Name:..... Class:.....

ELEMENTS, COMPOUNDS & MIXTURES

Domain: 5.7
relates properties of elements, compounds and mixtures to scientific models, theories and laws

What is an Element?

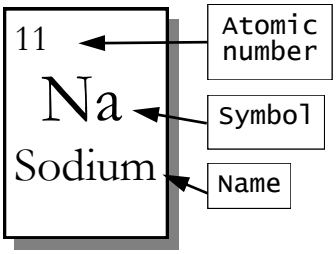
An element is a ***simple*** pure substance which cannot be made simpler using chemical means. A pure substance is a form of matter that has the same ***composition*** throughout. Elements are the building blocks of matter. Everything around us is made up of an element or elements.

All the known elements are listed in a special table called the ***Periodic Table***. There are 115 known elements. 92 of these elements occur ***naturally***. Of the 92 naturally occurring elements there are:

* **11 gases (hydrogen, oxygen, nitrogen, fluorine, chlorine, helium, neon, argon, krypton, xenon & radon);**
* **2 liquids (mercury and bromine);**
* **79 solids (mostly metals).**

Note: the elements are in these states at room temperature (25°C).

Each element in the table is denoted by a ***symbol***. The symbol for sodium is shown.



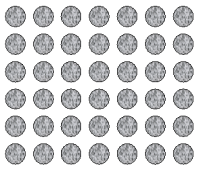
You will need to learn some of the symbols given on the Periodic Table.

An element is made up ***atoms*** joined together. The atoms are all the same for a particular element. For example, copper is made up of copper atoms, iron is made up of iron atoms etc.

Some important facts about elements include:

- The most common element on Earth is oxygen (about 50%);
- The least common naturally occurring element is Astatine;
- The most recently discovered element was Ununoctium - it was produced artificially.
- Scientists believe that all matter in the universe is composed of the same elements that are present on Earth.

An element is made up of atoms which are all the same:



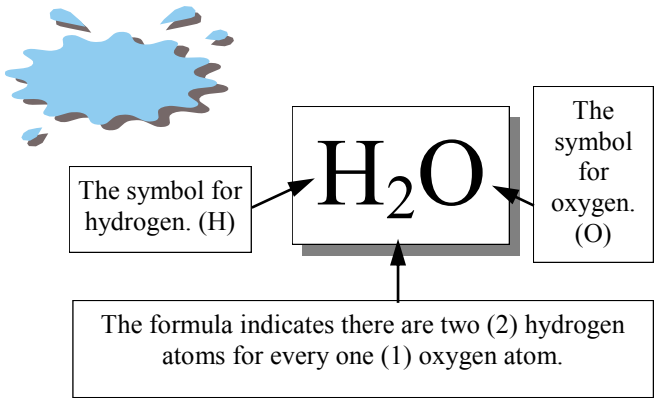
What is a Compound?

A compound is a pure substance that consists of ***atoms of two or more elements*** joined together. Compounds are formed when atoms of different elements ***react*** together. Compounds can be decomposed into elements using chemical means. Most pure substances are compounds.

Compounds have a ***chemical formula***. The chemical formula is made up from the symbols of the elements in the compound. It also indicates the ***number*** of atoms of each element in the compound. An example of a very important compound is ***water***. Water is made up of two elements- hydrogen and oxygen. The chemical formula for water is shown.

Other important compounds are:

Compound:	Formula:
sodium chloride (common salt used for cooking)	NaCl
carbon dioxide (a gas found in the atmosphere)	CO_2
sucrose (common sugar)	$C_{12}H_{22}O_{11}$



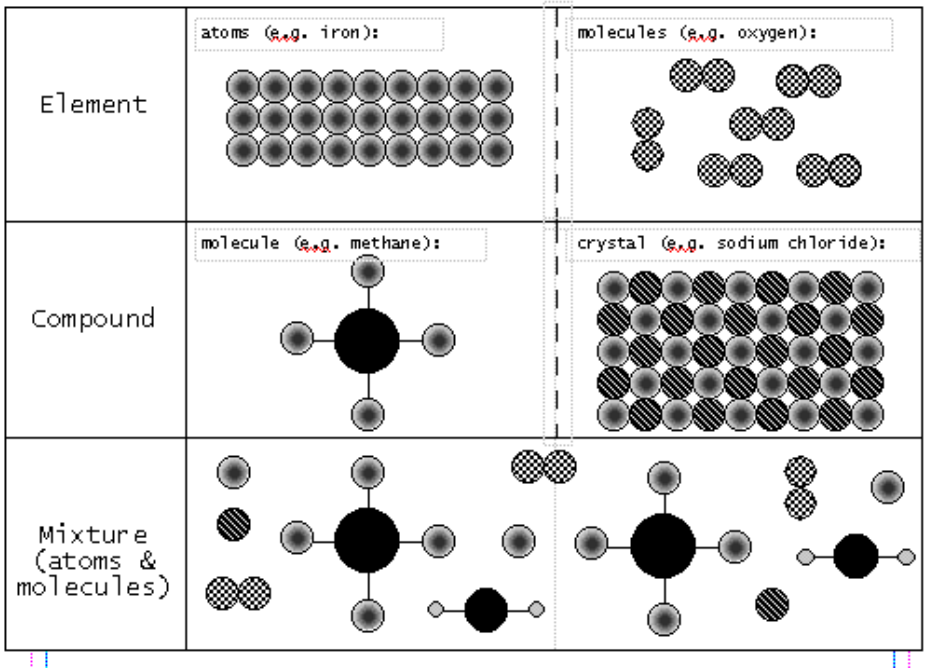
The elements which react together to form a compound have different ***properties*** to the compound formed. For example, sodium (a very reactive metal) can combine chemically with chlorine (a poisonous gas) to form sodium chloride, a chemically harmless white powder which we call salt.

