern gas stove

2. New technologies have been developed to provide thermal energy, without scorching your body. One of these has micro sensors that work like invisible thermostats, that measure the temperature of different parts of your body and generates thermal energy accordingly. This technology is ...
   A. still in the development stage
   B. found only in research labs
   C. an electric blanket
   D. thermal underwear

3. A technology that has replaced boiling water over an open campfire gives us a warning when the water has boiled. This technology is ...
   A. a micro-sensing digital boiler
   B. a solar powered water heater
   C. an electric kettle
   D. a hot water heater

4. Choose the technology that you would need so that you could heat a large room in your house, and maintain a constant comfortable temperature in that room.
   A. a gas furnace
   B. a wood-burning fireplace
   C. an electric fireplace
   D. a digital thermostat

5. Overheating can be a problem for hand-held hair dryers. A device, that is used to shut off the thermal energy when it gets too hot, is needed. This device is ...
   A. automatically controlled
   B. the heating element
   C. the fan
   D. a button on the hair dryer

Heat and Temperature Quiz
Topic 2 – Measuring Temperature

1. Estimating temperature is something that we do automatically. Touching something to see how hot or cold it is one technique that we use. Another is to ...
   A. use a thermometer
   B. look at the moving particles
   C. observe the color
   D. use the back of your hand

2. Because your senses can easily be fooled, thermometers were developed, because they are more reliable. The earliest thermometers contained a glass bottle with a long glass tube for the liquid to rise and fall. An important part was missing though. It was the ...
   A. type of liquid that senses temperature change
   B. type of glass that doesn't expand
   C. the calibrated scale of relative temperatures
   D. the protective stoppers to prevent the liquid from escaping

3. Pressure affects the boiling point and freezing point of water. Extreme pressure under a glacier can cause the ice to flow or even melt at temperatures ...
   A. above $0^{o}C$
   B. below $0^{o}C$
   C. around $0^{o}C$
   D. consistent with $0^{o}C$

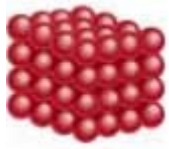
4. Absolute zero is a temperature on the Kelvin scale. Although no one has ever been able to cool anything down to absolute zero, scientist know that it is ...
   A. - 137.15 K
   B. - 237.15 K
   C. - 173.15 K
   D. - 273.15 K

5. A material, which is affected by changes in some feature of the environment, such as temperature is called a ...
   A. circuit
   B. sensor
   C. signal
   D. responder

6. Recording thermometers are called thermographs. The 'temperature writer' uses a rotating drum to record changes in temperature. Tiny movements of this device can make large movements of the recording instrument. The device which makes these tiny movements is the ...
   A. lever
   B. pen
   C. bimetallic strip
   D. rotating drum

Topic 3 - The Particle Model, Temperature and Thermal Energy

Particle Model:

Solid	Liquid	Gas
		
Particles are closely packed together	Particles can slip past each other	Particles have lots of space between them

The Particle Model of Matter is a scientific description of the tiny particles that make up all things. The key elements in this model are:

All substances are made of tiny particles too small to be seen
The particles are always in motion
The particles have spaces between them

Temperature and the Particle Model
When heat is added to a substance, the particles move faster. When heat is lost from a substance the particles move slower.
The motion of the particles increases when the temperature increases.
The motion of the particles decrease when the temperature decreases
Temperature indicates the average energy (speed) of the particles in motion in a substance.

What is Energy?
Energy is the measure of a substance's ability to do work - or cause changes.
There are two important elements that occur:
Changes happen when there is a difference of energy (every useful energy system has a high-energy source that powers the changes)
Energy is always transferred in the same direction: from a high-energy source (hot) to something of lower energy (cold).

Thermal Energy and Temperature Changes
When heat is transferred in a space the average energy of the particles - the temperature of the substance - is affected, by increasing or decreasing. The change in temperature depends on the number of particles affected.

What Energy is … and is NOT
Energy is not a substance. It cannot be seen, weighed or take up space. Energy is a condition or quality that a substance has. Energy is a property or quality of an object or substance that gives it the ability to move, do work or cause change.

The Law of Conservation of Energy states that:

Energy cannot be created or destroyed.
It can only be transformed from one type to another,
or passed from one object, or substance to another.

Topic Review p. 208
Wrap-Up (Topics 1-3) p. 209

Heat and Temperature Quiz
Topic 3 – The Particle Model

1. The Particle Model of Matter helps to explain ideas about Thermal Energy. This model includes each of the following points EXCEPT ...
   A. all substances are made up of tiny particles that are too small to see
   B. the particles are always in motion
   C. the particles increase their energy output when they collide
   D. the particles have spaces between them

2. Another important idea about temperature and the particle theory is that the motion of particles increases when the temperature increases. Which statement below is also correct?
   A. as the motion of particles decreases the temperature remains the same
   B. as the temperature decreases the motion of the particles also increases
   C. as the motion of the particles decreases the temperature decreases
   D. as the temperature increases the motion of the particles decreases

3. Energy is the measure of something's ability to do work. Which of the following has the most thermal energy?
   A. a dead battery
   B. a melted slurpee
   C. a cup of hot coffee
   D. a swimming pool

4. Which of the following energy transfers would be correct?
   A. thermal energy in a hot drink is transferred to cold hands
   B. thermal energy is transferred from a room to a heater, so it can be heated
   C. an ice cube loses thermal energy when it melts in hot lemonade
   D. thermal energy is lost by a match when it is lit

5. Which of the following statements about energy is a correct scientific description of what energy is?
   A. energy is a substance that can be transferred
   B. the mass of energy can be measured using a precision instrument
   C. energy fills the space with highly charged tiny particles
   D. energy is a description of a quality or a condition

Topic 4 - Expansion and Contraction

As the average energy of particles increases, the space between the particles increases. They **expand** (increase their volume) as the temperature increases.

