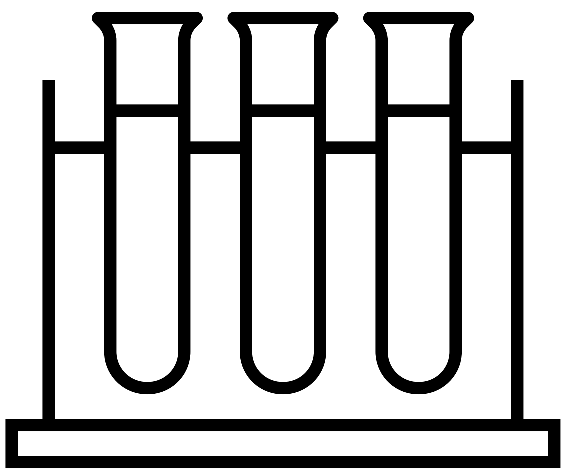
PARTICLE THEORY OF MATTER



NAME: ______________________________

IMPORTANT TERMS

Boiling Point ______________________________

Melting Point______________________________

Pure Substance ______________________________

Scientific Theory ______________________________

Particle Theory of Matter ______________________________

Temperature ______________________________

Heat ______________________________

Conduction ______________________________

Convection ______________________________

Radiation ______________________________

Mixture ______________________________

Homogenous ______________________________

Heterogenous ______________________________

Solutes ______________________________

Solvents ______________________________

Solubility ______________________________

Concentration ______________________________

Dilute ______________________________

Concentrated ______________________________

Saturated ______________________________

Unsaturated ______________________________

SCIENTIFIC FACT VS. THEORY VS. LAW

Fact:

Theory:

Hypothesis:

Law:

Motion of Particles

Describe what the properties are of solids, liquids and gases. Then, draw what the particles look like for solids, liquids, and gases.

Solids	Liquids	Gases

HEAT VS. TEMPERATURE

Heat and temperature are related because ____.

But they are different because heat is a ______________________________ while temperature is a ______________________________, or of how hot or cold something is.

Heat	Temperature

Pa[91] Th[90]
Particle Theory of Matter

1

2

3

4

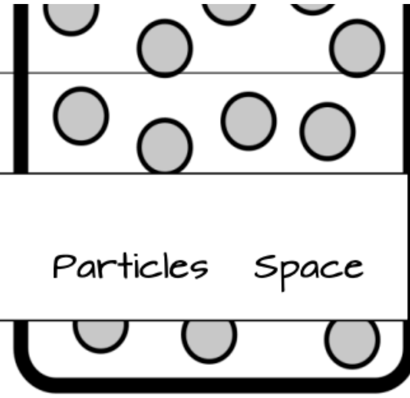
5

Kinetic Molecular Theory

Low energy → high energy

solid	liquid	gas

Particles



Word Bank

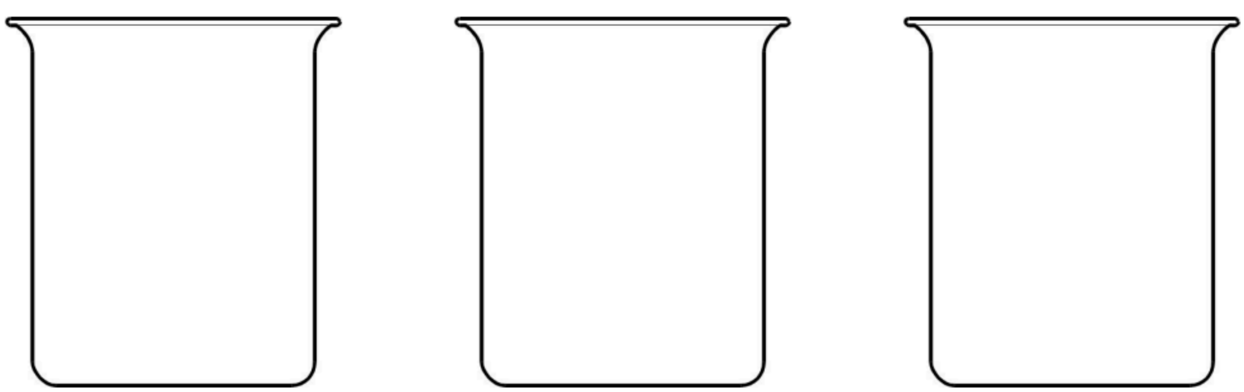
Space Particles State Moving Matter Form Particles Space

Fill in the blanks

Everything around us is ____________. All matter is made of tiny ________. The Particle Theory states that small particles are ____________ constantly. Particles move faster based on their __________ of matter. Different kinds of matter have different kinds of________. There is ________between all particles. The amount of _________between particles is dependent on the ___________ of matter.

Draw the Particles in Each State of Matter

Add dots to the beakers to represent which state of matter it is.



Gas Liquid Solid

Which particles are moving the fastest? Gas Liquid Solid

Sources of Heat

What is heat?

Heat is significant in our daily lives. There are many sources of heat around us. Think about how we stay warm during the winter months when it is very cold outside. We might put on extra layers of clothing or wear insulating clothes to keep warm. We might also set a fire in the fireplace to keep a room in the house warm. We also use furnaces to keep the house warm in the winter months. There are other times where we use heat as well. We heat water for showering and for cooking.

What are some sources of heat?

The Sun

One of the most obvious sources of heat is the Sun. The Sun provides over 90% of the energy that warms the Earth's surface and atmosphere. The Sun's energy comes from deep within its core. This is where nuclear reactions release huge amounts of energy called **solar energy**.

Thermal Energy

Other sources of energy get turned into **thermal energy,** which is heat energy. Wood and other fuels such as oil and natural gas contain large quantities of chemical energy. This chemical energy is transformed into thermal energy when the wood is burned. In home furnaces, the chemical energy stored in natural gas is relapsed in a controlled fashion and is then used to warm our homes.

Water Heater

A water heater is used to heat and store water until it is ready to use. There are different types of water heaters. Some water heaters are fuel-fired units that have a vent pipe at the top to carry away exhaust gases. Electric models have a power cable that connects the heater to the electrical service panel. Every water heater tank is equipped with insulation to help keep the water warm between heating cycles.

Insulation

Insulation is another way we keep our homes warm in the winter. Insulation is often added within the walls of homes to help keep the heat inside the home, and stop the heat from escaping. **Heat transfer** is the transfer of thermal energy between objects of differing temperature. Both solids and liquids make good insulation material if they can be trapped. When a building is well insulated, it is energy-efficient and provides more uniform temperatures throughout the space.

