Chapter 5 NOTES

2.10 Define temperature using the Particle Theory of Matter.

temperature

- a relative measure of how hot or cold something is
- the average kinetic energy of the particles in a substance

2.11 Define matter

matter

- anything that takes up space
- has mass
- is made up of particles

2.12 Describe the Particle Theory of Matter. Include:
(i) All matter is made up of tiny particles.
(ii) These particles are always moving - they have

energy. The more energy the particles have, the faster they move.
(iii) There is space between all particles.
(iv) There are attractive forces between the particles.
(v) The particles of one substance differ from the particles of other substances.

2.13 Define kinetic energy.

kinetic energy

- [kin-E-tic] energy that particles or an object has due to its motion

2.14 Define temperature as a measure of the average kinetic energy of the particles of a substance.

2.15 Explain how each state of matter reacts to changes in temperature.

- **Melting** is the change from the solid state to the liquid state. (+ energy)

- **Freezing** is the change from the liquid state to the solid state. (- energy)

- **Evaporation** is the change from the liquid state to the gaseous state. (+)

- **Condensation** is the change from the gaseous state to the liquid state.(-)

- **Sublimation** is the change from the solid state to the gaseous state. (+)

- **Deposition** is the change from the gaseous state to the solid state. (-)

In a **solid substance**, the particles are held tightly together. As you saw in Figure 5.15 on page 150, the particles have kinetic energy, so they vibrate. However, they remain attached to each other by forces that are represented by springs. As you add more energy in the form of heat, the kinetic energy of the particles increases and the temperature increases.

Eventually, you reach a temperature at which the kinetic energy of the particles is great enough to break the attractive forces, or springs, that are holding the particles together (see Figure 5.21). This temperature is the melting point of the substance. As the particles break away from one another and have enough energy to slide past each other, the substance becomes a liquid.

As a liquid is heated, the particles gain kinetic energy. Eventually, many particles have enough energy to break away from the attractive forces of the other particles and escape from the surface of the liquid as shown in Figure 5.22. These highenergy particles are now in the **gaseous state.**

2.16 Compare the characteristics of the three states of matter in terms of:

	SOLID	LIQUID	GAS
VOLUME	Does not change	Does not change	Expands to fill container
SHAPE	Does not take shape of container	TAKES shape of container	TAKES shape of container
Arrangement of particles	Particles TIGHTLY PACKED TOGETHER	Particles in contact with each other but can slip and slide past one another	RANDOM particle movement /large spaces between particles
Movement of particles	Particles vibrate in position/ They do NOT move away from each other	Particles slide past one another/ move away from one neighbouring particle to be attracted to another	Particles move freely in ALL different directions

2.17 Describe the three states of matter using the particle theory of matter in terms of:
(i) arrangement of particles
(ii) movement of particles

In **solids**, particles are closely packed together. Each particle is attracted to the particles on each side by a strong force. The particles stay beside the neighbouring particles like children holdings hands (see Figure 5.10, pg147). The particles can move with small vibrations but they do not separate from the closest particles.

In **liquids,** particles are packed closely together and are attracted to each other by a force. However, particles can slide past each other and move around. You might picture the motion as similar to the square dancers in Figure 5.11. The dancers are constantly changing partners or moving past each other, but they are always holding hands with at least one other person.

In **gases**, the particles are not touching one another. There are large distances between them. The particles collide and bounce off the walls and off one another. The attractive forces between the particles are very small. You might compare particles in gases to children playing tag as shown in Figure 5.12. The children are running in all directions but are rarely touching each other.

2.18 Define expansion and contraction

The term **thermal expansion** means that the volume of an object or substance increases when the temperature increases. When an object or substance cools, it contracts. That is, its volume decreases. The term **thermal contraction** applies to the reduction in volume with a decrease in temperature.

2.19 Use the particle theory of matter to explain expansion and contraction in the three states of matter.

Figure 5.14 represents the particles of a gas (A) at a cool temperature and (B) at a warm temperature. The lengths of the arrows represent the speed of the particles. When the temperature of a gas increases and the kinetic energy of the particles increases, the particles collide with the walls of the container with a greater force. If the walls of the container are flexible, the increased force on the walls causes them to move out and the volume of the gas becomes greater.

A similar process occurs in liquids and in solids when the temperature of the substance increases. The particles move faster and collide with each other with a greater force. However, the attractive forces between the particles in liquids and solids prevent them from moving as far as the particles in gases move. Nevertheless, the particles collide with greater forces when they are at higher temperatures and particles push each other farther apart. As a result, the volumes increase somewhat.