As the average energy of particles decreases, the space between the particles decreases. They **contract** (decrease their volume) as the temperature decreases.

Pure substances are matter that are made up of only one kind of particle, which can be a solid liquid or a gas.

These phases, or states have very specific properties in relation to the particle model.

	Solids	Liquids	Gases
Shape and Size	Keep their shape and size	Take the shape of the container	No definite shape or size
Compressibility (volume)	Cannot be compressed (fixed volume)	Almost incompressible (fixed volume)	Can be compressed (volume changes)

Expansion and Contraction in Solids

Solids can become longer or shorter depending on the temperature (average energy of the particles). Table 1 (p. 211) gives precise measurements of different solid materials at different temperatures.

Expansion and Contraction in Gases

When the particles in a gas are heated, their average energy increases and they need more room, so they expand.

When the particles in a gas are cooled their volume decreases, or contracts, because the particles need less room.

Under extremely high temperature conditions (like the temperatures inside the Sun, particles can be split into what makes them up (electrons and ions). This creates a fourth state of matter called plasma.

Expansion and Contraction in Liquids

When the particles in a liquid are heated, their average energy increases and they need more room, so they expand.

When the particles in a liquid are cooled their volume decreases, or contracts, because the particles need less room.

This is demonstrated by the liquid used in a thermometer. As the liquid expands and contracts, it moves up and down the inside tubing (the bore) of the thermometer.

Topic 4 Review p. 217

Heat and Temperature Quiz

Topic 4 – Expansion and Contraction

1. When a substance is heated the particles gain energy and spread out, creating more volume (spaces between the particles. So what about the mass of the substance? What happens to the mass of a substance when it is heated?

   A. mass increases
   B. mass decreases
   C. mass remains the same
   D. mass is lost

2. Solids made of different metals were all heated to 100^{o}C to determine how their volume and length would be affected. Which statement describes the most likely outcome of this experiment?

   A. All the volumes changed the same amount and the lengths remained constant.
   B. All the volumes changed, but each substance was the same length.
   C. Only some of the volumes changed with their length being increased.
   D. All of the volumes changed and so did their lengths.

3. Some students performed an experiment testing the affect of heat on different liquids. Which of the following variables would have been the manipulated variable?

   A. the amount of heat used
   B. the size and type of glass tubing each liquid would rise
   C. the different types of liquids
   D. the different levels each of the liquids reached in the glass tubing

4. Look at the experiment that the students set up to determine if a gas expands when heated. The experiment didn't work because the students were missing an important element to get the results they predicted. What was missing?

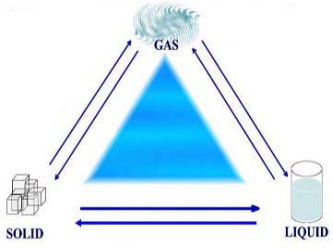
   A. proper safety equipment
   B. a larger balloon
   C. a larger flask was needed
   D. a heat source

5. A balloon filled with helium was put into a freezer to determine what the effect the lowering of the temperature would have on a gas. The responding variable in this experiment was the ...

   A. amount of gas in the balloon before and after
   B. the volume of the balloon before and after
   C. the temperature variation of the freezer
   D. the amount of time needed to change the balloon

Topic 5 - The Particle Model and Changes of State

Heat Capacity and Specific Heat Capacity
The amount of temperature change, when thermal energy is added to the particles is another property that particles in different materials have. Different materials will increase or decrease their average energy depending on how much thermal energy is provided.
Heat Capacity is the amount of thermal energy that warms or cools an object by $1^{o}C$ (it depends on the mass and the type of particle the object is made of).
Specific Heat Capacity is the amount of thermal energy that warms or cools 1 gram, of a specific type of particle, by $1^{o}C$.

Changes of State
Some substances, like water (or wax), can undergo observable changes through all three states of matter. 

Any pure substance can exist in all three states of matter. Some substances, like hydrogen, require high pressures and low temperatures ($-253^{o}C$) to make the particles slow down enough for them to change their state from a gas to a liquid.

Melting and Boiling Points
When heat is transferred in a space the average energy of the particles - the temperature of the substance - is affected, by increasing or decreasing. A substance will change its state when it reaches certain temperatures - called boiling and melting points. Table 3 (p. 221) At everyday temperatures on Earth, most substances are either gases or solids.

What Happens When A Liquid Evaporates?
In a liquid, the particles are moving very quickly. At the surface, some of the particles are able to escape into the air, while others do not have enough energy to escape and remain in the liquid. As high energy particles escape, the average energy of the remaining particles is less and so the liquid cools. The cool liquid then cools the surface on which it is resting. This is called evaporative cooling. It is common and useful in many situations:

- Joggers cooling down as their sweaty clothes dry out
- Water cools down a roof on hot summer day
- A wet cloth is placed on your forehead when you have a fever

Why The Temperature Stays The Same
During a phase change, the average energy of the particles remains the same, but, the particles are rearranging themselves. Particles become less organized as their energy increases, so the substance changes from a solid to a liquid to a gas. As the energy of the particles becomes less, the particles rearrange themselves more orderly, so a gas changes to a liquid and then to a solid. The total energy of the particles changes - by increasing or decreasing, because the particles are not increasing or decreasing their speed, just their arrangement. The average energy doesn't change. The energy change is hidden from a thermometer and is called 'hidden heat' or 'latent heat'.

