

Chemistry - Mixtures & Solutions

Grade 7 Science

What is a Chemical?

Chemical Facts

- All things that have mass are made up of **chemicals**.
- Chemicals are classified as either **elements** or **compounds**.
- **Elements** are substances made up of only one kind of atom. That is, the substance is **pure**. Today, 118 elements are known and listed on the periodic table.
- **Compounds** are substances made up of a combination of **two or more elements**.

Particle Theory of Matter

- All matter is made up of tiny particles (atoms and molecules)
- These particles are always moving
- There are spaces between the particles
- There are attractive forces between the particles (strongest in solids, weaker in liquids and almost none at all in gases)
- Particles of one substance are different from other substances

What is a Mixture?

Homogeneous and Heterogeneous

- **Mixture** - a sample of matter that contains two or more substances.
- **Homogeneous mixture** a mixture in which the parts appear to be the same throughout. Ex. Salt & water, vegetable oil, clean air.
- **Heterogeneous mixture** - a mixture that is made up of two or more parts. Usually, the parts are visible to the eye. Ex. concrete, sand on the beach, smog filled air

What is a Pure Substance?

- **Pure Substance** - is matter that is the same throughout. Ex. Calcium Carbonate, copper, pure water, table salt
- Each pure substance has its own kind of particle. This kind of particle is different from the kinds of particles that make up all other pure substances.



Pure Substances vs Mixtures

- If you have two clear liquids, one of them is pure water the other is a mixture of salt and water. How can you tell them apart?
- It would be impossible by just looking at them

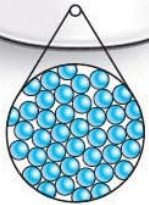
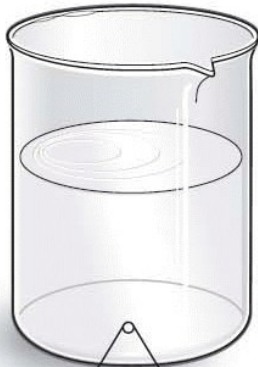


Pure Substances vs Mixtures

- To tell the two liquids apart, you would have to observe more of their properties. For example, you could measure their boiling points
- Pure water boils at 100°C and salt water boils at 103°C .
- Pure salt has a boiling point of 1465°C and when it is added to water, it affects the properties of water.

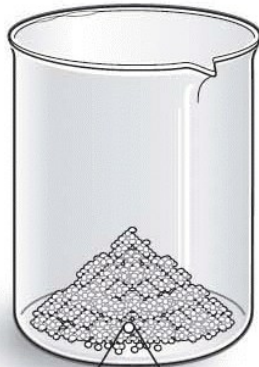
Pure Substances

Pure Substance



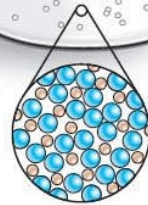
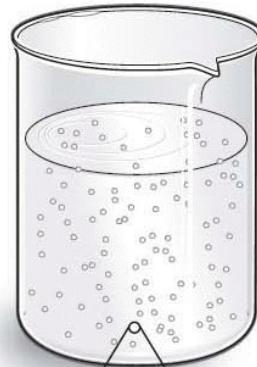
models of
water particles