Contraction simply works opposite to the descriptions above!
Ex. air pressure in tires increases during a car trip and footballs or soccer balls deflate when they are taken outside on a cold day

2.20 Explain changes of state using the Particle Theory of Matter. Include:

(i) melting

In a solid substance, the particles are held tightly together. As you saw in Figure 5.15 on page 150, the particles have kinetic energy, so they vibrate. However, they remain attached to each
other by forces that are represented by springs. As you add more energy in the form of heat, the kinetic energy of the particles increases and the temperature increases. Eventually, you reach a temperature at which the kinetic energy of the particles is great enough to break the attractive forces, or springs, that are holding the particles together (see Figure 5.21). This temperature is the melting point of the substance. As the particles break away from one another and have enough energy to slide past each other, the substance becomes a liquid.

(ii) freezing

The particles of a liquid are held together by attractive forces which are not as strong as those of solids leaving them free to move about. When the liquid loses energy the forces become so strong that they are pulled into fixed positions and become solids.

(iii) evaporation

As a liquid is heated, the particles gain kinetic energy. Eventually, many particles have enough energy to break away from the attractive forces of the other particles and escape from the surface of the liquid as shown in Figure 5.22. These highenergy particles are now in the gaseous state.

2.21 State a hypothesis, carry out an experiment, identify and control major variables and state a conclusion based on experimental data

2.22 Use heating and measuring tools accurately and safely

2.23 Organize, compile and display data using tables and graphs

The above three outcomes are completed by the Core Lab: The Plateau Problem
Know and understand the following graph.

2.24 Compare transmission of heat by conduction, convection, and radiation.
2.25 Define conduction, convection and radiation in terms of:
(i) particle movement

conduction the transfer of thermal energy that occurs when warmer particles come in contact with cooler particles and transfer energy to the cooler particles

convection the process in which a warm gas or liquid moves from one place to another, carrying heat with it

radiation the transfer of energy in a wave-like form

(ii) state(s) in which it occurs

Conduction - Conduction can occur in all three states of matter but decreases in efficiency from solids to liquids to gases.

Convection - Convection can occur in liquids and gases.

Radiation - Radiant energy is heat energy that is transmitted by electromagnetic waves that do not need matter in order to travel. Unlike conduction and convection, radiant energy can travel through a vacuum (no particles)

2.26 List common examples of the three processes of heat transfer. Include:

(i) conduction - cookware, ice pack, welding metal

(ii) convection - air current from hot air furnaces, heating a liquid such as soup; magma in the mantle

(iii) radiation - fireplace, sunlight, cell phones (hazardous)

2.27 Provide examples of heat technologies used past and present to heat homes in Newfoundland and Labrador. Include:

(i) wood stove

Many years ago, homes in Newfoundland and Labrador were often heated with a wood stove. Stoves were often black which made them efficient radiators of heat. The room in which the stove was located could be very warm on even the coldest days.

(ii) electric heat

Electric heating is any process in which electrical energy is converted to heat.

An electric heater is an electrical appliance that converts electrical energy into heat. The heating element inside every electric heater is simply an electrical resistor, that converts electrical energy into heat energy.

(iii) wood/oil furnace

During the first half of the 1900s, people began to install furnaces in basements with ducts running to all of the rooms. Coal was burned in most of the early furnaces. In the mid 1900s, many furnaces were converted to oil or gas. Air was drawn into the furnace and heated and fans would blow the warm air through the ducts and into the rooms. This system is sometimes called forced air heating. Wood furnaces work in the same fashion. Forced air is still used in many homes.

(iv) air to air heat pump

As the cost of fuel increases and pollution from the burning of fuel threatens the environment, people are looking for new technologies. One of these technologies, called an air-to-air heat pump, works very much like a refrigerator. A fluid is contained inside a system of pipes as shown in Figure 6.13 pg

186. In the summer, the fluid absorbs heat from the inside of the house and pumps it to the outdoors. In the winter, the heat pump is reversed.

It absorbs heat from the outside air and pumps it into the house. You are probably wondering how a fluid can remove heat from cold air. The fluid and the system of pipes have some very special characteristics. When a fluid is allowed to expand rapidly and evaporate from a liquid to a gas, it absorbs heat from the surroundings. To remove the heat, the gas is compressed and converted back into a liquid. This process causes the heat to be released.

(v) hot water radiation

In some houses, water was used to transfer water from the furnace to the rooms. A system of pipes carried water into the furnace where it was heated. Pipes passed through all of the rooms where the heat was transferred to the room air. Hot water heating is still used in many homes.

(vi) geothermal

A geothermal heat pump is similar to an air-to-air heat pump. Instead of exchanging heat with the outside air, it exchanges heat with the ground. Although it is much more expensive to install, it is more efficient. Just a few metres below the surface of the ground, the temperature stays the same throughout the year. The temperature underground is cooler than the air in the summer and warmer than the air in the winter. As shown in Figure 6.14 pg 187, a series of pipes are buried in the ground near a house or other building. In the summer, heat is pumped from the house to the ground. In the winter, heat is pumped from the ground to the house. Geothermal heat pumps have been installed in more than 30 000 buildings in Canada. The new Forest Centre building (see Figure 6.15 pg. 187) at Sir Wilfred Grenfell College in Corner Brook is the first building in Canada, other than a residential house, to use geothermal heat pump for heating and cooling.

(vii) solar

Solar Heating — A process whereby heat from the sun is absorbed by collectors and transferred by pumps or fans to a storage unit and used to heat a building's interior directly.

Solar heating design is divided into two groups:

- Active solar heating uses pumps which move air or a liquid from the solar collector into the building or storage area.
- Passive solar heating does not require electrical or mechanical equipment, and may rely on the design and structure of the house to collect, store and distribute heat throughout the building passive solar building design).

A man in Colliers, Newfoundland and Labrador invented and manufactures the solar panels that are shown in the photograph. A fan draws cool air from an inside room and sends it into the 15 cylindrical
columns. The curved plastic covering focuses the Sun's rays on the dark-coloured columns.
As the air passes through the columns, it is warmed by the solar radiation.Warm filtered air is then directed back into the room.

2.28 Identify different approaches taken to solve the problem of heating homes during cold times of the year
2.29 Make informed decision about the various technologies used to hear our homes, taking into account potential advantages and disadvantages
2.30 Provide examples of how the technologies used to heat homes have improved over time
2.31 Provide examples of how our understanding of evaporation and condensations of liquids resulted in the develoment of heat pumps

The STSE component, "Heat Pumps: An Alternative Way to Heat Homes" covers the outcomes above.

2.32 Describe how various surfaces absorb radiant heat.

Dull and/or dark surfaces absorb heat energy better than shiny and/or light surfaces.

2.33 Design and conduct an experiment to test identified questions, state a hypothesis, identify and control major variables.
2.34 Use experimental apparatus and tools safely.
2.35 Organize and display data using tables and graphs.
2.36 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.

The Laboratory outcomes above are addressed by completing CORE LAB 6-1d “Absorb That Energy”.

2.37 Distinguish between thermal conductors and insulators.

Thermal conductors materials that are good conductors of heat.

thermal insulators materials that are very poor conductors of heat.

Various technologies that reduce heat transfer are thermos bottles, styrofoam and fiberglass insulation in homes.

2.38 Provide examples of insulating technologies used today and in the past. Include:

(i) animal fur - fur coats worn for warmth or bedding

(ii) sod - laid down for bedding, roofing, or for stuffing between logs in a log cabin

(iii) fiberglass - used in household insulation

(iv) thermos - keeping drinks and foods warm or cool. (Coffee)

2.39 Compare, in qualitative terms, the specific heat capacities of some common materials. Include:

(i) water - 4.18 J/g .°C

(ii) ice - 2.093 J/g .°C

(iii) aluminum - .900 J/g .°C

(iv) concrete - low

(v) steel - .500 J/g .°C

This means that in order to warm an equal mass of water and aluminum (1g), water will require more energy (4.18 J - .900 J = 3.300J) to raise its temperature by the same amount (1oC).
Higher heat capacity substances will take more energy to raise the temperature.

2.40 Distinguish between heat and temperature.

Heat - a form of energy that flows between two samples of matter because of their differences in temperature.

temperature a relative measure of how hot or cold something is; the average kinetic energy of the particles in a substance

2.41 Define specific heat capacity.

specific heat capacity the amount of energy required to raise the temperature of 1.00 g of a substance 1.00°C

2.42 Describe how our needs related to heat can lead to developments in science and technology

Canadian Winters - survival and survival kits (blanket), first aid treatments (heat/cold technologies) to deal with injuries such as sprains, shock and hypothermia. (ie. Cold packs, heat packs, foil blankets), clothing past and present, home insulation past and present

2.43 Identify examples of science- and technology-based careers that are associated with heat and temperature.

Examples could include health care workers, furnace service technicians, light bulb manufacturers, and blacksmiths.