Topic Review p. 225

Heat and Temperature Quiz

Topic 5 – The Particle Model and Changes of State

1. The sun shines down on the banks of a river (and the river itself). The thermal energy absorbed will be ...
   - **A. more in the water**
   - **B. more in the soil**
   - **C. almost the same in both**
   - **D. dependant on the mass of each**

2. When a substance undergoes a change of state, energy is involved. Which change of state involves a release of energy?
   - **A. melting**
   - **B. sublimation**
   - **C. evaporation**
   - **D. fusion**

3. As high-energy particles escape from the surface of a liquid, by evaporation, the remaining liquid cools. This surface cooling phenomenon is described by scientists as ...
   - **A. evaporative cooling**
   - **B. subliminal cooling**
   - **C. fusion**
   - **D. condensive evaporation**

4. During a phase change, the temperature remains the same, so the particles have ...
   - **A. less average energy**
   - **B. more average energy**
   - **C. the same average energy**
   - **D. a faster speed**

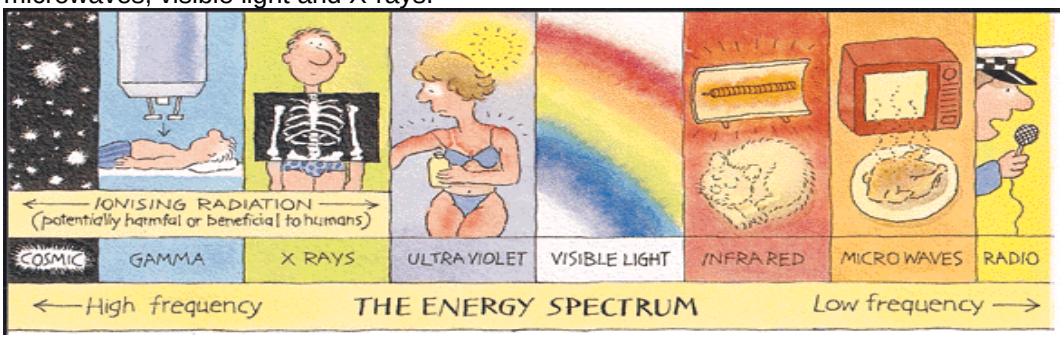
5. The water droplets that form on a shower door have undergone a phase change. Prior to the droplets forming, the water was in a state of ...
   - **A. absolute flux**
   - **B. suspended animation**
   - **C. liquid**
   - **D. gas**

Topic 6 - Transferring Energy

Energy can be transferred in three ways: Radiation, Conduction and Convection

Radiation Transfers Energy
Energy can be transferred even though there are no particles to transfer the energy. This type of energy transfer is called radiation. Radiation is the transfer of energy without any movement of matter. Energy that is transferred in this way is called radiant energy or electromagnetic radiation (EMR for short).

Radiant energy travels in waves (much like a tsunami). These waves can travel through space, air, glass and many other materials. There are different forms of EMR, including radio waves, microwaves, visible light and X-rays.



If the energy source is a warm object, like the sun, some of the thermal energy is transferred as a type of EMR called infrared radiation (IR) or 'heat radiation'.

Properties (characteristics) of Radiant Energy are:

- Waves of radiant energy can travel in a vacuum.
- All waves travel, across empty space, at an extremely high speed (300 Million m/s).
- Radiant energy travels in a straight line.
- they behave like waves
- they can be absorbed and reflected by objects
- All kinds of radiant energy interact with matter:
- Reflection occurs if the energy cannot penetrate the surface of the material it comes into contact with.
- Absorption occurs if the energy penetrates part way into the object.
- Transmission occurs if the energy penetrates completely, passing through the object with no absorption of energy.

Absorbing / Emitting Energy

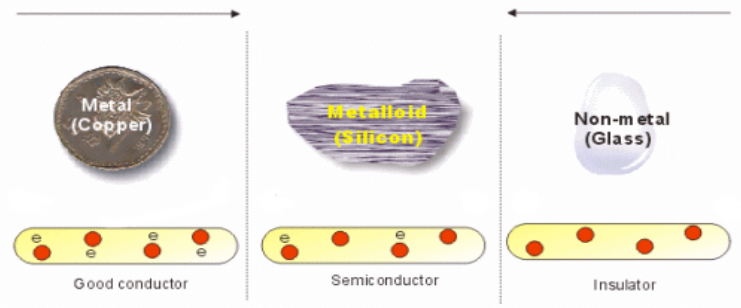
Dull dark objects absorb radiant energy when they are cool, and emit radiant energy when they are hot. (eg. asphalt sidewalk)
Light, shiny objects or surfaces do not absorb radiant energy readily and do not emit radiant energy readily. (eq. ice surface)

Radiant emission of energy from the body depends on surface area (smaller areas help to retain heat, whereas, larger areas radiate heat). This is evident in the adaptations of many species of animals who have successfully adapted to their environments.(desert animals - eg. Fox p. 140) (killer whales-The killer whale's fusiform body shape and reduced limb size decreases the amount of surface area exposed to the external environment. This helps killer whales conserve body heat.) The polar bear has black skin to absorb radiant energy with transparent hair that transmits ultraviolet radiation to the skin.

Most radiation (82%) people are exposed, to comes from natural sources. By far the largest source is radon, an odorless, colorless gas given off by natural radium in the Earth's crust. Artificial radiation, mostly from medical uses and consumer products, accounts for about eighteen percent of our total exposure. The nuclear industry is responsible for less than one percent. Radiation can be detected, measured and controlled. The measurement of radiation is by the amount of radioactivity present or the amount of radiant energy given off.