Pure Substance



models of
salt particles

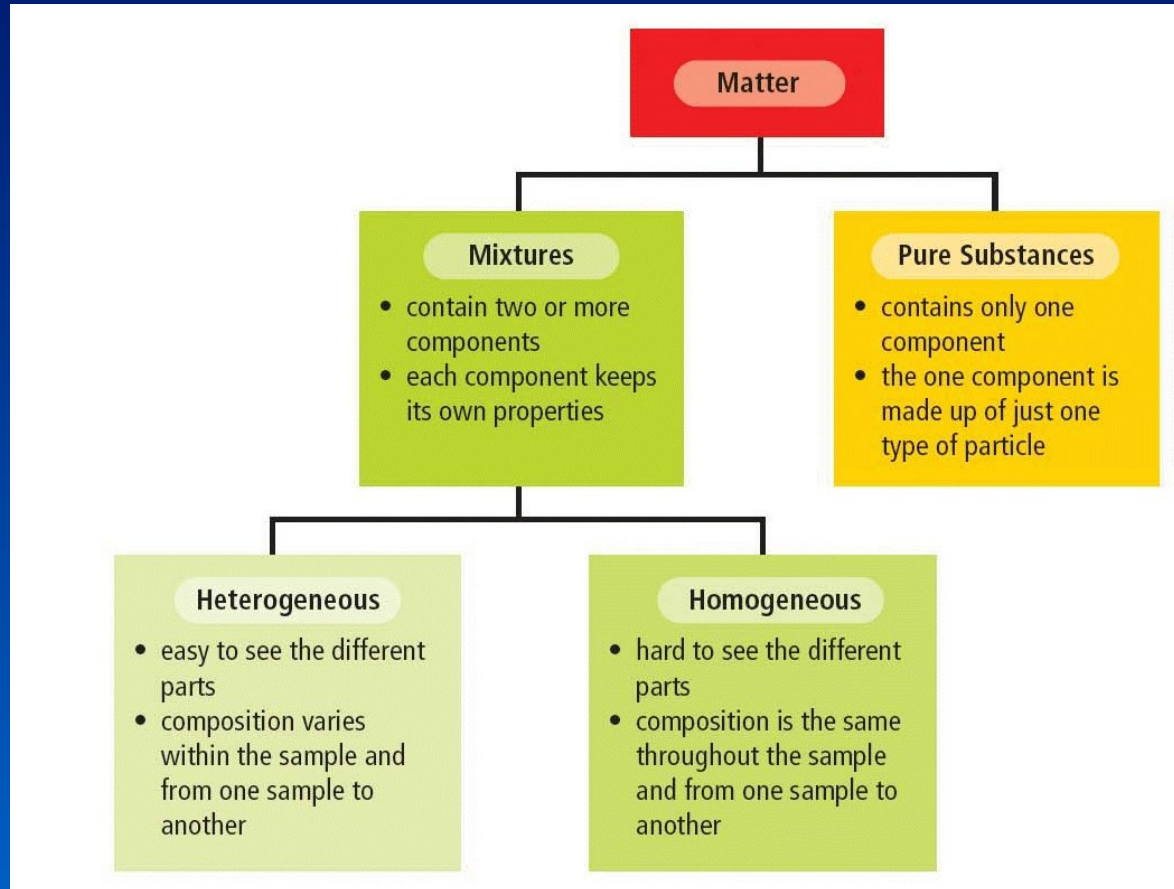
Mixture



models of water particles
and salt particles

Figure 7.7 Pure substances have only one type of particle, while mixtures have two or more types of particles.

Classifying Mixtures



Classifying Mixtures

Mechanical Mixtures

- Mixtures that are obviously heterogeneous (you can easily see the different types of matter) are sometimes called mechanical mixtures.
- These mixtures are easy to separate by hand or by mechanical means such as filtering.
- Many foods are mechanical mixtures ex. Pizza, sandwich, salad

Classifying Mixtures

Solutions

- **Solution** - If a mixture is homogeneous (the same throughout), it is a solution ex. Vinegar, tap water, hydrogen peroxide
- **Alloys** - are solutions made from two or more metals. Ex. Brass is made from a mixture of copper and zinc



Gold Alloys



Figure 7.11 The pie graphs show the percentages of gold and other metals in different "gold" objects. Which of the objects shown here are pure substances? Which are homogeneous mixtures (solutions)?

Solution or Heterogeneous Mixture?

How Can You Tell?

- **Use a microscope**. If the mixture is a solution, you will be able to see only one type of matter, even with a microscope.
- **Use a filter**. If anything is caught in the filter, then the mixture is definitely heterogeneous.
- **Use a light**. Solutions do not scatter light. A heterogeneous mixture such as muddy water or dusty air, however, does scatter light.

Combinations of Mixtures

Mixtures that are hard to classify.

Some mixtures such as Milk and Orange Juice are hard to classify as either homogeneous or heterogeneous.

Milk looks as if it is homogeneous. But under a microscope, you can see that milk contains “blobs.” or globules of fat. One drop of milk has about 100 000 000 fat globules.

Orange Juice tastes sweet so we can infer that sugar is dissolved, however, we can clearly see pieces of pulp.

In fact, milk and orange juice are a combination of mixtures, that is, they are homogeneous and heterogeneous at the same time.

Solutions

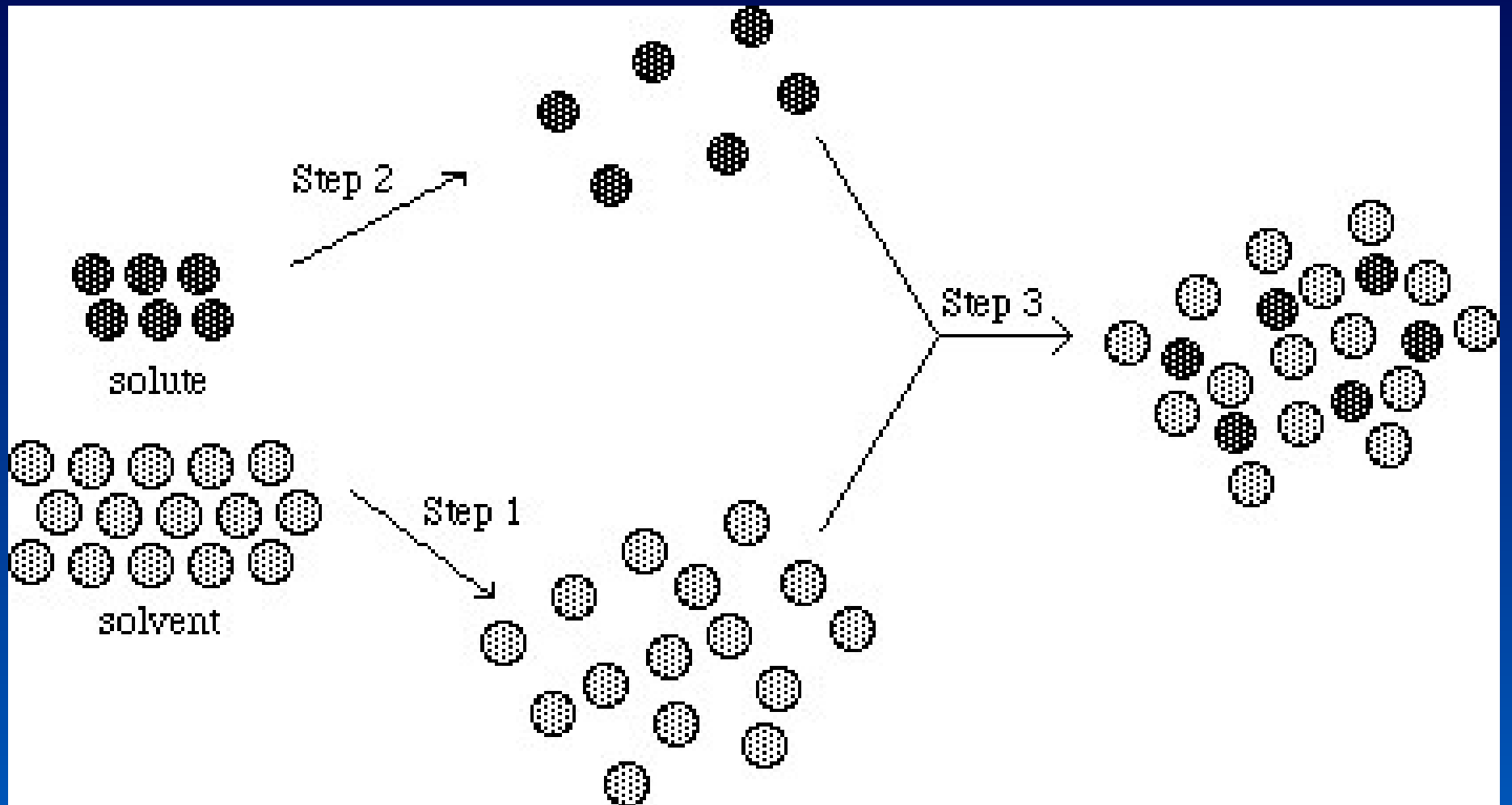
Solvents and Solutes

- Vocabulary
 - ▶ **Dissolve** - break down into smaller particles
 - ▶ **Solute** - the substance that is being dissolved when a solution is formed
 - Ex. In a Kool Aid drink, the Kool Aid crystals is the solute
 - ▶ **Solvent** - the medium in which a substance (the solute) is dissolved when a solution is formed
 - Ex. In a Kool Aid drink, the water is the solvent

Solutions

What is a Solution?

- **Solution** (in a liquid) - a mixture of one or more substances in a liquid that forms a **clear, transparent** liquid that may be colored or colorless.
- **Soluble** - a substance is said to be **soluble** when it can dissolve in a solvent to form a solution. The **opposite** of this is **insoluble**.
 - ▶ Sugar is soluble in water.
 - ▶ Flour is insoluble in water.



Solutes and Solvents

Why Some Substances Dissolve

- The particles of a substance stay together because they are attracted to each other.
- The sugar particles are also attracted to the water particles, so they mix with the water particles.
- A group of water particles can attract a sugar particle more strongly than the other sugar particles around it.

Solutes & Solvents

Why Some Substances Do Not Dissolve

- Using fat globules in milk and water as an example.
- For the particles of fat to dissolve in the water, they would have to be more attracted to the water particles than to the other particles of milk fat.
- But fat particles are not more attracted to the water particles. So the fat particles stay together and form insoluble globules in the liquid.

Solutions

Water

- Water is called the **UNIVERSAL SOLVENT**. This means that it dissolves almost everything to some degree.
- Harmful substances (like acid forming acid rain) as well as helpful ones can dissolve in water.

Concentrated or Dilute

- A **concentrated solution** has a larger amount of solute for a certain volume of solvent.
- A **dilute solution** has a smaller amount of solute for a certain volume of solvent.



Concentrated or Dilute

Concentration

- The quantity of solute that is dissolved in a certain quantity of solvent is the **concentration** of the solution.
- You can describe concentration **qualitatively** (with words) if you use the terms “concentrated” and “dilute.”
- You can also express concentration **quantitatively** (with numbers).

Concentrated or Dilute

Concentration

- One of the most common ways to show concentration is in units of **grams per litres (g/L)**.
- This tells you the mass of solute that is dissolved in 1 L of solution.
- Concentration can only go so high since the solvent can only hold a certain amount of solute.

Concentrated or Dilute

Saturated and Unsaturated Solutions

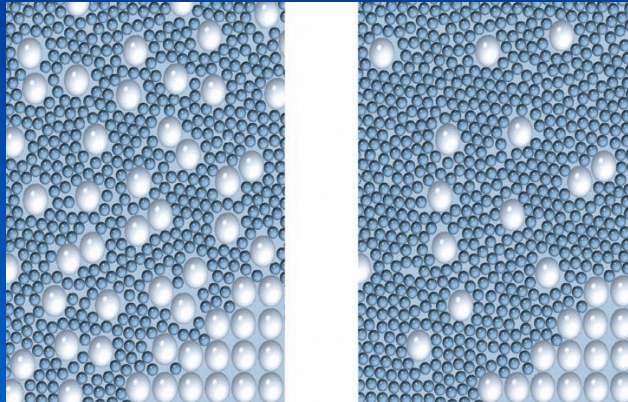
- A **saturated solution** forms when no more solute will dissolve in a specific amount of solvent at a certain temperature.
- An **unsaturated solution** is a solution that is not yet saturated. Thus, more solute can dissolve in it.

Solubility

- **Solubility** refers to how much of a solute that can dissolve in a certain amount of solvent at a certain temperature.
- In other words, only so much solute can dissolve in a certain amount of solvent before it becomes saturated. For example, 357 g of salt will dissolve in 1 L of water at 0 °C, therefore, the solubility of salt in water at 0 °C is 357 g/L.

Rate of Dissolving

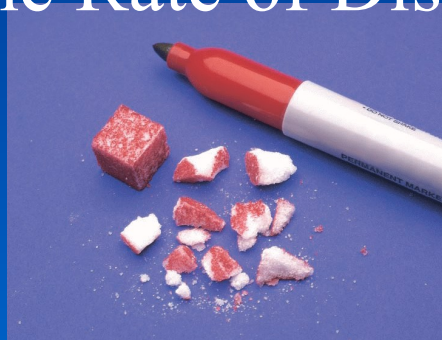
- The speed at which a solute dissolves in a solvent is called its **Rate of Dissolving**.
- There are many factors that affect the Rate of Dissolving.



Rate of Dissolving

Size of Solute

- The smaller the pieces of solute the faster it will dissolve.
- Dissolving occurs at the surface of the solute.
- By having the solute in smaller pieces, there are more surfaces for the dissolving to take place, therefore, the Rate of Dissolving is increased.



Rate of Dissolving

Temperature

- As the temperature increases, you are creating more space between the molecules of solvent, therefore creating more room for the solute to fit into.
- You are also increasing the movement of the solvent by making convection currents move faster. This causes more solvent to pass over the surface of the solute more often, picking up more solute molecules.

Pressure & Solubility of Gases

- Gases are more soluble in liquids when the pressure is higher
- The higher pressure forces more gas particles between the spaces of the water (solvent).
- In a pop bottle, the carbon dioxide that makes it “fizzy” stays in solution because it is under pressure.
- As soon as you remove the cap, you release the pressure, the carbon dioxide becomes less soluble and begins to escape.

Pressure & Solubility of Gases

The Bends

- When a diver goes under water, the pressure on the body increases because of the weight of the water.
- This forces more nitrogen gas to dissolve into the blood
- If the pressure on the body is released too suddenly by the diver coming to the surface too fast, then nitrogen bubbles will form in the blood, just like bubbles in a pop bottle.

Pressure & Solubility of Gases

The Bends

- This condition is called “the bends”. It can be very painful and if severe enough can cause death
- To avoid this, the diver must come to the surface slowly to let the nitrogen come out of the blood gradually without forming bubbles.

Separating Mixtures & Solutions

- Separating mixtures happens all the time.
- Anytime you sort a collection of coins into pennies, nickels, dimes and quarters, you are separating a mixture.
- A colander separates spaghetti and the water it was boiled in

Separating Mixtures & Solutions

Separating Heterogeneous Mixtures

- In some heterogeneous mixtures, the particles are so large they can be separated by hand.
 - ▶ **Example: separating Smarties into groups of colors**
- Other heterogeneous mixtures have particles so small, that it would be next to impossible to separate by hand
 - ▶ **Example: Beach sand and iron filings. We could use a magnet to remove the iron in this case.**

Separating Mixtures & Solutions

Mechanical Sorting

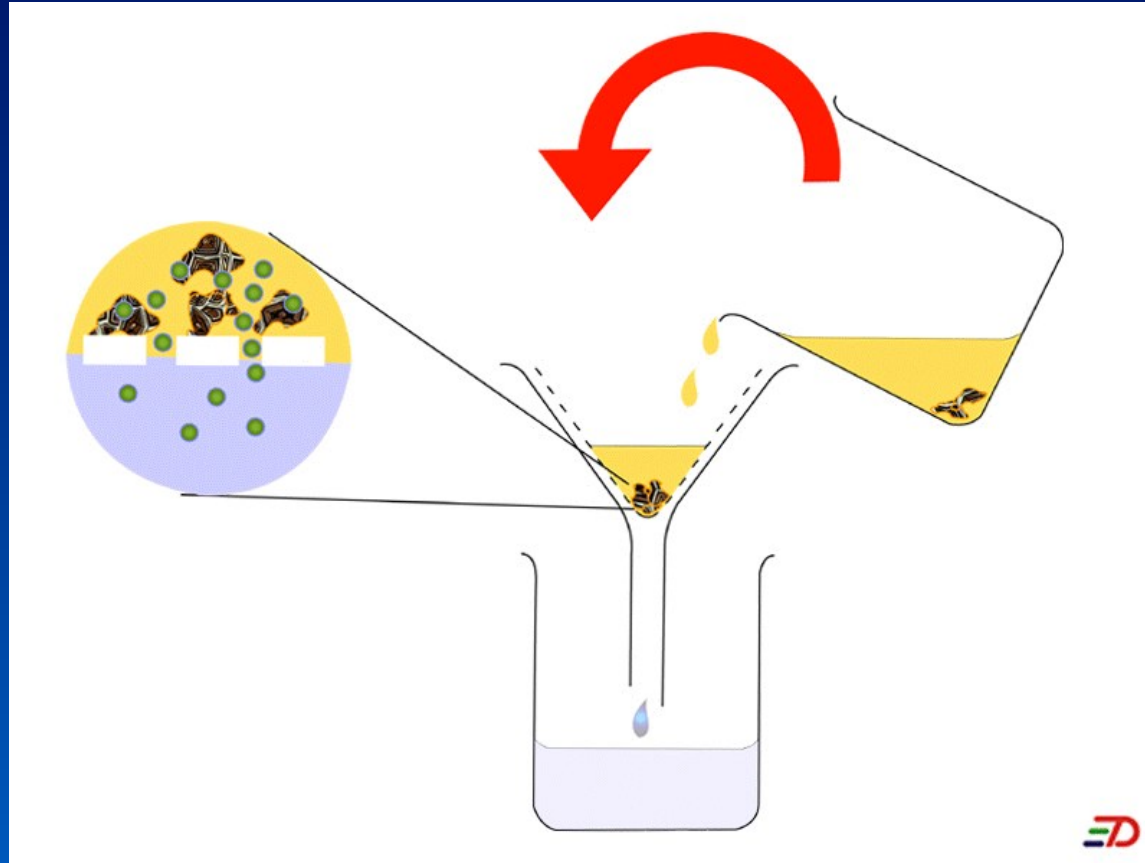
- **Mechanical Sorting** is when the components of a mixture are separated using such properties as particle size, magnetism, flotation, etc.
- In flotation, we separate based on one of the components being able to float in water and the other component sinks.
 - ▶ **Example:** The fat in soup will float to the top when boiled. When it is cooled, the fat will harden on the top and can be skimmed off.

Separating Mixtures & Solutions

Filtration

- **Filtration** is a very common method of separating solids from liquids. It does not work for solutions.
- Filtration works like mechanical sorting, because it depends on the size of the particles in a mixture.
- When a liquid is poured through a filter, in order to separate, the solid particles have to be larger than the holes in the filter. If this is true, the solid particles are trapped in the filter and the liquid passes through.
 - ▶ **Example: Oil filter in a car separates harmful metal & dirt particles from the liquid oil. This protects the engine.**

Filtration



Separating Mixtures & Solutions

Separating Homogeneous Mixtures

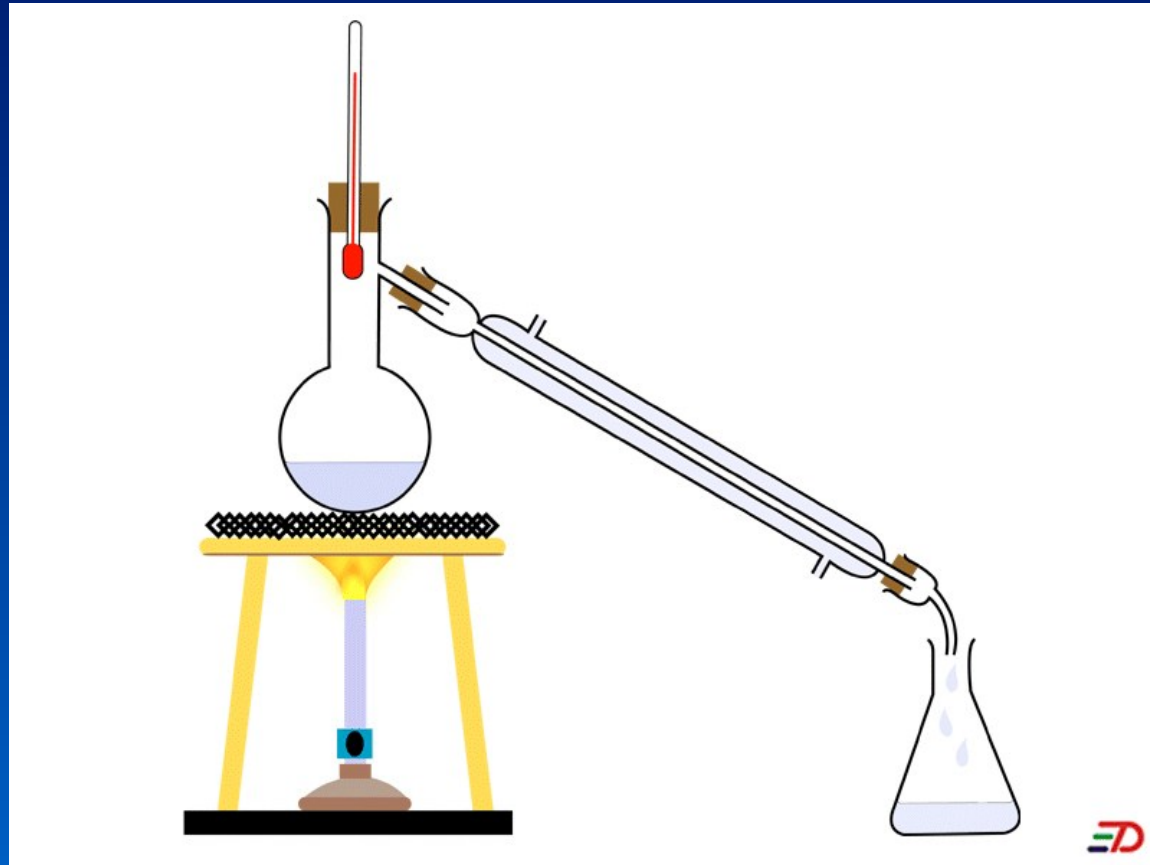
- **Evaporation** -as the liquid solvent evaporates the solute that is dissolved in it will be left behind.
- Sometimes evaporation is used to make a solution thicker. For example, maple syrup is made thicker by evaporating just some of the water (solvent).

Separating Mixtures & Solutions

Simple Distillation

- **Simple Distillation** is a method of separating ONE solvent from ONE solute.
- The solution is heated until the liquid solvent changes state into a gas. It passes through a tube which cools it and therefore condenses it back into a liquid. The solute stays behind in the original container.

Simple Distillation

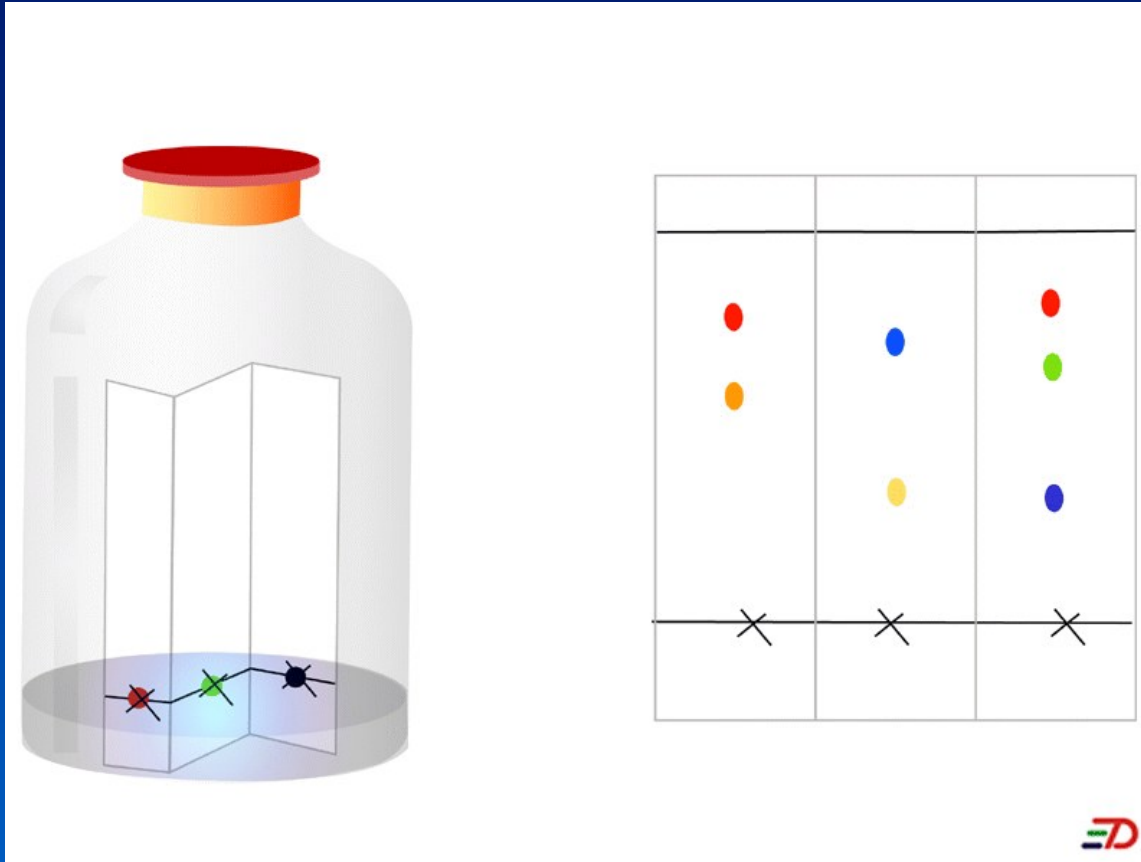


Separating Mixtures & Solutions

Paper Chromatography

- **Paper Chromatography** is often used to separate the coloured substances in a mixture such as ink. It works by seeing how fast a dissolved substance is carried by a solvent through a material, such as filter paper, that absorbs the solutes.
- Chromatography is often used by doctors or law enforcement to see what might be dissolved in a victim's blood.

Paper Chromatography



Separating Mixtures & Solutions

Fractional Distillation

- When there are more than two substances to separate, simple distillation is not a good way to do it.
- Petroleum (crude oil) is a mixture that is made up of many solid, liquid, and gas substances. Valuable substances in petroleum can be separated by **fractional distillation**, which is based on their boiling points.

Separating Mixtures & Solutions

Fractional Distillation

- Fractional distillation is a process that uses the boiling points of substances to separate a complex mixture into its parts.
- Petroleum is a much more complex mixture than salt water.
- Petroleum contains hundreds of different substances. Each of these substances has its own boiling point. This is the key to separating petroleum into its parts.

Separating Mixtures & Solutions

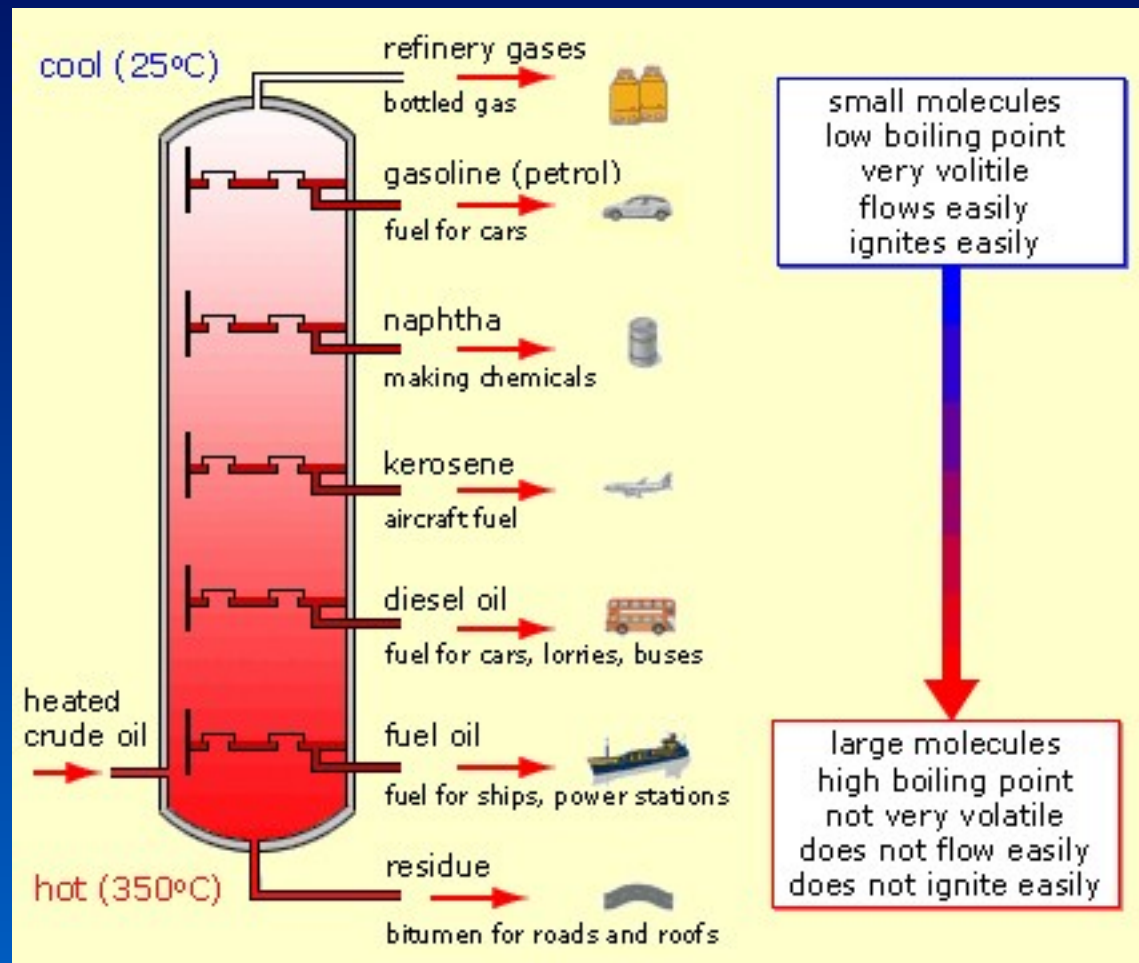
Fractional Distillation

- Crude Oil is heated in one tower and then the gases pass up another tower to cool.
- The heavier substances cool more quickly and therefore change back to a liquid faster than the lighter components.
- The second tower has collection points at different stages. As a particular component cools into a liquid, it is collected at the appropriate stage.

Fractional Distillation Towers



Fractional Distillation



Separating Mixtures & Solutions

Panning

- An **ore** is a rock mixture that contains one or more valuable substances. An example is iron ore -a rock that contains iron.
- Panning is a method used to separate a solid mixture. It is used when prospecting for gold. It works because gold is far denser than sand or gravel.
- A prospector will take up an amount of sand, gravel & water from a river. By swirling it around, the sand and gravel are washed away and the denser gold stays in the bottom of the pan (if they're lucky).