What is a Mixture?

A mixture is made up of ***two or more*** pure substances. These substances are not joined ***chemically*** and can be separated without using chemical means. Mixtures are said to be ***impure***.

An example of a mixture is ***air***. It is made up of nitrogen, oxygen and other gases. These gases are not chemically combined.

Mixtures can be separated into the substances which make up the mixture. Methods of separating mixtures include filtration, distillation and chromatography.

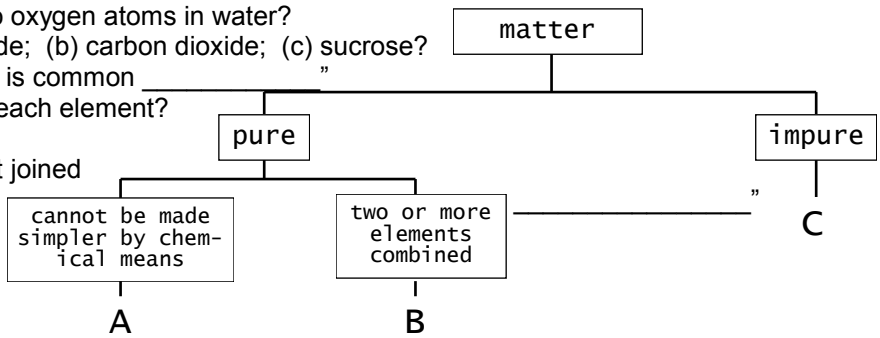


What is a Molecule?

Atoms can be bound together as a ***molecule***. Elements can be in the form of molecules. For example, oxygen consists of molecules which are two oxygen atoms bound together (O_2). Compounds can also be in the form of molecules. An example of a molecule which is a compound is carbon dioxide (CO_2). Water is also a compound which consists of molecules. Compounds can also have a crystalline structure. For example, sodium chloride (table salt) is crystalline when not dissolved in water.

Questions:

1. What is an element?
2. What is a pure substance?
3. Complete the sentence: "elements are the building blocks of _____"
4. Complete the sentence: " the known elements are listed in the _____ _____"
5. How many known elements are there?
6. What are the elements made up of?
7. What is the most common element on Earth?
8. What is a compound?
9. How are compounds formed?
10. Complete the sentence: " most pure substances are _____".
11. What does a chemical formula show?
12. (a) What is the chemical formula for water? (b) What elements are in water?
    (c) What is the ratio of hydrogen atoms to oxygen atoms in water?
13. What is the formula for: (a) sodium chloride; (b) carbon dioxide; (c) sucrose?
14. Complete the sentence: "sodium chloride is common _____"
15. In sucrose, what is the ratio of atoms for each element?
16. What is a mixture made up of?
17. Complete the sentence: "mixtures are not joined _____ and can be _____"
18. (a) What is a molecule?
    (b) Name an element which exists as a molecule.
    (b) Name a compound which exists as



Name:..... Class:.....

ELEMENTS, COMPOUNDS & MIXTURES

Domain: 4.7
describes observed properties of substances using scientific models and theories

20. On your Periodic Table:
* colour in the elements which are gases;
* colour in the elements which are liquids.
Include a suitable key e.g.

21. Complete the following table by finding the information on your Periodic Table:

Element	Atomic Number	Symbol	State (s,l or g)	Element	Atomic Number	Symbol	State (s,l or g)
Hydrogen	1			Argon	18		
Helium	2			Potassium	19		
Lithium	3			Calcium	20		
Beryllium	4			Iron	26		
Boron	5			Copper	29		
Carbon	6			Zinc	30		
Nitrogen	7			Bromine	35		
Oxygen	8			Silver	47		
Fluorine	9			Tin	50		
Neon	10			Iodine	53		
Sodium	11			Barium	56		
Magnesium	12			Platinum	78		
Aluminium	13			Gold	79		
Silicon	14			Mercury	80		
Phosphorus	15			Lead	82		
Sulfur	16			Uranium	92		
Chlorine	17						

Name:..... Class:.....

ELEMENTS, COMPOUNDS & MIXTURES

Domain: 4.7
describes observed properties of substances using scientific models and theories

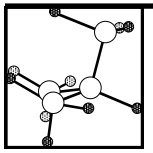
20. On your Periodic Table:
* colour in the elements which are gases;
* colour in the elements which are liquids.
Include a suitable key e.g.