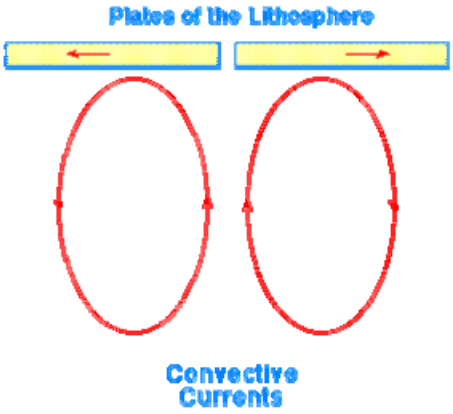
Radiation in the Environment
Radiation is a natural part of our environment. Humans have always lived on earth in the presence of radiation. Natural radiation reaches earth from outer space and continuously radiates from the rocks, soil, and water on the earth. Background radiation is that which is naturally and inevitably present in our environment. Levels of this can vary greatly. People living in granite areas or on mineralized sands receive more terrestrial radiation than others, while people living or working at high altitudes receive more cosmic radiation. A lot of our natural exposure is due to radon. a gas which seeps from the earth's crust and is present in the air we breathe.

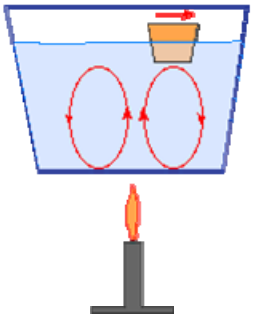
Conduction, Energy Through Solids
In solids, where the particles are closely packed together, thermal energy can be transferred from one particle to another very easily. Thermal conduction is the process of transferring thermal energy by the direct collisions of the particles. The space between the particles, in different solids, determines how quickly these collisions can take place. Good conducting materials are those materials where there is little space between the particles - like most metals. Poor conductors, like glass and wood are called heat insulators. These insulators when wrapped around an object slow down the rate of thermal conduction.



Applications
- Metals are good conductors of heat, so they are used extensively in cooking, because they transfer heat efficiently from the stove top or oven to the food.
- Hot and cold packs are used to treat muscle injuries.
- The Safety Lamp (The Davy Lamp) Davy invented his miner's safety helmet in 1815. The lamp of this safety helmet would burn safely and emit light even when there was an explosive mixture of methane and air present. Davy did not patent the lamp. (see explanation - Did You Know - p. 127)
- The Radiator of a car transfers heat away from the engine, so that the gasoline being used will not ignite. (Antifreeze is used to achieve this)
- The use of diamonds to transfer the heat generated by small electronic devices. Diamonds are called "ice" with good reason. Objects feel cold not only because they are at a lower temperature than our bodies, but also because they can transfer or conduct the heat away from us. When you touch a diamond to your lips, it feels ice-cold because it robs your lips of their heat. The capacity of a diamond to conduct heat distinguishes it readily from other gems and exceeds that of copper, an excellent thermal conductor, by about 4 times at room temperature. This exceptional property of diamond is increasingly being used for extracting heat from electronic devices to make them smaller and more powerful.
- A Great Science Resource can be found at Science Net.

Convection, Energy on the Move
Thermal energy can be transferred by fluids in a third way, by the circular motion of the particles, called convection. In convection, the warmer particles transfer their energy to the cooler particles as they move in a circular pattern, called a convection current.





A simple experiment
Lava lamps are good examples to see this in action.
Birds and para-gliders make use of 'thermals' to help them soar and glide - helping them to conserve energy when they migrate.
Convection currents are also involved in creating the force of magnetism that surrounds the earth.
The convection oven is another of the many practical applications of convection.
The heat inside the oven, helps to provide uniform beating as the convection current transfers the heat evenly inside the oven.
Heating occurs through currents in a fluid, such as radiator water heating and flowing from the basement to heat a radiator on a floor above.

Analyzing Energy Transfer Systems
What happens when energy is transferred? The energy is not lost, it is only changed. Particles allow this transfer of energy to take place. The example of a Volleyball is given in the textbook on page 232.
Carrie's energy in her fist transferred to the ball, which transferred it to the floor. Conduction occurred, when the energy in her fist was conducted by the particles in her fist to the particles in the ball. The particles in the ball conducted the energy to the particles in the floor. The particles in the air were also warmed by the flight of the ball and the particles transferred this energy by convection currents which were created in the air.

Features of Energy Transfer Systems
All energy systems have five common features:
- **Energy Source** - this is where the energy comes from that can be transferred throughout the energy system. The energy source can be mechanical, chemical, radiant, nuclear or electrical.
- **Direction of Energy Transfer** - energy is always transferred away from the concentrated sources. Changes in non-living systems spread out the energy evenly.
- **Transformations** - energy can change its form when it is transferred
- **Waste Heat** - almost all of the energy is transferred directly from particle to particle, but some of the energy can be lost to the surroundings.
- **Control Systems** - a control device can start and stop the transfer of energy (a thermostat in a home heating system)

Topic Review p. 236
Wrap-Up (Topics 4-6) p. 237

Heat and Temperature Quiz

Topic 6 – Transferring Energy

1. In a hot tub, your body gains thermal energy from the hot water. This thermal energy is then transferred throughout the inside your body by each of your living cells. It can be dangerous to stay in the tub for a long period of time, because your ...
   A. cells will get so large they will burst, losing all of their nutrients to the water
   B. normal body temperature begins to be transferred to the water
   C. cells will shrink because of osmosis
   D. blood vessels enlarge, blood pressure goes down, and your heart rate increases

2. Radiation is the transfer of energy without any movement of matter. This type of energy transfer is called ...
   A. radiative transduction
   B. radioactive transfer
   C. electrospectrum radiation
   D. electromagnetic radiation

3. A certain type of thermal energy transfer moves the energy by direct collisions, particle-to-particle. This type of thermal energy transfer is called ...
   A. concurrent
   B. conductive
   C. conduit
   D. convective

4. The transfer of energy in a fluid is very different. The heated particles become less dense and so they rise, with the colder, more dense particles rushing in to take their place. This type of thermal energy transfer creates a ...
   A. conduction current
   B. convection current
   C. radiative pathway
   D. concurrent current

5. Energy systems have five things in common - input energy, energy transfer, output energy, waste energy and ...
   A. collisions between particles
   B. energy source
   C. energy equilibrium
   D. concentrated flow

Topic 7 - Sources of Thermal Energy

This Topic expands on what you thought about and learned in Topic 1 about USING Energy. Much of the energy use for cooking and heating was found to be natural gas and electricity. These sources of Energy can undergo transformations before they are used for cooking and heating. There may also be environmental concerns in using each source of energy.