Stove Tops and Ovens

When the burner of a stovetop is very hot, it is a source of heat energy. Anything placed onto the stovetop and warmed, whether a pot of tea or skillet for frying eggs, also become sources of heat. This is one of the ways that we are able to cook our food in order to eat it. We also will preheat ovens to a certain temperature so that our food can be cooked thoroughly. We have to let the food sit after being in the oven so that the heat energy can escape, and the food can cool.

Body Heat

Our bodies contain heat energy that we can pass from person to person. Sometimes our heat energy gets transferred from our warm hands to a cool glass, which causes the glass to begin to condensate on the outside. We can also make someone else warm when we hug them as well.

Computer Heat

When the computer is turned on, the components inside of it generate heat energy. This

Sources of Heat

heat energy can become a little bit too much for the computer to handle. As a result, a small fan is installed within the machine to help cool down the parts of the computer.

Automobile Fuels

Automobile fuels such as gasoline are sources of heat energy. When we turn on a car, we might notice that the car begins to get warmer on the outside. This is because the fuel is being heated from the inside of the car. The hot engine of a racecar or a school bus is also a source of heat energy.

Fire

Any fire, from the smallest match, to the fireplace, contains heat energy. Fires can grow and expand easily, and the heat from the fire can burn things instantly.

Bolt of Lightning

A huge amount of heat energy is stored in a bolt of lightning. A bolt of lightning can strike and start a fire or cause an electrical outage. We sometimes see this during lightning storms in the summer when it is more likely to be the stormy time of year.

Chemical Energy

Humans began using chemical energy long before we ever understood much about it. Individuals would collect wood for their fires, and they were unaware that stored chemical energy was released in the form of thermal energy when the wood burned. Coal also contains stored chemical energy that needs no further treatment to produce thermal energy as it burns.

Geothermal Energy

Geothermal energy is an energy that is harnessed from the Earth's interior. Volcanoes, hot springs, and geysers are indications of extremely hot materials that exist inside Earth's crust. The hot material inside Earth that shoots or oozes out during a volcanic eruption can also produce hot water or even steam, which moves through the cracks in rocks. This boiling water can be piped to a power plant at the surface. Here it is channeled through a control system to turbines, and it is turned into electrical energy.

Heat and Volume Anticipation Guide

Before reading about how heat affects the volume of solids, liquids, and gases fill out the "before reading" column. Read the statements in the middle column and identify whether you think each statement is true or false. After reading, complete the "after reading" column using the same statements.

Before Reading		After Reading
true false	Heat causes solids to expand.	true false
true false	When heat is applied to a solid, it will change into a liquid.	true false
true false	Heat causes gases to condense.	true false
true false	To expand means to get larger.	true false
true false	Heat causes the volumes of solids, liquids, and gases to expand or increase.	true false
true false	Heat causes liquids to expand.	true false
true false	According to the particle theory, particles at a higher temperature move faster than particles at a lower temperature.	true false

Heat and Volume

Remember that heat is an essential source for us in our everyday lives. The heat helps to keep us warm during the winter months, it allows plants to grow, and it also helps our food to cook when we need it. What impact does heat have on the volume of solids, liquids, and gases? Before we answer this question, we need to explore what solids, liquids, and gases are and what the particle theory tells us about each of these three states of matter.

What is a solid, liquid, and gas?

Remember that a solid has a fixed shape, and the particles are tightly packed together. A liquid flows more easily than solids, and there is some space between particles. Finally, gas flows easily and has lots of space between particles so that the particles can move past each other.

What is the particle theory of matter?

The particle theory of matter tells us more about solids, liquids, and gases and the particles that make up each state of matter. The particle theory states that particles are always moving, and particles at a higher temperature move faster on average than particles at a lower temperature.

What happens when heat is applied to a solid, liquid, or a gas?

When heat is applied to all three states of matter, they all expand. The atoms or particles that make up the state of matter does not expand, but the volume they take up does.

Solids

When a solid is heated, its particles vibrate faster. The increase in the size of solids when heated is small. Metal railway tracks have small gaps so that when the sun heats them, the tracks expand into these gaps and do not buckle. The same goes for sidewalks and bridge segments. Each of these expands in hot weather, and if they are cooled too quickly, it can result in the cracking of the sidewalk or bridge segment.

Liquids

When a liquid expands, it is also because the particles are vibrating faster. Since the bonds between separate molecules are usually less tight, they expand more than solids. Think about a thermometer. An increase in temperature results in the expansion of the liquid, which means it rises in the glass. Another example would be the sea levels. Sea levels are rising because global warming is making the oceans warmer, and the water in them is expanding.

Gases

Particles in gases are further apart and weakly attracted to each other. Heat causes the molecules to move faster, which means the volume of a gas increases more than the volume of a solid or a liquid. An example of a gas expanding is when the air in car tires expands on hot pavement. As heat increases, the tires tend to inflate.

Heat and Volume

What happens to all states of matter when heat is added to the particles?

Rank the amount of expansion for a solid, liquid and gas from least amount of expansion to the greatest amount of expansion.

Least amount of expansion | **Some amount of expansion** | **Most amount of expansion**

Using the chart below, write a daily example of the expansion in volume of a solid, a liquid or a gas.

Example of Thermal Expansion in Solids	Example of Thermal Expansion in Liquids	Example of Thermal Expansion in Gases

Conduction

What is meant by the term conduction? When talking about heat, **conduction** is the process by which heat or electricity is directly transmitted through a substance when there is a difference in temperature without the movement of the material. Let's break down this definition further. When we talk about the transmission of heat, we are talking about the movement of heat energy from one object to another, or from one place to another. An example of this is when we harm our homes through the winter. We are transferring the heat from the central heating furnace to rooms around the house.

What is Conduction?

When we cook an egg in a pan on a hot stove, there is a transmission of thermal energy–the thermal energy transmitted from the hot stove burner and through the pan. The energy then moves from the pan and into the cold egg. The particles in the stove vibrate quickly. Remember that particles with a higher temperature move faster than particles with a lower temperature. When the pan comes into contact with the burner, the fast-moving particles of the burner collide and transfer energy to the slow-moving particles of the cold pan. This energy transmitted raises the temperature of the pan.

When we talk about the egg in the pan, eventually, the energy from the hot pan will collide and transmits energy to the particles of the cold egg. The temperature of the egg rises, and the egg begins to cook. Conduction is the transmission of thermal energy through a substance, or between substances in contact. This energy transmission is caused by the collision of particles.

Conductors and Insulators

Some materials allow for the transmission of energy to move faster than other materials. These materials are called conductors because these materials allow for the transmission energy easily.