Solid Liquid Gas

21. Complete the following table by finding the information on your Periodic Table:

Element	Atomic Number	Symbol	State (s,l or g)	Element	Atomic Number	Symbol	State (s,l or g)
Hydrogen	1	H	g	Argon	18	Ar	g
Helium	2	He	g	Potassium	19	K	s
Lithium	3	Li	s	Calcium	20	Ca	s
Beryllium	4	Be	s	Iron	26	Fe	s
Boron	5	B	s	Copper	29	Cu	s
Carbon	6	C	s	Zinc	30	Zn	s
Nitrogen	7	N	g	Bromine	35	Br	l
Oxygen	8	O	g	Silver	47	Ag	s
Fluorine	9	F	g	Tin	50	Sn	s
Neon	10	Ne	g	Iodine	53	I	s
Sodium	11	Na	s	Barium	56	Ba	s
Magnesium	12	Mg	s	Platinum	78	Pt	s
Aluminium	13	Al	s	Gold	79	Au	s
Silicon	14	Si	s	Mercury	80	Hg	l
Phosphorus	15	P	s	Lead	82	Pb	s
Sulfur	16	S	s	Uranium	92	U	s
Chlorine	17	Cl	g				

Name:..... Class:.....



3
Li
6.941
Lithium

- Atomic number (Z)
- Symbol
- Relative atomic mass
- Name of element

1
H
1.008
Hydrogen

- There are 92 naturally occurring elements
- At room temperature and pressure:
  - → 2 are liquids (Hg and Br)
  - → 11 are gases (H,N,O,F,Cl,He,Ne,Ar,Kr,Xe,Rn)
  - → the rest are solids

Periodic Table 2006

Metals:
Left side of step.
Non-metals:
Right side of step.

																	2 **He** 4.0003 Helium
3 **Li** 6.941 Lithium	4 **Be** 9.012 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 22.99 Sodium	12 **Mg** 24.31 Magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.97 Phosphorus	16 **S** 32.06 Sulfur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.90 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.71 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.38 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 72.59 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 98.91 Technetium	44 **Ru** 101.1 Ruthenium	45 **Rh** 102.9 Rhodium	46 **Pd** 106.4 Palladium	47 **Ag** 107.9 Silver	48 **Cd** 112.4 Cadmium	49 **In** 114.8 Indium	50 **Sn** 118.7 Tin	51 **Sb** 121.8 Antimony	52 **Te** 127.6 Tellurium	53 **I** 126.9 Iodine	54 **Xe** 131.3 Xenon
55 **Cs** 132.9 Caesium	56 **Ba** 137.3 Barium	57-71 Lanthanides	72 **Hf** 178.5 Hafnium	73 **Ta** 180.9 Tantalum	74 **W** 183.9 Tungsten	75 **Re** 186.2 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.2 Iridium	78 **Pt** 195.1 Platinum	79 **Au** 197.0 Gold	80 **Hg** 200.6 Mercury	81 **Tl** 204.4 Thallium	82 **Pb** 207.2 Lead	83 **Bi** 209.0 Bismuth	84 **Po** (210) Polonium	85 **At** (210) Astatine	86 **Rn** (222) Radon
87 **Fr** (223) Francium	88 **Ra** 226.0 Radium	89-103 Actinides	104 **Rf** (261.1) Rutherfordium	105 **Db** (262.1) Dubnium	106 **Sg** (263.1) Seaborgium	107 **Bh** (264.1) Bohrium	108 **Hs** (265.1) Hassium	109 **Mt** (268) Meitnerium	110 **Uu** (269) Ununnilium	111 **Uu** (272) Unununium	112 **Uu** (277) Ununbium	Not found	114 **Uu** (289) Ununquadium	Not found	116 **Uu** (289) Ununhexium	Not found	118 (293) **Uuo** Ununoctium

57 **La** 138.9 Lanthanum	58 **Ce** 140.1 Cerium	59 **Pr** 140.9 Praseodymium	60 **Nd** 144.2 Neodymium	61 **Pm** (145) Promethium	62 **Sm** 150.4 Samarium	63 **Eu** 152.0 Europium	64 **Gd** 157.3 Gadolinium	65 **Tb** 158.9 Terbium	66 **Dy** 162.5 Dysprosium	67 **Ho** 164.9 Holmium	68 **Er** 167.3 Erbium	69 **Tm** 168.9 Thulium	70 **Yb** 173.0 Ytterbium	71 **Lu** 175.0 Lutetium
89 **Ac** 227.0 Actinium	90 **Th** 232.0 Thorium	91 **Pa** 231.0 Protactinium	92 **U** 238.0 Uranium	93 **Np** 237.0 Neptunium	94 **Pu** (239.1) Plutonium	95 **Am** (241.1) Americium	96 **Cm** (244.1) Curium	97 **Bk** (249.1) Berkelium	98 **Cf** (252.1) Californium	99 **Es** (252.1) Einsteinium	100 **Fm** (257.1) Fermium	101 **Md** (258.1) Mendelevium	102 **No** (259.1) Nobelium	103 **Lr** (262.1) Lawrencium

Name:..... Class:.....