Chemical Energy
Chemical Energy can be transformed into Thermal Energy when wood, or coal is burned.
(Environmental Impacts: pollution caused by the burning of these fossil fuels)

Electrical Energy
Electricity is produced in many ways. Hydro-electric dams use the force of gravity which pulls the water over the dam to turn turbines, which are attached to generators, which produce the electrical energy from the mechanical energy of the generators.
Electricity can also be produced at thermo-electric (fuel-burning) generating stations that burn fossil fuels.
(Environmental Impacts: wildlife in the area of the dam lose valuable habitat, plants may perish when the river which was blocked overflows its banks to create the reservoir for the dam, commercial enterprises may be adversely affected, pollution by the burning of fossil fuels, heated waste water can affect organisms in lakes where this waste water is dumped.)

Mechanical Forces
Mechanical forces that push or pull objects often release thermal energy, as do Frictional forces.
(Environmental Impacts: Natural disasters like earthquakes)

Geothermal Energy
Volcanoes, hot springs and geysers are sources of geothermal energy - energy from the interior of the earth. The thermal energy from these events can produce hot water or steam, which can be then piped to a power plant at the surface. This can be used to run turbines which produce electrical energy. HRD (hot, dry rock) can be used as another technique to generate thermal energy. (Water is pumped into cracks in the earth's crust. It returns to the surface as steam, which can be used to generate electricity.
(Environmental Impacts: more extensive use of this clean and environmentally friendly technique, could reduce the threat of oil spills, the pollution caused by burning fossil fuels and the wastes from mining fossil fuels.)

Solar Energy (A Solar Energy Information Resource)
Solar energy is clean and is guaranteed not to run out. It is not available all the time (nighttime, less in winter/ than in summer).
There are two techniques that can help to overcome these issues. (See Figure 3.32, page 243)
Passive solar heating - uses the materials in the structure to absorb, store and release the solar energy.
Active solar heating - uses mechanical devices to collect and distribute the thermal energy.
(Environmental Impacts: some devices may have an impact on the aesthetics where they are located)

Wind Energy
Wind energy is the energy of moving air, and is a result of solar energy and convection. As the sun heats up the air, the warm air rises and cools off. The cooler air falls, creating the convection currents called thermals. These convection currents on a global basis, form the Earth's wind systems. The windmill is a turbine (a wheel with fan blades), which is connected to a generator. When the windmill spins the generator produces electricity.
(Environmental Impacts: aesthetics)

More Sources of Thermal Energy
The living organisms burn food (chemical energy) in their bodies to generate body heat (thermal energy).
A composter is another source of thermal energy. Decomposers break down food and as these chemical changes occur, thermal energy is produced, which in turn helps speed up the process of decomposition.
(Environmental Impacts: waste management)

Fossil Fuels
An energy resource is anything that can provide energy in a useful form. Most energy supplies come from fossil fuels (in Alberta and throughout the world). Fossil Fuels are chemicals from plants and other organisms that died and decomposed millions of years ago and have been preserved underground.
(Environmental Impacts: global warming, changing climate zones around the world, plant growth, depleted water resources and thermal pollution)

Fossil Fuels: Two Problems
The widespread use of fossil fuels has created 2 primary problems.

- these energy sources are non-renewable and their supplies are running out
- they produce toxic chemicals which can harm the environment by producing a greenhouse effect resulting in global warming

Co-generation uses some of the two-thirds of the energy release by the burning of fossil fuels as thermal energy, to heat a building, or a fuel, to generate electrical energy.

Topic Review p. 247

Heat and Temperature Practice Quiz

Topic 7 – Sources of Thermal Energy

1. Much of the energy used in Alberta is found in the vast resources of fossil fuels. This type of energy source is useful and is stored until we need it. Fossil fuels are considered to be sources of ...
   A. chemical energy
   B. industrial energy
   C. biological energy
   D. geothermal energy

2. Electrical energy can be generated at a Dam, using generators and can also be generated by thermo-electric generating stations which burn coal. The reason that thermo-generating stations are used is because ...
   A. coal is so abundant
   B. it is cleaner and cheaper
   C. a large waterfall is not available
   D. heated water is more efficient

3. Thermal energy from inside the Earth's crust can be harnessed as a useful thermal energy source. Volcanoes, hot springs and geysers are example of this type of thermal energy source. This type of thermal energy is ...
   A. an environmental pollutant
   B. a clean alternative to using fossil fuels
   C. called geovolcanic energy
   D. used to generate fossil fuel resources

4. Solar energy can be a very good alternative thermal energy source. The way a house is situated on the lot it is built on is a passive solar energy technique. This technique is important because the sun is not always ...
   A. shining
   B. in the same direction
   C. on the same plane
   D. providing EMR

5. Co-generation is the use of ...
   A. electrical energy to get waste energy
   B. waste energy to generate electrical energy
   C. waste energy to generate mechanical energy
   D. mechanical energy to generate waste energy

Topic 8 - Conserving Our Fossil Fuels

Despite the many disadvantages of using fossil fuels, we continue to use them. Coal is burned to generate electricity. Oil and natural gas are abundant in Alberta and we use it, maybe more than we should. Alternatives to using these non-renewable resources need to be utilized, so that future generations of Albertans can continue to thrive in our beautiful province.

It's Hot In Here
Programmable thermostats and other technologies have provided many ways to conserve energy and save money. A recirculating hot water system (Figure 3.41, p. 252) saves energy and produces instant hot water at all times.