Other materials do not allow for the transmission of energy, and these materials are called insulators. Examples of conductors are copper and other metals. Examples of insulators are foam, felt, or fleece.

Think about the materials our cooking pots and pans are made of. They are usually made of some kind of metal because metal is a good conductor and allows for the transmission of thermal energy. If we were using a metal spoon to stir a pot, the heat would eventually be transmitted from the liquid in the pot to the tip of the spoon that our hand is on. This would cause us to get burnt. However, if we were to use a wooden spoon or a plastic spoon, the heat would not get transmitted.

One last example…

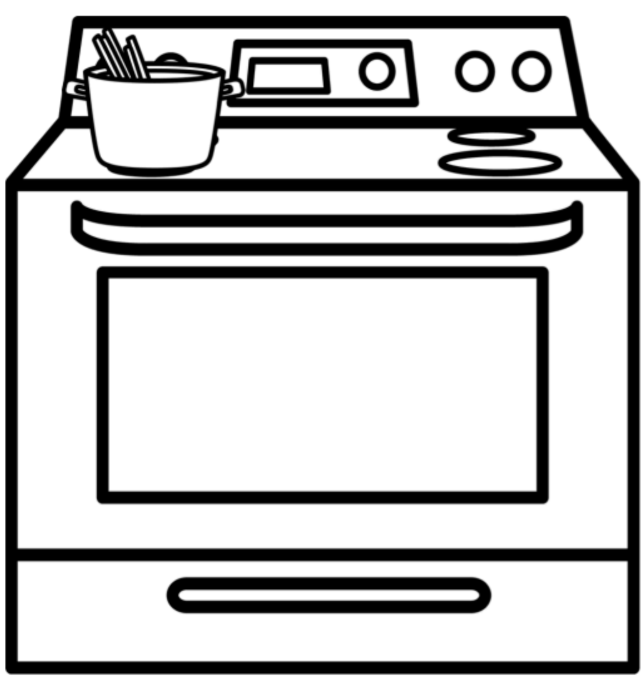
Let's take a look at another example. Remember that with heat conduction, heat energy travels from the hot point to a cold point. A pan of hot soup is taken off the stovetop and put on a table. The pot is still hot. The area of the table under the pot gets hot. The heat has been moved from the pot to the tabletop by conduction.

Conduction

What is **conduction?**

Give an example of the transmission of heat.

Using the diagram below, draw arrows to show the transmission of heat. Explain how the transmission of heat occurs with the example.



Convection

What is convection?

Convection is the transmission of thermal energy caused by the flow of a fluid's particles. Convection does not occur in solids because the particles of a solid only vibrate, and they cannot flow.

What are some examples of convection?

In substances such as water and air, thermal energy can be transmitted from one area to another. This transfer of energy relies on the fluid characteristics of such materials.

Let's look at a pot of soup cooking on the stove. When the soup is heated, the water particles near the bottom of the pot start to move faster and farther apart. This movement makes the particles near the bottom, less dense and lighter than those near the top. In turn, the colder, denser soup near the top sinks to the bottom of the pot. This causes the less dense soup to move upward and replace the cold soup. This creates a current in which colder soup near the top of the pot moves to the bottom and warms up. The warmer soup near the bottom moves to the top and cools down. The process continuously repeats.

Convection and natural processes

Convection is common in both the atmosphere and in the oceans. Heated air in the atmosphere expands, becoming less dense. Because it is less dense, it rises upward. Cooler air rushes in to replace the air that lifted up. As the warm air rises and cool air falls, a giant circular pattern is created. Eventually, the warmer air cools and begins to fall again.

Convection also occurs in the ocean. Convection happens because the oceanic waters heat up and become less dense. This water moves above the cooler water, and give off its heat to the surrounding environment. As it cools, it begins to sink, and the process begins again. Convection results in the continual circulation of ocean water on a global scale.

Convection

What is **convection**?

How is **convection** different than **conduction**?

What is an example of convection? Draw a labelled diagram that shows this example. Use red arrows for hot and blue arrows for cold.

Describe the labelled diagram you have drawn above. Be sure to explain the movement of hot/cold.

Convection & Natural Processes

What is convection?

Convection is the transmission of thermal energy caused by the flow of a fluid's particles. Convection does not occur in solids because the particles of a solid only vibrate, and they cannot flow.

Convection and land

Have you ever noticed that air feels cooler near lakes and oceans in the summer? Energy from the Sun does not heat the air over land and water evenly. Near a lake, the air above the water is colder than the air above the land because land requires much less of the Sun's energy to warm up than does water. The warm air particles above the land are more strongly heated by the warm land surface below. The warm air particles moved faster and spread apart. This makes the air above the land, less dense than the air over the water. The cool, dense air above the water moves down toward the land. This movement of air near a body of water is caused by convection.

When the Sun goes down in the evening, the land cools more quickly than the water. The warm water heats the air above it, making the air less dense. The cool, dense air over the land moves down and out toward the water. This pushes the less dense air over the water higher into the atmosphere.

Thunderstorms

Thunderstorms produce lightning and thunder and are associated with strong winds and heavy rains. Thunderstorms often form on hot, humid days. The Earth's surface is warmed by energy from the Sun. The energy is then transferred to the air above the surface of the ground by conduction. This warmed air is less dense than the surrounding cooler air. The warm air is rapidly pushed up higher into the atmosphere by convection, carrying along with the water vapour with it. As convection pushes the air higher, the water vapour cools and condenses into droplets of water that appear as large
puffy clouds.

Geology and Convection

The top of the mantle is cooler than the bottom of the mantle. Over millions of years, cooler mantle rock sinks as warmer mantle rock rise closer to Earth's crust. This creates slow convection currents. These currents transfer energy and may cause volcanic eruptions.

Radiation

What is radiation?

Radiation is the transmission of radiant energy in the form of electromagnetic rays. Have you ever wondered how energy travels from the Sun to the Earth? Both conduction and convection require particles to transfer energy. However, radiant energy travels outward from the Sun through empty space. Radiant energy travels in the form of electromagnetic waves or rays. Radiant energy from the Sun includes visible rays and invisible rays. The Sun emits electromagnetic rays in all directions, but only a small portion of them reach Earth.

Absorbing and repelling radiant energy

Did you know that matter can both absorb and give off radiant energy? An example is a bench at an outdoor stadium. These benches get quite hot when the radiant energy from the Sun shines on them. This is because the radiant energy absorbed by the particles of the benches is then converted to thermal energy. When this occurs, the particles of the material move faster, and this raises the temperature of the benches.