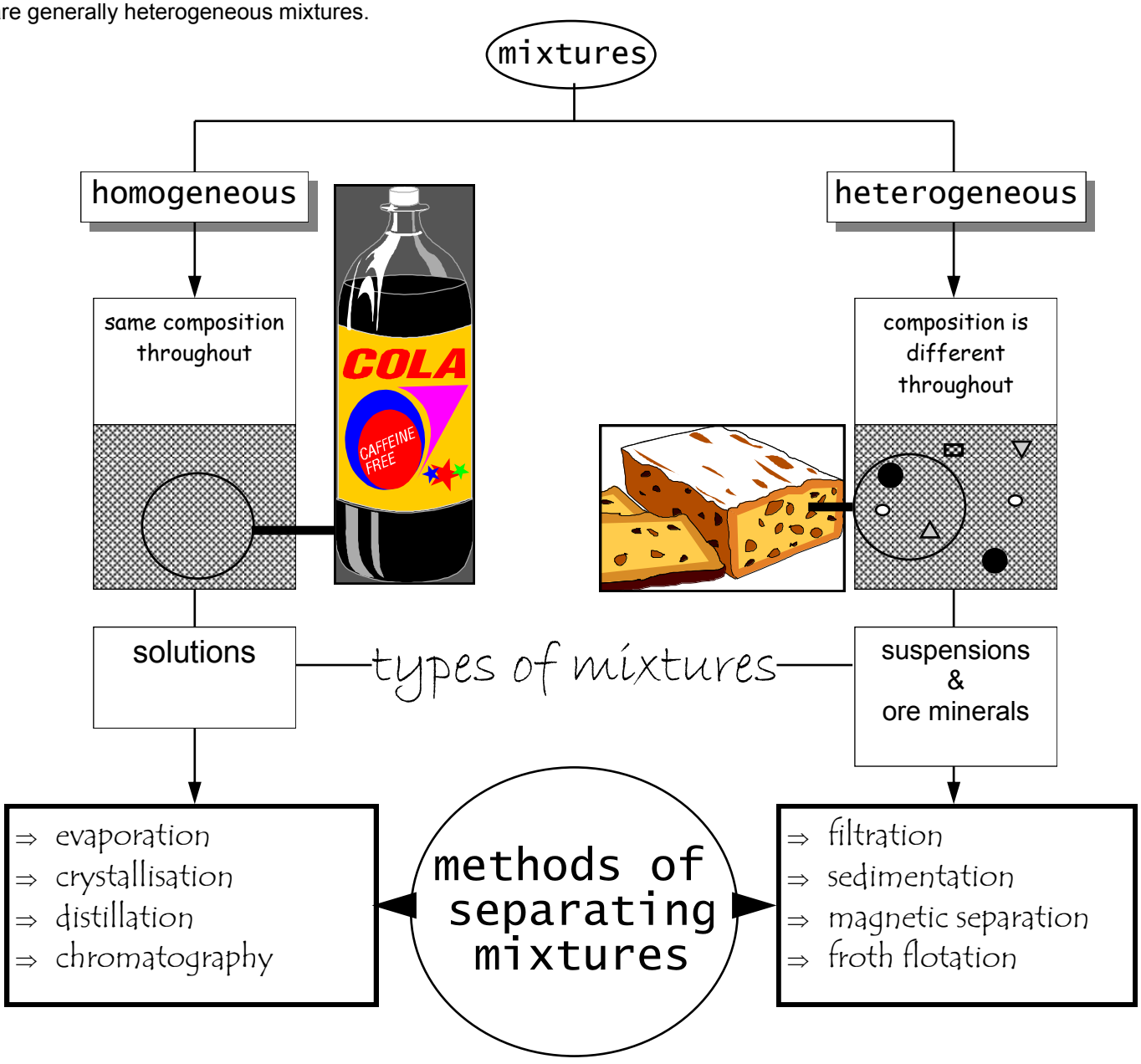
SEPARATING MIXTURES

Domain: 4.7
describes observed properties of substances using scientific models and theories

Types of Mixtures

Mixtures can be classified as ***homogenous*** or ***heterogenous***. A homogeneous mixture appears to be made up of a single state of matter and has the ***same composition throughout***. ***Solutions*** are said to be homogeneous.

Mixtures made up of two or more states of matter are heterogeneous mixtures. Heterogeneous mixtures can also consist of one state of matter which contains different materials. ***Suspensions*** and rocks containing ***useful minerals*** are generally heterogeneous mixtures.



What is a Solution? -

A solution is formed when one substance ***dissolves*** in another. The substance which is in the larger amount (the major component) is called the ***solvent***. The other substance (the minor component) is called the ***solute***. Generally, we will deal with solutions in which ***water*** is the solvent.

A substance which dissolves in another substance is said to be ***soluble***. A substance which does not dissolve is said to be ***insoluble***.