It's Cold In Here
Refrigerators and air conditioners are thermal energy movers. A thermal energy mover is a device that transfers thermal energy from one location to another at a different temperature. The operation of these devices require refrigerants (liquids that evaporate easily at low temperatures) to remove thermal energy from food. As the refrigerant evaporates, it absorbs the thermal energy from the food so it cools down. This warmed gas is then compressed and releases the thermal energy into the room.

Danger: Thermal Energy
Some harmful effects of thermal energy are:

- burning ourselves on a hot utensil (us)
- forest fires (our environment)
- burning houses (our belongings)
- Storage and use of fossil fuels can pose a forest fire risk, but also can pollute the environment, by leaking into the groundwater and soil.

By-Products of Thermal Energy Use
Not all the dangers of using thermal energy are as obvious as the ones already discussed. One of the products (carbon dioxide) that is released from the burning of fossil fuels is a greenhouse gas, which traps heat energy in our atmosphere and leads to global warming.
Sulfur-dioxide is released when coal and natural gas are burned. This gas is an irritant to the eyes, nose and throat.
Carbon monoxide is produced when a fire burns without enough oxygen. It is clearless, odorless and very lethal. It hinders the brain's reasoning ability and can kill you.
Smoke detectors and carbon monoxide detectors should be installed in every building to protect the people from being overcome by these lethal gases.

Topic Review p. 256

Wrap-Up (Topics 7 - 8) p. 257

UNIT REVIEW pgs. 262 - 265

Heat and Temperature Quiz

Topic 8 – Conserving Our Fossil Fuels

1. Prior to the enormous pollution problem caused by the Industrial Revolution and the automobile, a pollutant was creating problems that were just as deadly. The horse and buggy age in our big cities, was slow and also dangerous to our health, because of the ...

A. dangers of being run over
B. large quantities of manure
C. temperament of the animals
D. lack of safety standards

2. Programmable thermostats can be used while the occupant of the home is asleep or away. These devices ...

A. adjust the temperature
B. increase the temperature
C. decrease the temperature
D. all of the above

3. An **ENERGUIDE** label is found on most household electrical appliances and tells the consumer how much electricity is ...

A. needed to run the appliance
B. used running the appliance
C. wasted by the appliance
D. generated while running the appliance

4. Thermal energy has the power to hurt us and destroy our possessions. All of the following practices are dangerous and harmful EXCEPT ...

A. reclamation programs
B. dumping of toxic chemicals
C. forest fires
D. volcanic eruptions

5. A dangerous by-product, from the use of fossil fuels (coal, natural gas and oil) enters the atmosphere when the fuel is burned. This by-product can cause irritations to the eyes, nose and throat. This pollutant greatly affects asthma sufferers. It is ...

A. carbon dioxide
B. sulfur dioxide
C. carbon monoxide
D. sulfur monoxide

Heat and Temperature Review

Focusing Questions:
What heat-related technologies do we use to meet human needs?
What scientific principles are these technologies based on?
What implications do these technologies have for sustainable use of resources?

Heat-related Technology	Science Principle	Implication for Sustainability

Guiding Questions and Activities to Help you Study Key Concepts

Topic 1 Thermal Energy

Can you identify how **Thermal Energy** is used?

_____

_____

How is temperature **measured**?

_____

_____

Identify the following **relative temperatures**:

freezing water _____ ^{o}**C** **boiling water** _____ ^{o}**C**

normal body temperature _____ ^{o}**C** **comfortable room temperature** _____ ^{o}**C**

Topic 2 Measuring Temperature - Technological devices and systems using Thermal Energy

What is a **thermocouple**?

_____

_____

What is a **bimetallic strip**?

_____

_____

What is a **recording thermometer**?

_____

_____

What is an infrared **thermogram**?

_____

_____

Topic 3 The Particle Model of Matter

What are the 4 key points addressed in the **Particle Model of Matter**?

_____

_____

_____

_____

Explain how gas particles can be **compressed** and what happens to the volume of the gas.

_____

_____

What **properties** distinguish solids, liquids and gases?

_____

_____

Define **Thermal Energy**, **Heat** and **Temperature** in terms of the **Particle Theory.**

Thermal Energy_____

_____

Heat _____

_____

Temperature _____

_____

Topic 4 Thermal Expansion and Contraction

Describe **expansion** and **contraction** of solids liquids and gases in terms of the Particle Model.

Expansion _____

_____

_____

Contraction _____

_____

_____

Why are two different **metals** used to make a **thermocouple** and a **thermostat** (bimetallic strip)?

_____

_____

Topic 5 Changes of State: melting, freezing, vaporization, condensation and sublimation

Describe the Changes of State and the terminology when a substance undergoes a specific change.

Melting		
Freezing		
Evaporation		
Condensation		
Sublimation		

Topic 6 Energy Transfer Systems

Explain, using an **operational definition**, the differences between **conduction, convection** and **radiation** - in terms of ***energy transfer***.

Conduction _____

_____

_____

Convection _____

_____

_____

Radiation _____

_____

_____

Describe how **a convection current** is created.

_____

_____ *Illustration*

_____

_____

_____

_____

How is **energy transferred** differently in solids than it is in gases and liquids?

_____

_____

What are the five *common characteristics* that are involved in all **energy transfer systems**?

_____

_____

_____

_____

_____

_____

Topic 7 Sources of Thermal Energy: Advantages and disadvantages of using Fossil Fuels Thermal Pollution Greenhouse Effect

Describe the **impacts** different energy sources have on the environment.

Thermal Energy Source	Impact on the Environment
chemical	
electrical	
mechanical	
nuclear	
geothermal	
solar	
wind	
tidal	
fossil fuels	

The **Green Solution** involves using alternative energy. Why is it called the **Green Solution** and what positive impacts does it have on the environment?

_____

_____

_____

_____

Alberta's main source of energy is **Fossil Fuels**. Describe this energy resource in terms of its abundance and importance to Albertans.

_____

_____

Describe what happens to create the **Greenhouse Effect**.

_____

_____ *Illustration*

_____

_____

_____

_____

What is **Thermal Pollution** and what causes it?

_____

_____

Topic 8 Conservation Technologies and Strategies to help us Conserve Fossil Fuels and make their Use Safer.

Provide an operational definition of **cogeneration**.

_____

_____

Describe technologies and practices that **conserve fossil fuel resources**.

_____

_____

How does a **programmable thermostat** work?

_____

_____

What is an **ENERGUIDE** label and what does it tell the consumer?

_____

_____ Illustration of **ENERGUIDE** label

_____

_____

_____

Heat and Temperature UNIT TEST

1. This type of Thermal Energy source can be used to cook food, but they are hard to control, dangerous and messy.

A open fires
B fireplaces
C pioneer stove
D modern gas stove

2. New technologies have been developed to provide thermal energy, without scorching your body. One of these has micro sensors that work like invisible thermostats, that measure the temperature of different parts of your body and generates thermal energy accordingly. This technology is ...

A still in the development stage
B found only in research labs
C an electric blanket
D thermal underwear

3. A technology that has replaced boiling water over an open campfire gives us a warning when the water has boiled. This technology is ...

A a micro-sensing digital boiler
B a solar powered water heater
C an electric kettle
D a hot water heater

4. Choose the technology that you would need so that you could heat a large room in your house, and maintain a constant comfortable temperature in that room.

A a gas furnace
B a wood-burning fireplace
C an electric fireplace
D a digital thermostat

5. Overheating can be a problem for hand-held hair dryers. A device, that is used to shut off the thermal energy when it gets too hot, is needed. This device is ...

A automatically controlled
B the heating element
C the fan
D a button on the hair dryer

6. Estimating temperature is something that we do automatically. Touching something to see how hot or cold it is one technique that we use. Another is to ...

A use a thermometer
B look at the moving particles
C observe the color
D use the back of your hand

7. Because your senses can easily be fooled, thermometers were developed, because they are more reliable. The earliest thermometers contained a glass bottle with a long glass tube for the liquid to rise and fall. An important part was missing though. It was the ...

A type of liquid that senses temperature change
B type of glass that doesn't expand
C the calibrated scale of relative temperatures
D the protective stoppers to prevent the liquid from escaping

8. Pressure affects the boiling point and freezing point of water. Extreme pressure under a glacier can cause the ice to flow or even melt at temperatures ...

A above 0oC
B below 0oC
C around 0oC
D consistent with 0oC

9. Absolute zero is a temperature on the Kelvin scale. Although no one has ever been able to cool anything down to absolute zero, scientist know that it is ...

A - 137.15 K
B - 237.15 K
C - 173.15 K
D - 273.15 K

10. A material, which is affected by changes in some feature of the environment, such as temperature is called a ...

A circuit
B sensor
C signal
D responder

11. Recording thermometers are called thermographs. The 'temperature writer' uses a rotating drum to record changes in temperature. Tiny movements of this device can make large movements of the recording instrument. The device which makes these tiny movements is the ...

A lever
B pen
C bimetallic strip
D rotating drum

12. The Particle Model of Matter helps to explain ideas about Thermal Energy. This model includes each of the following points EXCEPT ...

A all substances are made up of tiny particles that are too small to see
B the particles are always in motion
C the particles increase their energy output when they collide
D the particles have spaces between them

13. Another important idea about temperature and the particle theory is that the motion of particles increases when the temperature increases. Which statement below is also correct?

A as the motion of particles decreases the temperature remains the same
B as the temperature decreases the motion of the particles also increases
C as the motion of the particles decreases the temperature decreases
D as the temperature increases the motion of the particles decreases

14. An important skill that is needed when preparing for exams is to have a good set of notes. The note-taking format you should have used in this unit was as follows …

A write, review, select, highlight, read
B review, highlight, write, read, select
C select review, read, review, highlight
D read, select, write, highlight, review

15. Energy is the measure of something's ability to do work. Which of the following has the most thermal energy?

A a dead battery
B a slurpee
C a cup of hot chocolate
D a swimming pool

16. Which of the following energy transfers would be correct?

A thermal energy in a hot drink is transferred to cold hands
B thermal energy is transferred from a room to a heater, so it can be heated
C an ice cube loses thermal energy when it melts in hot lemonade
D thermal energy is lost by a match when it is lit

17. Which of the following statements about energy is a correct scientific description of what energy is?

A energy is a substance that can be transferred
B energy is a description of a quality or a condition
C energy fills the space with highly charged tiny particles
D the mass of energy can be measured using a precision instrument

18. When a substance is heated the particles gain energy and spread out, creating more volume (spaces between the particles. So what about the mass of the substance? What happens to the mass of a substance when it is heated?

A mass increases
B mass decreases
C mass remains the same
D mass is lost

19. Solids made of different metals were all heated to 100oC to determine how their volume and length would be affected. Which statement describes the most likely outcome of this experiment?

A all the volumes changed the same amount and the lengths remained constant
B all the volumes changed, but each substance was the same length
C only some of the volumes changed with their length being increased
D all of the volumes changed and so did their lengths

20. Some students performed an experiment testing the affect of heat on different liquids. Which of the following variables would likely have been the manipulated variable?

A the amount of heat used
B the size and type of glass tubing each liquid would rise
C the different types of liquids
D the different levels each of the liquids reached in the glass tubing

21. Thermal energy has the power to hurt us and destroy our possessions. All of the following practices are dangerous and harmful EXCEPT ...

A volcanic eruptions
B dumping of toxic chemicals
C forest fires
D reclamation programs

22. A balloon filled with helium was put into a freezer to determine what the effect the lowering of the temperature would have on a gas. The responding variable in this experiment was the ...

A amount of gas in the balloon before and after
B the volume of the balloon before and after
C the temperature variation of the freezer
D the amount of time needed to change the balloon

23. The sun shines down on the banks of a river. The thermal energy absorbed will be ...

A more in the water
B more in the soil
C almost the same in both
D dependant on the mass of each

24. When a substance undergoes a change of state, energy is involved. Which change of state involves a release of energy?

A melting
B sublimation
C evaporation
D fusion

25. As high-energy particles escape from the surface of a liquid, by evaporation, the remaining liquid cools. This surface cooling phenomenon is described by scientists as ...

A evaporative cooling
B subliminal cooling
C fusion
D condensive evaporation

26. During a phase change, the temperature remains the same, so the particles have ...
A less average energy
B more average energy
C the same average energy
D a faster speed

27. The water droplets that form on a shower door have undergone a phase change. Prior to the droplets forming, the water was in a state of ...
A absolute flux
B suspended animation
C liquid
D gas

28. In a hot tub, your body gains thermal energy from the hot water. This thermal energy is then transferred throughout the inside your body by each of your living cells. It can be dangerous to stay in the tub for a long period of time, because your ...
A cells will get so large they will burst, losing all of their nutrients
B normal body temperature begins to be transferred to the water to the water
C cells will shrink because of osmosis
D blood vessels enlarge, blood pressure goes down, and your heart rate increases

29. Radiation is the transfer of energy without any movement of matter. This type of energy transfer is called ...
A radiative transduction
B radioactive transfer
C electrospectrum radiation
D electromagnetic radiation

30. A certain type of thermal energy transfer moves the energy by direct collisions, particle-to-particle. This type of thermal energy transfer is called ...
A concurrent
B conductive
C conduit
D convective

31. The transfer of energy in a fluid is very different. The heated particles become less dense and so they rise, with the colder, denser particles rushing in to take their place. This type of thermal energy transfer creates a ...
A conduction current
B convection current
C radiative pathway
D concurrent current

32. Energy systems have five things in common - input energy, energy transfer, output energy, waste energy and ...

A collisions between particles
B energy source
C energy equilibrium
D concentrated flow

33. Much of the energy used in Alberta is found in the vast resources of fossil fuels. This type of energy source is useful and is stored until we need it. Fossil fuels are considered to be sources of ...

A chemical energy
B industrial energy
C biological energy
D geothermal energy

34. Electrical energy, generated by thermo-electric generating stations, burn coal. The reason that thermo-generating stations are used is because ...

A coal is so abundant
B it is cleaner and cheaper
C a large waterfall is not available
D heated water is more efficient

35. Thermal energy from inside the Earth's crust can be harnessed as a useful thermal energy source. Volcanoes, hot springs and geysers are example of this type of thermal energy source. This type of thermal energy is ...

A an environmental pollutant
B a clean alternative to using fossil fuels
C called geovolcanic energy
D used to generate fossil fuel resources

36. Solar energy can be a very good alternative thermal energy source. The way a house is situated on the lot it is built on is a passive solar energy technique. This technique is important because the sun is not always ...

A shining
B in the same direction
C on the same plane
D providing EMR (electromagnetic radiation)

37. Co-generation is the use of ...

A electrical energy to get waste energy
B waste energy to generate electrical energy
C waste energy to generate mechanical energy
D mechanical energy to generate waste energy

38. Prior to the enormous pollution problem caused by the Industrial Revolution and the automobile, a pollutant was creating problems that were just as deadly. The horse and buggy age in our big cities, was slow and also dangerous to our health, because of the ...

A dangers of being run over
B large quantities of manure
C temperament of the animals
D lack of safety standards

39. Programmable thermostats can be used while the occupant of the home is asleep or away. These devices ...

A adjust the temperature
B increase the temperature
C decrease the temperature
D all of the above

40. An **ENERGUIDE** label is found on most household electrical appliances and tells the consumer how much electricity is ...

A needed to run the appliance
B used running the appliance
C wasted by the appliance
D generated while running the appliance

41. This type of solar heating involves complex mechanical systems and devices called solar collectors.

A Active solar heating
B Passive solar heating
C Radiant heating
D Generated heating

42. Refrigerators use liquids that can evaporate easily at low temperatures to remove thermal energy from food. These liquids are called …

A evaporators
B refrigerants
C condensers
D compressors

NR1 - Match the change in state with the term that is used to describe it.

1 solid to liquid
2 liquid to gas
3 solid to gas
4 liquid to solid

_____ **evaporation**
_____ **fusion**
_____ **sublimation**
_____ **solidification**

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Heat and Temperature Topic Quiz - Answer Keys

Science Focus 7 Topics	Questions					
	1.	2.	3.	4.	5.	6.
Topic 1 - Using Energy From Heat	A	C	C	D	A	
Topic 2 – Measuring Temperature	C	C	B	D	A	C
Topic 3 - The Particle Model	C	C	C	A	D	
Topic 4 - Expansion and Contraction	C	A	C	D	B	
Topic 5 - The Particle Model and Changes of State	C	B	A	C	D	
Topic 6 - Transferring Energy	C	D	B	A	B	
Topic 7 - Sources of Thermal Energy	A	C	B	C	B	
Topic 8 - Conserving Our Fossil Fuels	B	D	B	A	B	

Heat and Temperature – Unit Test Answer Key

1	A	12	C	23	C	34	C
2	C	13	C	24	B	35	B
3	C	14	D	25	A	36	C
4	D	15	C	26	C	37	B
5	A	16	A	27	D	38	B
6	C	17	B	28	B	39	A
7	C	18	C	29	D	40	B
8	B	19	D	30	B	41	A
9	D	20	C	31	B	42	B
10	B	21	D	32	B	NR1	2134
11	C	22	B	33	A		