Radiant energy sources on Earth

There are also sources of radiant energy on Earth. Candle flames and incandescent light bulbs glow and feel hot. They glow because they give off visible light. They feel hot because they emit infrared rays. These rays are also emitted by hot objects that do not glow such, as curling irons and hot plates.

We can also see radiant heat transfer while baking a potato in the oven. The oven is heated up, and then the heat is transferred radiantly from the walls of the oven to the potato in the oven.

Radiant energy and colours

Radiant heat can be partially controlled by using colour. Dark colours absorb radiant heat while light colours repel the energy.

Have you ever walked barefoot on the pavement to get to a swimming pool? The pavement might not be glowing, so you would not know the surface is hot. However, the radiant energy from the Sun is absorbed by the pavement, which causes the particles in the pavement to move faster. The pavement in the shade is cooler to touch than pavement in the Sun. This is because the pavement in the shade is not absorbing as much, if any, radiant energy. Therefore, the particles of the pavement are cooler and of a lower temperature.

Radiation

What is **radiation**?

What is different about radiation compared to convection and conduction?

Sarah goes to sit on a metal bench. It has been sunny all day long. When she sits down she immediately feels like her legs have been burned. Explain to Sarah what has happened.

If radiant energy travels onto surfaces that are darker like asphalt, what would it feel like on a really warm day? Consider that you cannot see how hot the surface is.

Heat Transfer

What is meant by **heat transfer?** What are the three methods of heat transfer you have learned about?

Using the chart below, define each method of heat transfer and give a quick example of it in our daily lives.

	Convection	Conduction	Radiation
Definition			
Example			

Identify which of the following statements are an example of convection, conduction or radiation.

Mary sits on a metal bench in a park. Her legs get burnt from the metal bench. What example of heat transfer heated up the bench?

a) convection b) conduction c) radiation

A hot pot of soup is on the stove top. The warm soup rises from the bottom up to the top, and the cool soup at the top moves to the bottom where it gets warm again. The process continues.

a) convection b) conduction c) radiation

You put a pan on the stove top. You turn on the stove. The stove begins to get hot. The heat is transmitted to the pan. You put an egg in the pan and the heat from the pan is transmitted to the egg.

a) convection b) conduction c) radiation

Reducing Heat Loss

Heat loss – What is it?

Heat loss is the loss of heat. Most often, heat loss is the result of poor construction, or not choosing the right materials to make a product or a device.

Heat loss and homes

Houses are usually specially designed to reduce heat loss in multiple ways. First, homes are insulated. **Insulation** helps to trap the heat inside the homes. Some homes are poorly insulated, and as a result, individuals might spend more money heating their homes and trying to keep their homes warm.

Green roofs

Another way that a home is designed to reduce heat is with the roof. A **green roof** is a roof of a building that is partially or completely covered with vegetation. Green roofs help to absorb rainwater and provide insulation. The green roof is not that popular in Ontario. Can you think of any reasons why it might not be popular?

Clothing and insulation

The clothes we wear can also be an example of a way to reduce heat loss. In the summer, we wear fewer layers of clothing, or lighter materials because we do not want to trap heat. Instead, we want the heat to be transferred to another place to help keep us cool. In the winter, we want to be warmer. As a result, we might wear layers of clothing or wear clothing made of materials that are very well insulated. This allows for the heat to be trapped and to keep us warm and comfortable. It also makes it possible for us to enjoy outdoor activities in the winter.

Energy efficient buildings

An **energy-efficient building** is also known as a green building. These buildings are environmentally responsible and resource-efficient. The objective of green buildings is to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources;
- Protecting occupant health and improving employee productivity;
- Reducing waste, pollution, and environmental degradation.

Designers of these buildings intend for the buildings to use less operating energy. Designers will use details that reduce air leakage through the building envelope. They also specify high-performance windows and extra insulation in walls, ceilings, and floors.

Pure Substances and Mixtures

A Pure Substance

All samples of matter are either pure substances or mixtures. A pure substance contains only identical particles. Pure substances have a definite set of properties. A pure substance could be an element which has only one type of atom or it could be a compound which has two or more elements that are combined chemically. Pure Substances have a fixed melting and boiling point. They cannot be separated by physical means. Distilled water, sugar, table salt, baking soda, aluminum and gold are examples of pure substances. Pure substances rarely occur naturally, and most are separated from raw material by people.

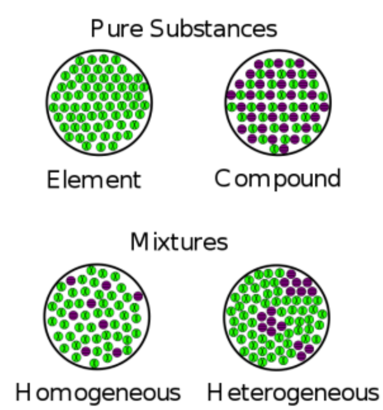
Mixtures

A mixture contains two or more types of particles. Matter is most often a mixture. In a mixture no chemical reaction takes place between the particles. Mixtures do not have a definite set of properties. They come in different proportions and they don't have a fixed ratio. Mixtures don't have a fixed melting or boiling point. They can be separated by physical means. Mixtures can be classified as homogeneous mixtures or heterogeneous mixtures. The difference between the two types of mixtures is how well they are combined.

Heterogeneous Mixtures

Heterogenous mixtures which are also called mechanical mixtures are made up of two or more types of particles and you can see or feel the different types of particles. For example, cereal in milk, raspberry jam, oil and water.

Heterogenous mixtures are not uniform. If you take a sample from different parts of the mixture, the sample will not have the same composition. You can use a mechanical method to separate components of a heterogenous mixture. For example, you can pick the cereal out of the milk, or you can allow the oil to float to the top of the water and skim it off or you can use cheesecloth to strain the raspberry seeds and solids out of the jam.



Homogeneous Mixtures

Homogeneous mixtures are made of two or more types of particles but look like only one type of particle for example, apple juice, sugar and water, blood.

Pure Substances and Mixtures - Questions

Mixture Type	Examples
Two or more solids	Sand and sugar, Salad - lettuce and tomatoes
Solid and a Liquid	Cereal and milk, sugar and water
Two or more liquids	Milk and tea, chocolate syrup and milk

Examples

Write examples of each of the types of mixtures

Mixture Type	Examples
Two or more solids	
Solid and a Liquid	
Two or more liquids	

Visualizing

Draw what you were picturing while you were reading the text

Question

Answer the question below using evidence from the text

What is the difference between a pure substance and a mixture?