SEPARATING MIXTURES

Types of Solutions-

Type of Solution	Examples
solid dissolved in a liquid	* sugar dissolved in water
liquid dissolved in a liquid	* ethanol (an alcohol) dissolved in water
gas dissolved in a liquid	* carbon dioxide dissolved in water- as in soda water

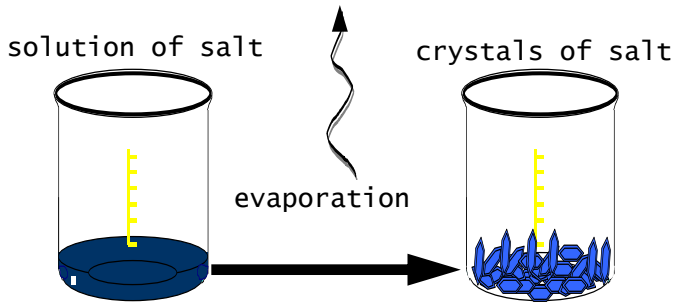
Three important processes used to separate the components of a solution are:

Evaporation & Crystallisation-

The process of evaporation leads to the separation from a solution of a solute in the form of crystals. Crystallisation is the process of growing crystals of a solid from a solution. Impure crystalline substances can be recrystallised to remove impurities.

Common table salt (sodium chloride) is crystallised from sea water by evaporation. It is purified by recrystallisation.

Crystallisation:



Distillation-

Distillation is the process whereby a liquid is purified by being turned into a vapour (gas) and then allowing the vapours to condense in another container. Distillation is used for separating:

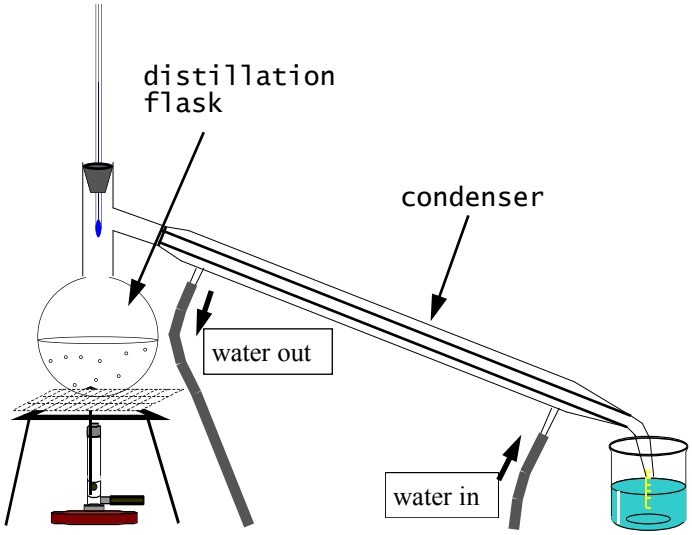
* two or more liquids mixed together;
* dissolved solids from liquids.

For example, a mixture of water and alcohol could be separated using this method.

Also the salt in saltwater could be separated from the water using this method.

In distillation, the mixture is heated until the liquid(s) start to boil and turn into a gas. Every liquid boils at a different temperature. The condenser cools the gas down so that it forms a liquid again (condenses). The liquids can be collected as they boil at different temperatures.

Apparatus for distillation:

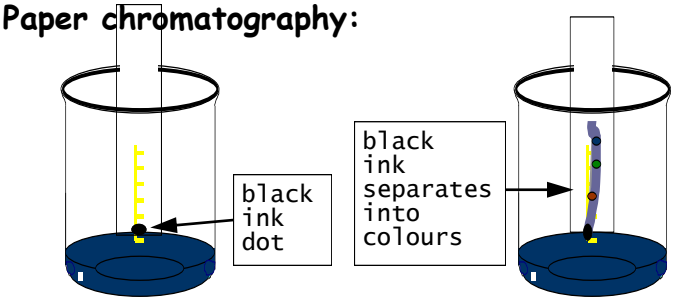


Chromatography-

Chromatography is a method which separates substances based on the rate at which a solvent will carry the substances across an adsorbing surface. A substance is adsorbed when it attaches to another material.

Paper chromatography can be used to separate a mixture of coloured substances. The colours in black ink can be separated using this method.

Paper chromatography:



Name:..... Class:.....

SEPARATING MIXTURES

Suspensions & Rocks Containing Minerals-

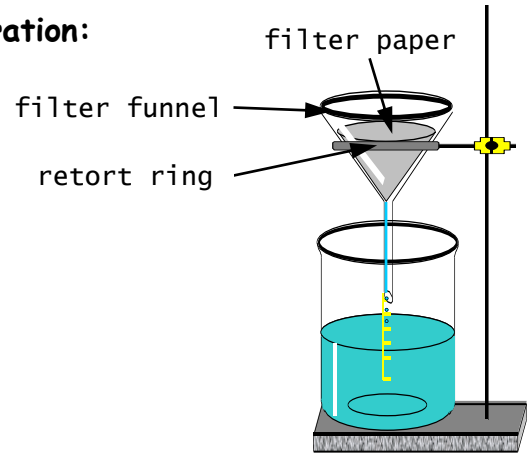
A ***suspension*** is a liquid containing an insoluble material suspended in it. The material is referred to as a ***sediment*** when it settles to the bottom of the container. Many minerals are used to manufacture ***metals***. These minerals are called ***ore*** minerals. They are mined from the ground and are usually found mixed with other minerals and rock material. The metal mineral must be ***extracted*** from the mixture. Three important separations processes are:

Filtration & Sedimentation-

Filtration is used to separate undissolved solids or suspended matter from a liquid. For example, if muddy water is filtered, the mud particles can be separated from the water. Filtration usually involves pouring the mixture through filter paper. The liquid which passes through the filter paper is called the filtrate. The solids collected in the filter paper is called the residue.

A suspension can also be allowed to stand so that the solid matter drops to the bottom of the container. This is referred to as sedimentation. The process of sedimentation can be accelerated by using a centrifuge. A centrifuge spins rapidly so that the sediments move towards the base of the container.

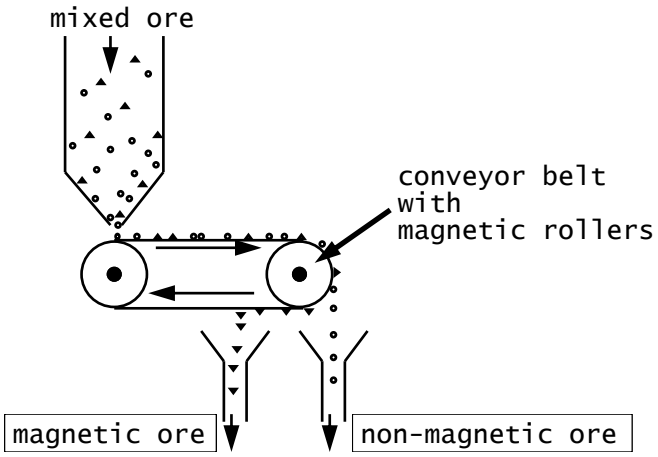
Filtration:



Magnetic separation-

In the separation of some ores use is made of the fact that one mineral will be more strongly attracted to a magnet than another. The ore is crushed and then dropped on to a conveyor belt. The rollers which turn the conveyor belt are magnetic. The non-magnetic minerals drop directly from the end of the conveyor belt into a chute. The magnetic minerals travel further being attracted to the roller. When the magnetic force is too weak to support the magnetic mineral, it drops into a second chute.

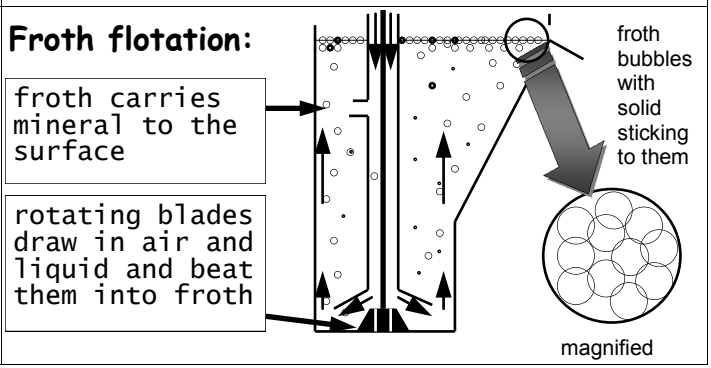
Magnetic separation:



Froth flotation-

This method is used extensively to separate minerals from useless rock material. The minerals are 'wetted' by a special oil. This oil helps the mineral grains adhere to the froth. In the froth flotation tank, air is bubbled through the water containing the minerals and detergent. The froth produced carries the light mineral to the surface. The froth carrying the mineral grains is collected from the top of the tank and undergoes further chemical treatment.

Froth flotation:



Importance of Separation

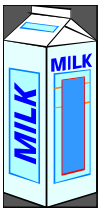
Materials we use either originate directly from the Earth's ground, oceans or atmosphere, or they are ***extracted*** or ***converted*** from other materials. These materials we use are called ***resources***.

The separation processes we have examined are used to convert resources or to extract more useful products from the resources. Other separation processes are used in chemical analysis and testing or reducing pollution and contamination. Some examples are given in the table below:

Separation Process	Examples of uses:
Evaporation & Crystallisation	⇒ Separation of salt from sea water. Salt is used in industry and to flavour food. ⇒ Extraction of raw sugar from sugar cane.
Distillation	⇒ Turning saltwater into freshwater. ⇒ Manufacturing wines & spirits. ⇒ Extracting oxygen from air (fractional distillation). ⇒ Separating crude oil into components such as petrol (fractional distillation). ⇒ Producing asphalt for roads. ⇒ Extracting oils from plants, e.g. eucalyptus oil.
Chromatography	⇒ Identifying components of pesticides in water. ⇒ Identifying components of hydrocarbons in oil. ⇒ Identifying components of drugs in blood samples. ⇒ Identifying components of gases in air or exhaust fumes.
Filtration	⇒ Purifying drinking water. ⇒ Cleaning water used in swimming pools. ⇒ Removing contaminants from fuel and oil. ⇒ Treating sewage in sewage plants.
Sedimentation	⇒ Removing suspended solids from sewage in a sedimentation tank.
Magnetic Separation	⇒ Extracting magnetic minerals from mineral (black) sands.
Froth Flotation	⇒ First step in extracting copper from its ore.