____

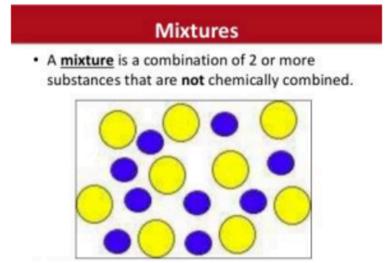
____

____

____

Mixtures

Mixtures



Mixtures are made of two or more substances that are not chemically combined. They are combined physically and the substances combined together retain their original chemical identity. Mixtures can be in the form of solids, liquids, and/or gases, in any combination.

An example of a liquid mixture is vinegar and water. These will form a homogeneous mixture because you will not be able to see the individual components. Two solids, salt and Sand will form a heterogeneous mixture. You will be able to see each component even after you mix them together. Brass is a solid homogeneous mixture of copper and zinc.

Soft drinks are a mixture of all three states of matter. A liquid, water, is mixed with a solid, sugar and flavouring that could be solid or liquid. These ingredients are mixed with carbon dioxide, a gas, to give the drink bubbles. Air is a mixture of gases including nitrogen, carbon dioxide and oxygen.

Mechanical Mixtures

Mixtures can be classified as mechanical mixtures or solutions. Mechanical mixtures are heterogeneous mixtures. You can see the components after you have combined the components. When you make a salad, you combine the ingredients, but you can still see them separately and they maintain their own properties.

The oil and vinegar salad dressing you use on your salad is also a heterogeneous or mechanical mixture because the components don't mix, they maintain their own properties.

Another example of a mechanical mixture is asphalt. The components, gravel, sand and bitumen form together and make a strong solid road surface, however, you can still see the individual components of the asphalt.

Mixtures - Questions

True or False — Circle whether the statement is true or false

1. Solutions are mixtures.	True	False
2. Mixtures can be made with different combinations of solids, liquids and gases.	True	False
3. Mechanical mixtures are homogeneous mixtures	True	False
4. Mixtures are made of 2 or more substances that are chemically combined.	True	False
5. Oil and Vinegar are a homogeneous mixture.	True	False

Visualizing — Draw what your were picturing while you were reading the text

Describe your picture below using words from the text

____

____

____

Make a Connection — Use your own experiences to answer the question

What are some mixtures that you have made? Were they homogeneous or heterogeneous mixtures?

____

____

____

Solutions

Solutions

A solution is a mixture that looks like a single pure substance. A uniform mixture of two or more pure substances is also known as a homogeneous mixture. There are two main parts of a solution Including:

1. A **solute** which is the substance that is being dissolved into the other substance. The solute is the smaller part of a solution. Salt is a solute because it dissolves into water.
2. A **solvent** which is the substance that dissolves the other substance. The solvent is the larger part of the solution, the part of the solution into which the solute dissolves.

How do Solutions Form?

When particles of one substance are more attracted to particles of another substance than they are to themselves, they will form a solution. Particles on the surface of the solute will break away and begin to fill the spaces between the solvent particles until all the solute particles are evenly mixed between the solvent particles.

Water and Water Pollution

Water dissolves more different substances than any other solvent. Because water is the most common solvent in solutions it is called the universal solvent. Water does not dissolve everything. Oils and fats are not water soluble.

Our bodies are 70 percent water. The water in our bodies is a solvent that can carry calcium, potassium, oxygen and salt to name a few of the essential nutrients our bodies need to function.

Seventy percent of the earth's surface is covered by water. Solutes in the water can be absorbed by plants and living things. Fertilizer, pesticides, waste from mining, sewage and household products put down the drain are all solutes that can be dissolved in water causing water pollution.

Solid Solutions

Solutions that are solids have both solid solutes and solid solvents. Pure gold is 24 Karat gold. It is a pure substance. 14 Karat gold has 14 parts gold to 10 parts other metals. To make a solution both metals are heated and mixed together into a homogeneous mixture. Gold is the solvent and the other metals are the solutes.

Solutions - Questions

True or False — Circle whether the statement is true or false

1. Salt is the solvent in a salt water solution	True	False
2. Sugar is the solute in a sugar water solution	True	False
3. A solution is a mixture	True	False
4. A solution has a solvent and a solute	True	False
5. The solute mixes with a solvent in a solution	True	False

Summarize — What is the main idea and supporting details from the reading passage

____

____

____

____

____

Key Words — What are the characteristics of the substances below?

	What does it mean?	Example
Solution		
Solutes		
Solvents		

Process of Forming a Solution

Making Solutions

Making a solution is easy, we add a solute to a solvent and wait for it to mix or we help it combine by stirring. We hope to see the solute dissolve into the solvent to make a homogeneous solution. The process happens in three steps:

1. The solute is placed in the solvent and depending on the concentration of the mixture, the particles will slowly break down. If you stir the liquid, the mixing process will happen faster.

2. The particles of the solvent start to move out of the way as they create space for the particles of the solute. For example, the water has to allow space for the salt particles to spread out.

3. The solute and solvent continue interacting with each other until the concentration of the two substances is equally distributed throughout the solution.

Factors Affecting the Process of Forming a Solution

There are a few factors that impact the process of forming a solution.

1. Concentration

The **concentration** of the solute compared to the amount of solvent impacts how fast the solution will form. When there is more solute there are more spaces between the particles for the solvent to fit in between.

2. Temperature

The **temperature** of the solvent is also a factor. Usually when we heat up a solvent, it can dissolve more solid materials (sugar) and less gas (carbon dioxide). The higher the temperature of the solvent the faster the particles of solvent move. More movement of the solvent particles causes more collisions between particles causing the solute to break down faster. When the temperature of the solvent increases, the spaces between the solvent particles get bigger. This leaves more room for solute particles.

The higher the temperature of the solvent the more energy is in the solution. The more energy that is in the solution the easier it is to break the attraction between the solvent particles. This also leads to the solvent particles spreading out faster.

3. Pressure

Pressure can also affect solutions. We see this with soda as we can dissolve more gas under higher pressure. A can of soda has water (solvent) and carbon dioxide (solute) in a pressurized can to allow more carbon dioxide to dissolve into the solvent. This gives our soda more fizz.

4. Size

The **size** of the solute particles and pieces affect the dissolving process. If you take a teaspoon of sugar and stir it into water, it will dissolve quickly. If you take a sugar cube and stir it into water, it will take longer to dissolve. Similarly, fine table salt will dissolve more quickly than coarse rock salt.

Process of Forming a Solution Questions

Match the definition with the word being defined from the word bank

WORD BANK

Solute Solvent Dissolve Dilute Mechanical Mixture

The act of a solute completely combining with a solvent to become a solution.	
To weaken the strength of a solution by increasing the amount of solvent	
A material made up of at least two different pure substances, each material maintains its own properties	
A substance that can be dissolved in a solvent.	
A substance, in which other materials dissolve to form a solution.	

Question

What are the four factors that affect the forming of a solution?

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True or False Circle whether the statement is true or false

1. You add the solute to the solvent in the first step of forming a solution	True	False
2. The molecules in the solvent move out of the way to create space	True	False
3. A cold liquid solvent can dissolve the solute faster	True	False
4. The concentration of a solute affects how fast it dissolves	True	False
5. If the solute dissolves completely, we get a homogeneous solution	True	False

Summarize What are the main ideas from the reading

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Kinetic Energy in Solutions

Kinetic Energy

Particles move because they have kinetic energy. **Kinetic energy** is the energy of movement. The opposite of kinetic energy is potential energy, which is energy that is not in motion. Anything that is moving has kinetic energy. When a ball rolls down a hill, it has kinetic energy. When the ball rests at the top of the hill, the ball has potential energy.

The particles that matter is made up of have kinetic energy. In solids, the particles vibrate in one place, but they do not move very much. When a substance is in a liquid state, its particles move more and have more kinetic energy than when it is in a solid state. In a gaseous state, the particles move the fastest because they have more room to bounce off each other. Therefore, the particles in a gas have more kinetic energy.

How Temperature Affects Kinetic Energy

Temperature is the measure of the average kinetic energy of the particles in a substance. It measures how hot a substance is. The higher the temperature of a substance, the more kinetic energy it will have. The particles in a warmer substance will move faster than a colder substance. This can be observed when you pour cold oil into a hot frying pan. At first, the oil will not move around the pan very quickly. As the oil heats up, it will travel around the pan much faster. The oil now has more kinetic energy - more heat!

Heat is the energy that transfers from a substance at a higher temperature to one at a lower temperature. You can feel heat transfer when you put a spoon into a cup of hot chocolate. Heat from the hot chocolate causes the particles in the spoon to vibrate faster, making the spoon get hotter. The particles in the spoon move faster causing the entire spoon to get hotter, not just the part of the spoon submerged in the hot chocolate.

Homogeneous vs Heterogeneous

What is a solution?

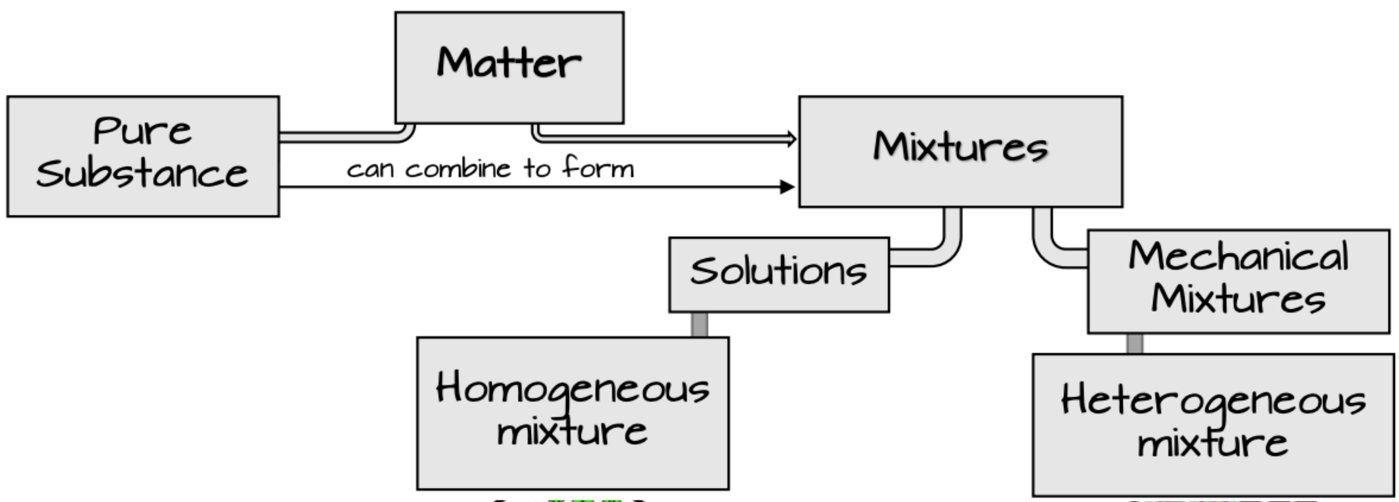
In chemistry, a **solution** is a type of mixture where one substance is dissolved into another. When we put chocolate syrup into milk, we are dissolving the syrup into the milk. The result is a solution that looks like one pure substance, meaning it is homogeneous. A **homogeneous** solution is a mixture where the components that make up the mixture are uniformly distributed throughout the mixture. The look of the mixture is the same throughout. When we look at chocolate milk, it is a homogeneous solution because it looks the same throughout the entire cup.

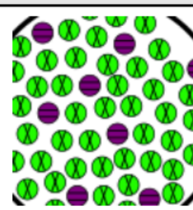
A **heterogeneous** mixture means we can see the two substances separately in the container. For example, cereal is a heterogeneous mixture because we can see the cereal and the milk separately in the bowl. The one substance has not dissolved into the other, meaning it is a heterogeneous mixture and not a solution. A solution can only be homogeneous because the one substance dissolves into the other..

Identifying and Classifying Matter

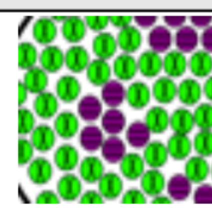
Classifying Matter

All samples of matter are either pure substances or mixtures.





Particles in a homogeneous mixture



Particles in a heterogeneous mixture

Use the classification of matter flowchart to classify 8 common substances used in your home. Explain how you know which classification it is.

Solutes and Solvents

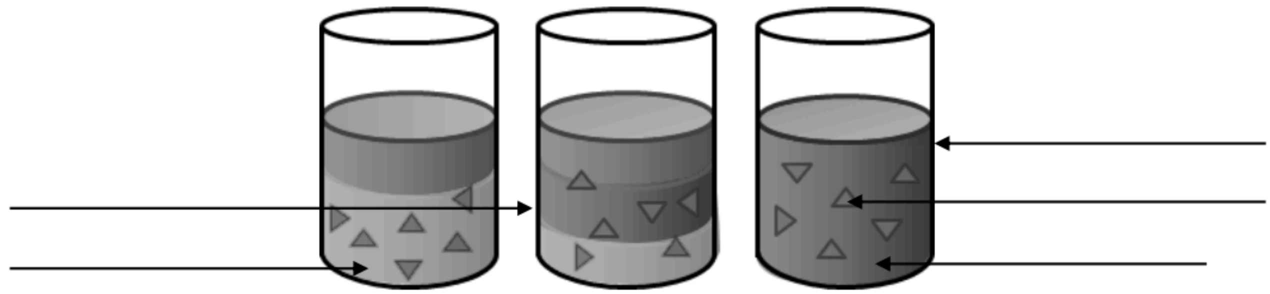
Solute

A **solute** is the substance that is being dissolved into the other substance. Salt is a solute because it dissolves into water.

Solvent

A **solvent** is the substance that dissolves the other substance. Water is a solvent because it allows the salt to dissolve into it.

Label the Diagram



Word Bank

Solution Solute Solvent Homogeneous Heterogenous

Dissolving

All solutions are made of a solvent and a solute. For a mixture to be a solution, the solute needs to dissolve into the solvent. When we make a mixture of two substances, we do not always get a solution because sometimes the solute will not dissolve into the solvent. **Dissolving** happens when the larger crystal of particles within a solute breaks up into smaller groups or individual particles. This break down of particles is a result of coming into contact with the solvent. The particles of the solute then spread out more evenly and mix with the particles of the solvent. This leads to a homogeneous solution that all looks the same.

Solubility

Solubility Definition

Solubility is the ability of a solid, liquid, or gaseous substance, the ***solute***, to dissolve in a ***solvent*** (usually a liquid) and form a solution. The **solubility** of a substance depends on the solvent used, as well as temperature and pressure. Solubility does not depend on particle size; given enough time, even large particles will eventually dissolve.

Qualitative
relating to, measuring, or measured by the quality of something rather than its quantity.
Quantitative
relating to, measuring, or measured by the quantity of something rather than its quality.

Concentration

The amount of solute in a solvent can be stated in qualitative terms. A concentrated solution is a solution that contains a large amount of dissolved solute and very little solvent. For example, frozen juice concentrate is a concentrated solution of orange juice solids (solute) and a small amount of water (solvent). When we make the orange juice, we add 3 cans of water to the frozen concentrate to make delicious juice. If we add 4 cans of water, we are diluting the orange juice and the flavour is weak because the solution is diluted.

The amount of solute in a solvent also can be stated in quantitative terms. For example, if 5 grams of sugar are dissolved in 500 ml of water, the concentration of the solution is 5 g/500 ml or 1 g/100 ml. This can be read as, five grams per five hundred millilitres, or one gram per one hundred millilitres. We could also call this a 1 percent solution. For example, a concentration of 1 g/ 100 ml means that 100 ml of the solvent has 1 g of solute dissolved in it.

Saturation

The solubility of a substance in a solvent is measured by the concentration of the saturated solution. A solution is considered saturated when adding additional solute no longer increases the concentration of the solution, at a particular temperature. When we stir sugar into a glass of iced tea, we will get to a point where additional sugar instead of mixing with the Iced tea just drops to the bottom of the glass. This is because the iced tea is saturated with sugar. There is no more room between the iced tea particles to dissolve any more sugar.

If more solute can be dissolved in a solvent at a given temperature, then the solution is unsaturated. You can dissolve more solute in an unsaturated solution.

Factors Affecting Solubility

Temperature

The solubility of a given solute in a given solvent depends on temperature. For many solids dissolved in liquid water, solubility corresponds with increasing temperature. As water molecules heat up, they vibrate more quickly and are better able to interact with and break apart the solute. Solubility increases with temperature for most substance. For example, more sugar will dissolve in hot water than in cold water. For gases, it is the opposite, as temperature increases, gas solubility decreases.

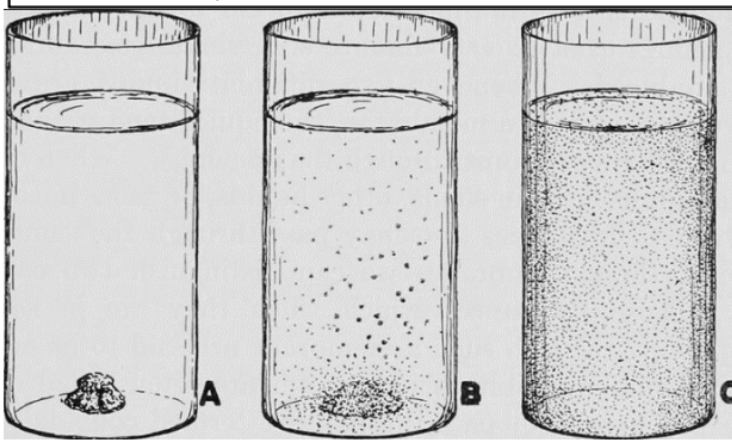
Pressure

Pressure has a negligible effect on the solubility of solid and liquid solutes, but it has a strong effect on solutions with gaseous solutes. When you open a soda can; the hissing sound from the can is due to the fact that its contents are under pressure, which ensures that the soda stays carbonated (that is to say, that the carbon dioxide stays dissolved in solution). You can dissolve more gas in liquid when the liquid is under pressure keeping the gas in the liquid.

Heterogeneous Suspensions

What is a Suspension

A **suspension** is a mixture of a liquid and particles of a solid. A mixture is considered a suspension if the particles in the liquid do not dissolve. Instead, the particles become dispersed throughout the liquid after they have been mixed. They are "suspended" in the liquid. Over time, **the particles will settle at the bottom**. An example of a suspension mixture would be sand and water. When we mix the sand into the water, the sand will disperse throughout the water. If you leave the sand and water mixture alone, the sand will eventually settle to the bottom because it is denser than the water (it weighs more).



Check it out

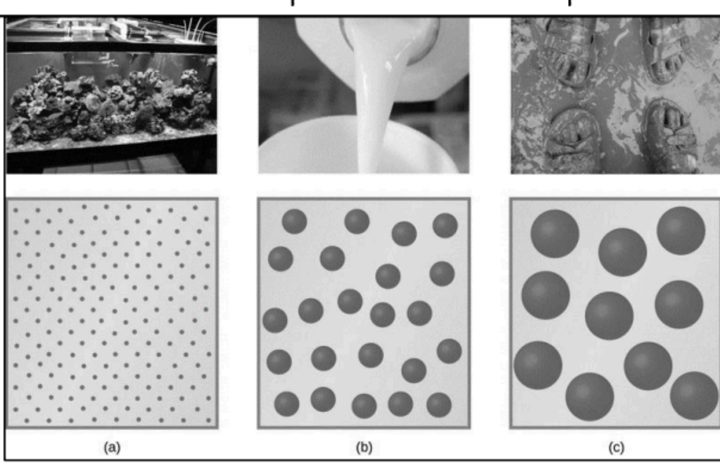
In figure A, the liquid and the solid particles are both separate. The mixture has not been stirred yet. In figure B, the stirring has begun, and the particles are now beginning to disperse throughout the liquid. In figure C, the mixture has been completely mixed and the particles are now evenly dispersed throughout the liquid. This is a suspension mixture because if we left this mixture long enough, the particles would settle again at the bottom of the liquid, just like in figure A.

Heterogeneous Colloids

What is a Colloid?

A **colloid** is a mixture where very small particles of one substance are evenly distributed through another substance. A colloid mixture looks like a solution because the small particles appear to dissolve into the other substance. This is not the case however, as the particles are floating or suspended in the other substance, even if you cannot see it with your eyes. A colloid is similar to a suspension except for the fact that in a colloid, the particles do not eventually settle on the bottom. The particles in a colloid will stay suspended or floating.

Colloids can be mixtures of solids, liquids or gases. An example of a liquid colloid is milk. Milk has butterfat globules dispersed and suspended in water. No matter how long you leave milk, the globules will not settle. Smoke is an example of a gaseous colloid mixture as particles are suspended in the air.



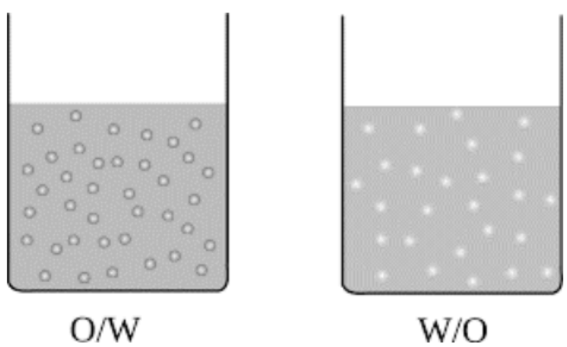
Check it out

In figure A, the water is a colloid of tiny particles (minerals) mixed in the liquid water. In figure B, the water in the milk is mixed with the butterfat globules that are slightly larger particles than the minerals in figure A. In figure C, the mud is a colloid mixture of water and soil. The soil particles are even larger than the butterfat globules, but they will not settle regardless of how long the mixture sits.

Heterogeneous Emulsions

What is an Emulsion?
An **emulsion** is a heterogeneous mixture of two or more liquids where one ends up as very tiny droplets inside the other. The liquids are usually not mutually soluble, which means they do not mix completely. For example, when we add water to a bottle of cooking oil, you will notice that after some shaking and agitation, the water will not dissolve into the oil. Instead, it will appear as bits and pools in the oil. When you leave the bottle for awhile, the liquid with the higher density will sink to the bottom.

Oil and Water Emulsions
Most of the emulsions contain water as one of the two liquids. For this reason, emulsions are classified into two categories: (1) oil-in-water and (2) water-in-oil. **Oil-in-water** emulsions mean water is the main liquid and an oil liquid is being mixed into the water. **Water-in-oil** emulsions mean that oil is the main liquid with water being mixed into the oil.



Check it out
The image on the left shows how oil and water interact with each other. The O/W beaker shows the oil-in-water type of emulsion and the W/O beaker shows the water-in-oil mixture.

1. What would happen to the O/W beaker if we left it for awhile? Which liquid would rise?

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2. What would happen to the W/O beaker? Which liquid would rise?

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True or False — Circle whether the statement is true or false

1. An emulsion is a homogeneous mixture where two liquids dissolve evenly	True	False
2. An emulsion is a mixture where two liquids do not mix completely	True	False
3. The two main liquids in an emulsion are water and oil	True	False
4. The liquid with a higher density in an emulsion will rise to the top	True	False
5. An emulsion is a mixture of a liquid and tiny particles of a solid	True	False

Question — Use information from the text to support your answer

What is an emulsion? Provide an example of one emulsion.

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Social Responsibility

Human production, use, and disposal of pure substances and mixtures have both benefits and costs. We use pure substances and mixtures in everything we do. Some mixtures contain pure substances that are harmful to people and the environment, such as cadmium and mercury. Some pure substances are beneficial but are also potentially dangerous. Substances don't usually occur in their pure form in nature, so in order to obtain pure substances, people must refine raw materials. Some examples of pure substances are gold, aluminum, uranium and sugar.

People have also created new and innovative materials that help make our lives easier such as plastic and compact fluorescent light bulbs. Many of the manufacturing processes and products we use have environmental impacts.

Maple Syrup Manufacturing.

Maple syrup is made by heating the sap from maple trees to evaporate the water content out of the sap leaving the sweet syrup behind. 40 litres of sap are reduced to make just one litre of maple syrup. This process is traditionally done in small sugar shacks which use wood burning stoves to heat the maple sap. This produces a lot of carbon emissions into the air.

Carbon Dioxide

Carbon Dioxide is a by product of burning wood, paper and sugar. Carbon Dioxide is a green house gas that forms a layer around the earth that traps heat from the earth's surface. This is necessary for life on earth but because the layer of greenhouse gases is getting thicker the temperature on earth is rising causing melting of polar ice caps and glaciers. This is also called global warming.

Mining

Mining for gold is often done in open pit mines. When it rains ground water runs over the ground that has been disturbed by the digging activity. The ground water picks up elements such as mercury, cadmium and lead and carries it over fields were crops are grown and into lakes and rivers. Plants and marine life absorb these poisonous elements and when people eat the fish and plants they also ingest these poisonous elements.

Manufacturing Plastics

Plastics are made from fossil fuels which are extracted from the earth by drilling or fracking. The fossil fuel is transported for manufacture. Most plastic is used for single use packaging which ends up in the landfill, being incinerated or as litter both on land and in the water. Plastics cause green house gas emissions through extraction, transportation, manufacture and disposal. As we create new materials and solutions we need to be aware of the impact on our planet that these solutions will have.

<u>Nuclear Energy</u>

Uranium is the fuel source most commonly used in generating electricity from nuclear power. Uranium is not burned, so there is no release of air pollution. However, waste uranium material from nuclear power generation remains dangerously radioactive for a very long time. Spent nuclear fuel may be a hazard for at least 10,000 years. Given that an average nuclear power plant produces up to 30 tonnes of waste fuel per year, the safe disposal of nuclear fuel is a very large problem.