Questions:

1. What are the two classifications of mixtures?
2. (a) When is a solution formed? (b) What is the difference between the solute and solvent?
3. Give an example of the following solutions:
   (a) a solid dissolved in liquid; (b) a liquid dissolved in a liquid; (c) a gas dissolved in a liquid.
4. (a) What does evaporation lead to? (b) What is crystallisation?
5. (a) What is distillation? (b) What can distillation be used for? (c) What is the function of the distillation flask?
   (d) What is the function of the condenser?
6. (a) What is chromatography? (b) What does adsorb mean?
7. (a) What is a suspension? (b) What do ore minerals contain which is useful to humans?
8. (a) What is filtration? (b) What is the difference between the filtrate and residue? (c) What is sedimentation?
9. What type of minerals is magnetic separation useful for removing from a mixture?
10. (a) What is froth flotation used for? (b) Why are the minerals 'wetted' by oil?
    (c) Why do you think detergent is added to the water in the froth flotation process?
11. List one (1) use for each separation process examined.
12. (a) The milk you buy is homogenised. What does this mean? What type of mixture is it?
    (b) If milk is not refrigerated, what happens to it? What type of mixture is it now?



PHYSICAL & CHEMICAL CHANGES

Domain: 4.7
describes observed properties of substances using scientific models and theories

Physical & Chemical Changes

Matter is constantly undergoing ***change***. These changes are either:

Physical changes:	**Chemical changes:**
* no new substance is formed * only a small amount of energy is involved * it is easy to reverse	* new substances formed * generally involves large amounts of energy * more difficult to reverse
Examples: * melting ice * freezing water * melting butter * dissolving sugar	Examples: * burning wood * iron rusting * dynamite exploding * petrol burning

Recognising a chemical change:

1. Heat may be produced;
2. There may be a colour change;
3. A gas may be produced (bubbles may be seen);
4. The substance involved in the reaction dissolves.

ELEMENTS, COMPOUNDS & MIXTURES

Questions:

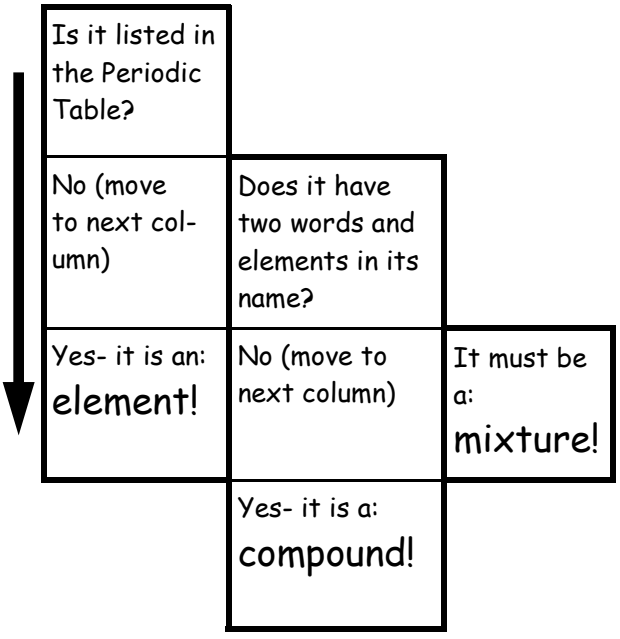
1. What is an element?
2. What is a pure substance?
3. Complete the sentence: "elements are the building blocks of _____"
4. Complete the sentence: " the known elements are listed in the _____ _____"
5. How many known elements are there?
6. On your Periodic Table:
   * colour in the elements which are gases; * colour in the elements which are liquids.
   Include a suitable key e.g.

Solid Liquid Gas

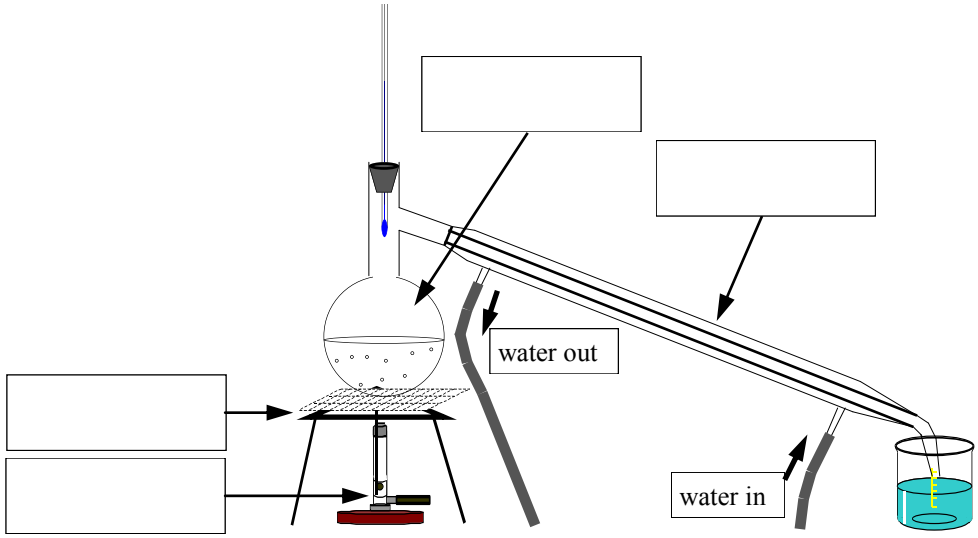
7. Draw up a table as shown. Use your Periodic Table to complete the table for the following elements:
   *** first twenty elements (1-20) plus:**
   iron, copper, zinc, bromine, silver, tin, barium, gold, mercury & lead

Element	Atomic number	State (solid, liquid or gas)	Symbol
30 lines ↓			

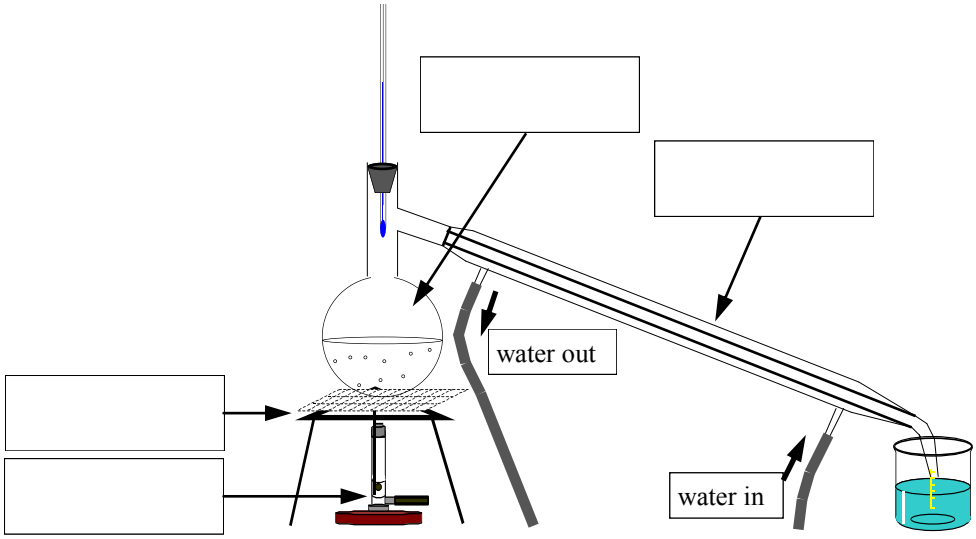
8. What are the elements made up of?
9. What is the most common element on Earth?
10. What is a compound?
11. How are compounds formed?
12. Complete the sentence: " most pure substances are _____".
13. What does a chemical formula show?
14. (a) What is the chemical formula for water?
    (b) What elements are in water?
    (c) What is the ratio of hydrogen atoms to oxygen atoms in water?
15. What is the formula for: (a) sodium chloride; (b) carbon dioxide; (c) sucrose?
16. Complete the sentence: "sodium chloride is common _____"
17. In sucrose, what is the ratio of atoms for each element?
18. What is a mixture made up of?
19. Complete the sentence: "mixtures are not joined _____ and can be _____"
20. What are three methods used to separate mixtures?
21. Which separation method could be used to separate:
    (a) the colours in black ink; (b) suspended matter in water; (c) salt from saltwater?
22. Classify the following as an element compound or mixture.
    *the diagram opposite may help;
    * draw up a table with the headings element, compound, mixture for your answers.
    iron, air, sodium chloride, saltwater, concrete, ice cream, aluminium, water, hydrogen, carbon dioxide, lemonade, sodium, lithium iodide, soup, nitrogen, iron sulfide
23. What are the two types of changes matter can undergo?
24. What are three differences between physical and chemical changes?
25. Classify the following as physical or chemical changes:
    (a) margarine melts; (b) water boils;
    (c) wax melts; (d) kerosene burns;
    (e) aluminium corrodes.



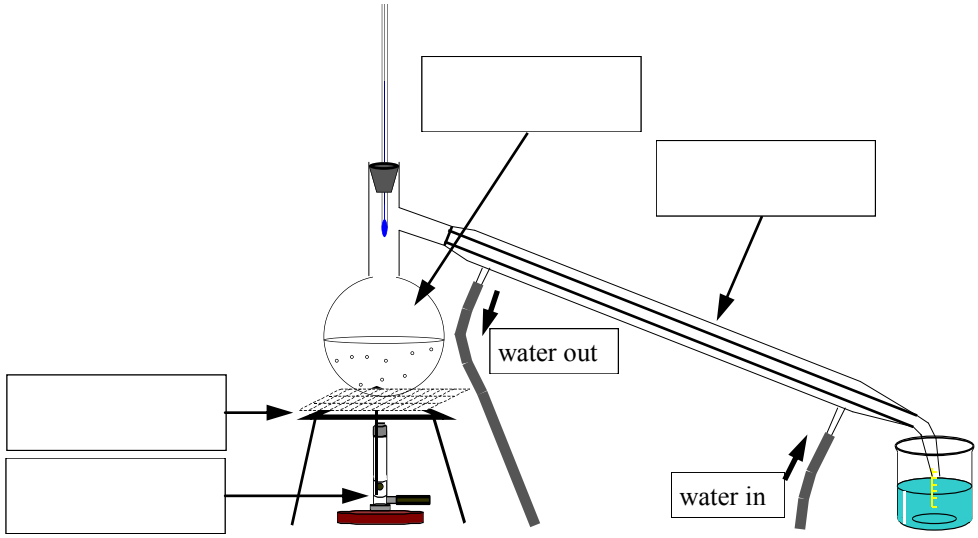
Apparatus for distillation:



Apparatus for distillation:



Apparatus for distillation:



Apparatus for distillation: