Gr8 Chemistry 2025

Term 2

Gr8 CHEMISTRY

Lesson 1: Topic 4 Unit 1 & 2 ATOMS (p71-78) *Revision of LOCKDOWN WORK*

Atoms: the smallest units that elements are made of.

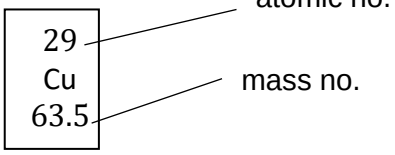
- They're very very small. Radius ~ 0.0000000001m (i.e. $1x10^{-10}$ in scientific notation)
- Imagine cutting a millimetre into 10 million pieces.

Elements – there are about 100 different types. These are listed on the Period Table which was largely created by the Russian chemist Dimitri Mendeleev over 100 years ago

(see table at back of textbook & page 2 of these notes)

What to notice about the Periodic Table (on p2)

- Study the key of Cu = copper

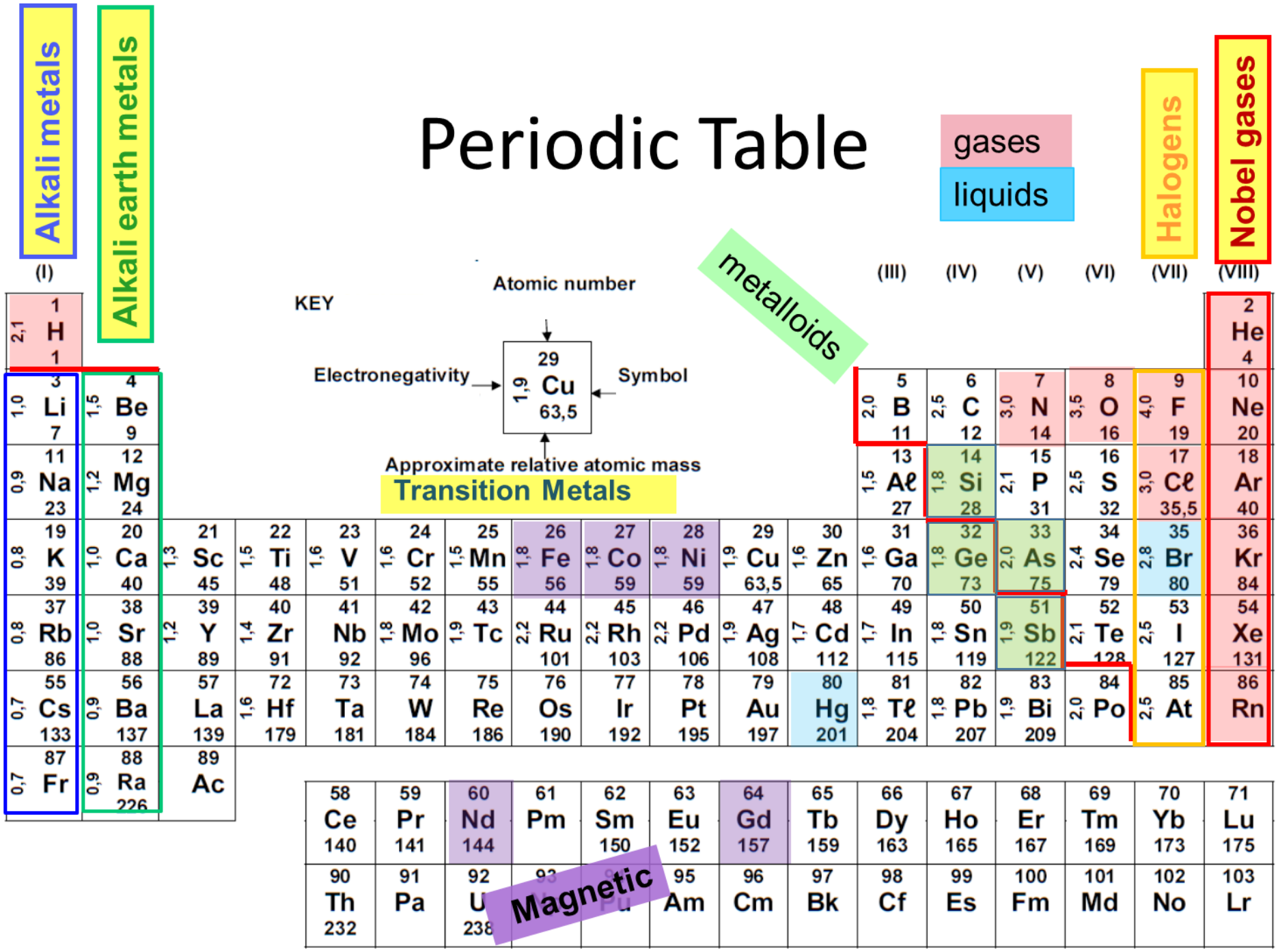


- We use the **atomic number** and relative atomic **mass number**. Not to worry about the electronegativity number along the side
- Notice how the atomic numbers increase from left to right in rows called **periods.**
- Periodically patterns repeat and hence the elements are put in columns, called **groups**, that have similar properties.
- Notice the **main groups** are numbered using the Roman Numerals: I, II, III, IV, V, VII, VIII
- Your text book's table at the end of the book labels groups 1-18. At school we concentrate on the **main groups: I – VIII only**
- Some groups get special names. Study these: alkali metals, alkali earth metals, halogens, noble gases (all vertical columns) & transition metals (the big group in the middle).
- Notice that the distinction between metals and non-metals follows the red step like line. **Metals** are to the left and **non-metals** (including Hydrogen) are to the right and above the steps with some in green, that have properties of both metal & non-metals, called the **metalloids** or semi-metals

Activity 1:

1. *Note the names and symbols of the 1st 20 elements + Fe, Co, Ni, Cu, Zn, Br, Ag, I, Pt, Au, Hg, Pb, U, Pu.*
2. *Colour in your periodic table p3 with the colours shown by your teacher and fill in the labels. Do same for a second one for your notebook*

Periodic Table



ATOMS & SUB-ATOMIC PARTICLES (P76 & 77)

- Atoms are made of smaller particles called subatomic particles.
- The nucleus is made of protons, p^+ which are positively charged and neutrons which are neutral (i.e. have no charge)
- The nucleus is very tiny compared to the rest of the atom and yet it contains more than 99% of the mass of the atom. *Seems unbelievable but there is strong evidence. A bit too complicated to explain yet for Gr8.*
- Electrons, e^-, are negatively charged. They orbit the nucleus like planets around the sun.
- Atoms are neutral and therefore have an equal number of protons (p^+) and electrons (e^-).
- The atomic number is equal to the number of protons (and electrons) which gives its position on the periodic table.
- The electrons are arranged in layers around the nucleus like the layers of an onion.
- The layers correspond with the periods of the Period Table (rows).

Symbols & Structure of an atom: Let's use Lithium (Li no. 3 on the table) as our example 1.

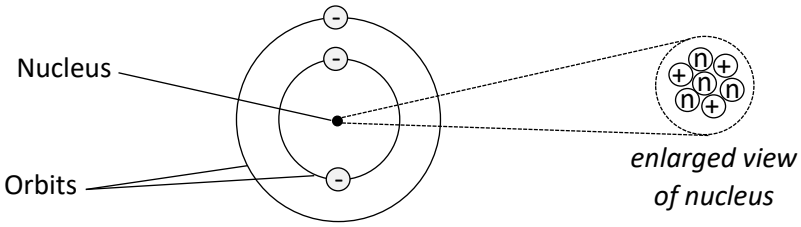
It's symbol is shown as any of the 3 examples: $^{7}_{3}\mathrm{Li}$ or $^{3}_{7}\mathrm{Li}$ or $\overset{3}{\underset{7}{\mathrm{Li}}}$ depending which textbook you read.

$\overset{3}{\underset{7}{\mathrm{Li}}}$

Atomic no. = p^+ (no. protons in nucleus) = e^- (no. electrons in orbits) } equal for atom to be neutral

Mass no. = $p^+ + n^0$ (i.e. no. protons + neutrons)

therefore: *(name)* Lithium has 3 protons and 4 neutrons in its nucleus and 3 electrons orbiting the nucleus.



Key:
⊕ = p^+
ⓝ = n^0
⊖ = e^-

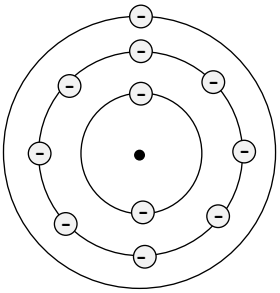
Activity 2:

Give the name and number of subatomic particles.

e.g. $\overset{11}{\underset{23}{\mathrm{Na}}}$ 2 e^- in 1st layer, 8 in 2nd layer and 1 in 3rd layer, like the periods in the Periodic Table.

name sodium *no.* p^+ = 11 & *no.* n^0 = 12 & no. e^- = 11

Fig. shows electron arrangement of sodium, Na *(not examinable)*



Homework 1

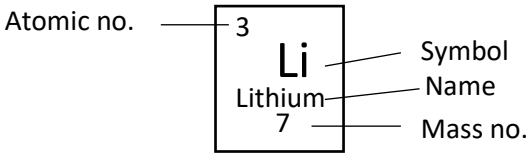
DO Activity 4 of textbook p77: *Do in your notebook.*

<u>Lesson 2</u>: Topic 4 Unit 2 cont…

Previous HW Activity 4 p77 *ANSWERS*

Question 1. the periodic table at the end of the textbook has the following format

e.g Lithium



	Element	Symbol	No. protons = atomic no.	No. electrons = atomic no.	Protons + Neutrons = mass no.	No. neutrons = mass no. – atomic no.
1	hydrogen	H	1	1	1	0
2	helium	He	2	2	4	4-2= 2
3	lithium	Li	3	3	7	7-3= 4
4	beryllium	Be	4	4	9	9-4= 5
5	boron	B	5	5	11	6
6	carbon	C	6	6	12	6
7	nitrogen	N	7	7	14	7
8	oxygen	O	8	8	16	8
9	fluorine	F	9	9	19	10
10	neon	Ne	10	10	20	10
11	sodium	Na	11	11	23	12
12	magnesium	Mg	12	12	24	12
13	aluminium	Al	13	13	27	14
14	silicon	Si	14	14	28	14
15	phosphorous	P	15	15	31	16
16	sulphur	S	16	16	32	16
17	chlorine	Cl	17	17	36	19
18	argon	Ar	18	18	40	22
19	potassium	K	19	19	39	20
20	calcium	Ca	20	20	40	20

Note *that you are* ***not*** *required to memorize the numbers. You must be able to use the table to describe the number of subatomic particles and which are in the nucleus and which ones orbit the nucleus.*

Question 2.

2.1 a) 7 protons (in nucleus) 7 electrons (orbiting) 7 neutrons (in nucleus)
b) Nitrogen, N

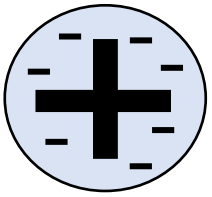
2.2 a) 4 protons (in nucleus) 4 electrons (orbiting) 5 neutrons (in nucleus)
b) Beryllium, Be

Historical development of the atomic model *p74*:

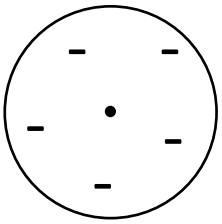
- The term atom comes from the Greek word “Atomos” meaning “uncuttable”, i.e. cannot be subdivided.
- Since then more has been discovered. We now know about the sub-atomic particles.

1. Dalton’s model (~1800): solid spheres like a “billiard ball”

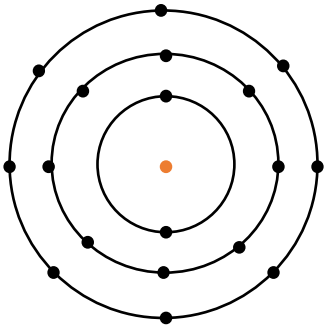
2. Thompson’s model (~1900): discovered charges. 99% of the mass is positively charged with negatively charged electrons (e^-) randomly spread throughout (nicknamed “plum pudding” model).
(*I like to think of it like a hot cross bun: The dough is most of the mass of the bun like the protons. The raisins are like the electrons)*



3. Rutherford (~1909): The positively charged protons (p^+) concentrated in a very small but very massive **nucleus** in the centre of the atom. Most of the space of the atom is occupied by electrons (e^-) buzzing around



4. Bohr (~1913): Electrons (e^-) arranged in orbits around the nucleus like layers of an onion.



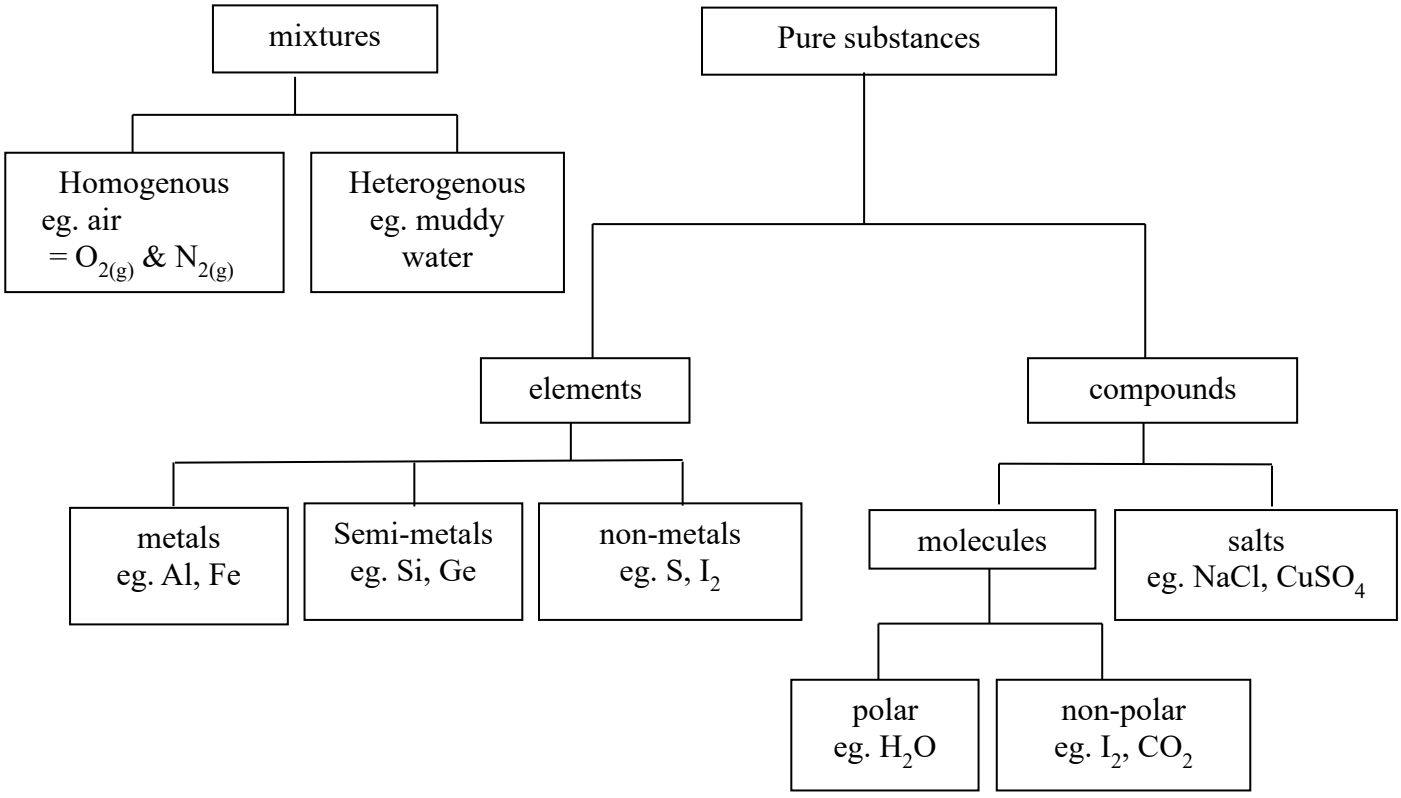
5. Chadwich (~1931): Discovered neutrons (n^0) in the nucleus.

Homework 2:

1. Read p74-75
2. revise everything in these first 5 pages

Lesson 3: Unit 3

Classification of matter:



Pure Substances p79

1. **Elements** are substances consisting of only 1 type of atom.
   - They cannot be broken up into simpler substances by chemical reactions.
   - Some exist as single atoms e.g. noble gases: He, Ne, Ar ....
   - others have millions of atoms bonded together e.g all metals
   - and some as **molecules** e.g. non-metals like: H_2 , O_2 , N_2 , F_2 & Cl_2 (these are all gases)

2. **Compounds** are two or more elements chemically bonded together.
   - Properties of a compound are very different to the elements it's made of
   - Can't separate by physical means.
   - Can be molecules e.g. When non-metals bond together: H_2O , CO_2
   - Or **salts** e.g. When a metal bonds with a non-metal: NaCl, $ZnCl_2$

- **Molecules**: two or more non-metal atoms bonded together
  - Can be elements like: H_2 , O_2 , N_2 , F_2 , Cl_2 , Br_2 , I_2 all diatomic
  - Or compounds: H_2O , CO_2 , HCl , NH_3 , $C_6H_{12}O_6$ (glucose - sugar)
  - water, carbon dioxide, hydrogen chloride ($HCl_{(aq)}$ hydrochloric acid), ammonia

Lesson 3 cont. **Physical Properties of substances** p80

Ask the questions:

1. What's its phase (at room temp)? Solid (s), Liquid (l) or Gas (g)?
2. Conductivity: does it conduct electricity?
3. Solubility: does it dissolve in water? If so, it's called an **aqueous** solution (aq)
4. Density: does it float or sink in water? For water: D= 1.0 g.cm^{-3}. More dense sinks & less dense floats.
5. Magnetism? Is it magnetic? Magnetic elements are: Fe - iron, Co - cobalt & Ni – nickel.

   (Also rare earth metals Nd & Gd form very strong magnets).
6. Melting Point (MP): temperature of melting / freezing?
7. Boiling Point (BP): temperature of boiling / condensing?

These properties can be used to identify a pure substance.

Demo: *Your teacher will show you some substances and their physical properties.*
Record observations in the table below: Volume expressed as: 1000cm^3 = 1000 ml = 1 dm^3 = 1 litre

Substance	***Phase***	***Conductivity heat & elec***	***Solubility? dissolves in water***	***Density (sink or float?) D_{water}= 1,0 g.cm^{-3}***	***Magnetic***	***Malleable (bends) (or Brittle)***
Iron	***s all metals except mercury***	***✓Elec & heat all metals***	***✗ does NOT dissolve in water***	***sink D_{Fe} = 7,8 g.cm^{-3}***	***✓ (also: Ni, Cobalt)***	***Malleable metal***
Copper	***s***	***✓Elec & heat***	***✗***	***sink D_{Cu} = 9,8 g.cm^{-3}***	***✗***	***Malleable metal***
Sulphur	***s***	***✗ all non-metals except graphite***	***✗***	***sink D_S = 2,0 g.cm^{-3}***	***✗***	***Brittle***
Carbon Graphite (pencil lead)	***s***	***✓the only non-metal solid conductor***	***✗***	***sink D_C = 2,3 g.cm^{-3}***	***✗***	***Brittle***
Wood	***s***	***✗***	***✗***	***float (a few exceptions)***	***✗***	***Brittle***
Pure Water	***liquid***	***✗***	***✓***	***–***	***✗***	***ice brittle***
Salt	***solid***	***✗***	***✓not all salts***	***sink & dissolve***	***✗***	***Brittle***
Salt water	***aqueous solution***	***✓ all salt solutions***	***✓***	***–***	***✗***	***NA***

Homework L3 *read p80 including the diagrams and do Activity 6*

Lesson 4: Separation of Mixtures p87 *Watch VIDEO*

Mixtures can be separated by **physical means**.

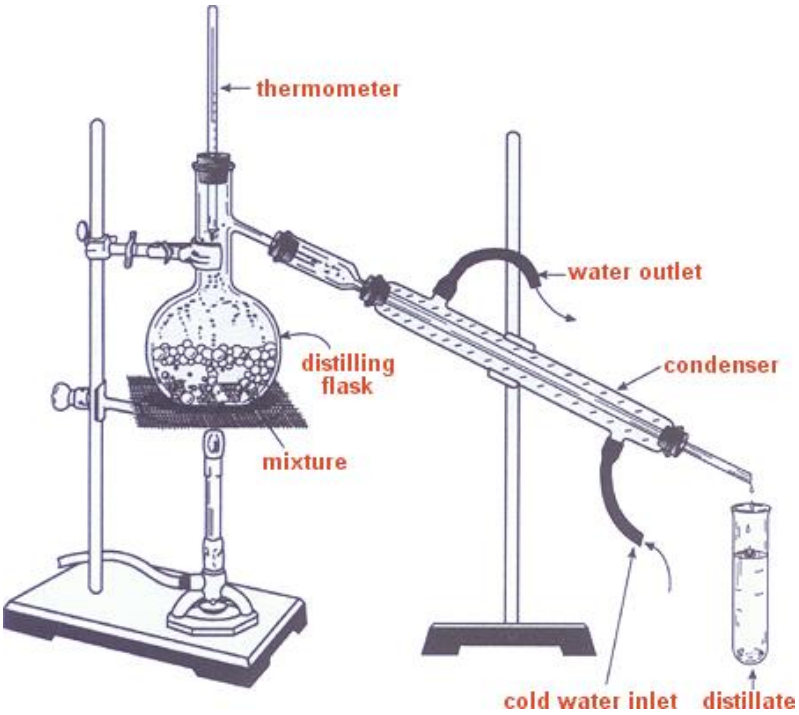
- To separate: identify how the properties of the components differ from each other. This will guide the method of separation.

Question: How would you separate the following mixtures?

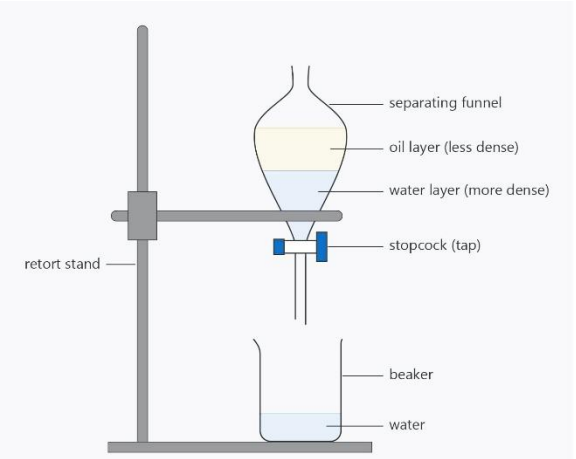
	Mixture	property difference	Separation method
1	Beans & sand	shape & size	Sorting by shape or colour / sieve by size
2	Sand & water	sand solid & insoluble, water liquid	Filter
3	Salt & water	salt doesn't vapourize, water evaporates (becomes water vapour = gas)	Evaporate the water
4	Sulphur & iron filings	iron magnetic, sulphur (S) not. S soluble in carbon disulphide	Magnet to remove iron or dissolve Sulphur in carbon disulphide
5	Water & alcohol	alcohol boiling point (BP) 78^0C, water BP 100^0C	Distill the alcohol
6	Oil & water	Oil & water immiscible (does not mix). Oil less dense & floats on top	Separating funnel

VIDEO: *Your teacher will show you a video on how to separate the mixtures listed above. Fill in relevant information. Label the diagrams below.*

Distillation Apparatus



Separating Funnel



<u>Lesson 6</u>: Chemical Reactions p84-86 & 115-120

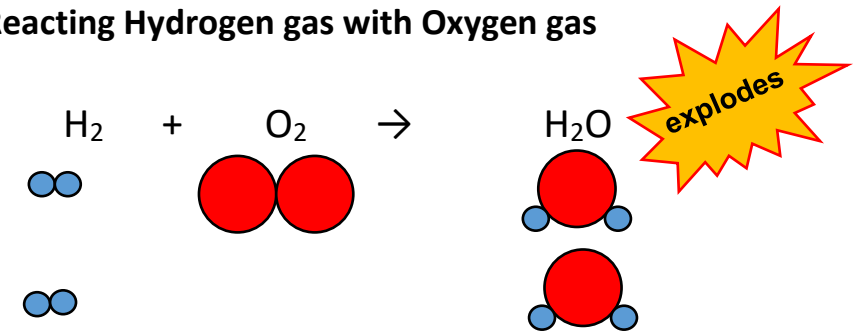
Your teacher may be able to demonstrate some of these reactions but there are videos on all of them. These are also on the arhs.vip site

During a chemical reaction:

- some bonds are broken (requires energy) &
- new bonds formed (releases energy)

1 Elements reacting to form a compound: (VIDEO)

E.g. 1) **Reacting Hydrogen gas with Oxygen gas**



- Trick is linking what you observe with a balance chemical equation. We see that it requires: two H_2 molecules for every one O_2 molecule and forms two water molecules.
- Writing these in is called balancing the equation.

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

Word equation: hydrogen gas + oxygen gas reacts to form water + energy

REMEMBER COKE BOTTLE ROCKET AND POPPING SOUND WHEN HYDROGEN IGNITES

E.g. 2) **Reacting Iron and Sulphur** *(SEE VIDEO)*

Heat iron filings and sulphur powder strongly in a test tube until it starts to glow.

$$Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$$

Word equation: iron + sulphur reacts to form iron sulphide

Name	Iron filings	Sulphur	Iron sulphide
Appearance	Grey filings (powder)	Yellow powder	Grey solid
Properties	Magnetic	Non – magnetic Dissolves in carbon disulphide	Non-magnetic
Acid test	Hydrogen bubbles form ($H_{2(g)}$) Explodes (popping sound) when ignited	No reaction	Hydrogen sulphide bubbles form. Smells like rotting eggs H_2S (gas)

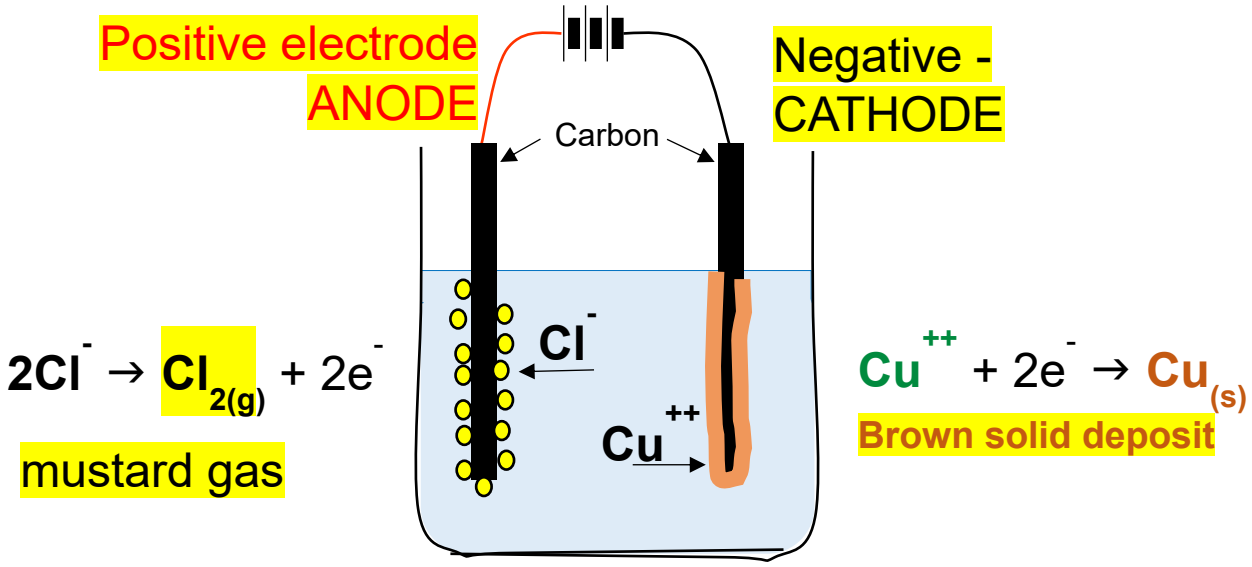
The complication here when reacting solids is that only the atoms on the outside of the powder particles get to react. So, there is a lot of unreacted iron mixed with the product. This makes the magnet test inconclusive. Whilst the iron sulphide is not magnetic the unreacted iron is.

***Home Lesson 6**: Revise the two reactions you observed today*

B. Decomposition reactions: (VIDEO)

3. Electrolysis of Copper Chloride, ($CuCl_2$) p85

Annotate the diagram below:



A chemical reaction caused by electricity is called electrolysis.

- The two half reactions occur at each electrode.
- At the positive electrode (anode) chlorine gas bubbles is formed. This smells like jik / bleech
- Brown copper metal deposits on the negative electrode (cathode)

Equation:

Symbols: $CuCl_{2(aq)} \rightarrow Cu_{(s)} + Cl_{2(g)}$

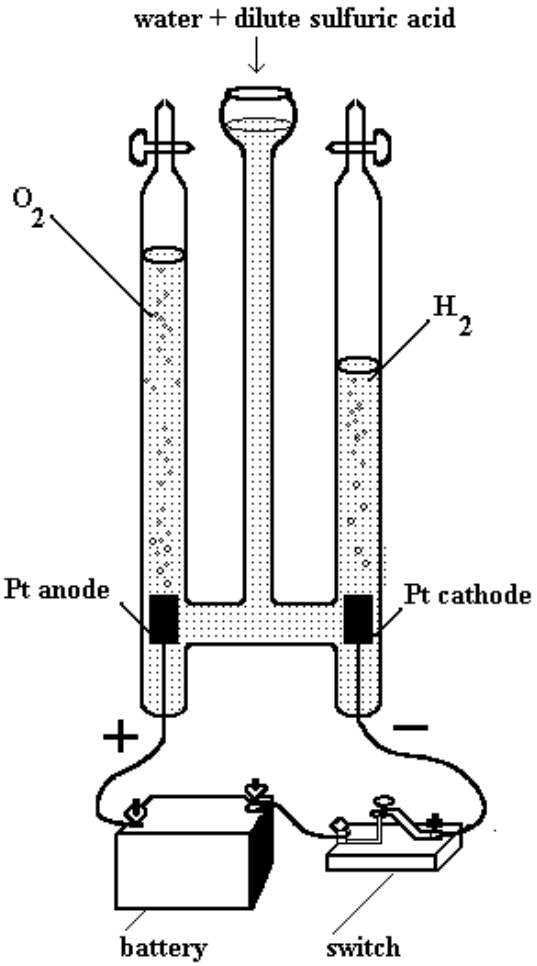
Word: Copper Chloride reacts to form copper & chlorine

<u>Application of electrolysis is in Electro-plating</u>

Precious metals are often deposited onto cheaper metals to prevent rusting or for decorative purposes. Examples include:

1. Nickel coating coins – the 'silver' coins e.g. R1.00 and R2.00 coins.
2. Chrome coating of exhaust pipes for motorbikes and old vintage cars.
3. Silver and gold plating of jewellery and expensive cutlery and ornaments.

eg.4. Electrolysis of Water, (H_2O) using a Hofmann Apparatus (VIDEO) pupil p12



Q1. What gases form at the positive electrode = anode (+ve) and at the negative electrode = cathode (-ve)?

Anode (+ve) : Oxygen

Cathode (-ve): Hydrogen

Ratio $H_2 : O_2 = 2:1$

Test for the gases:

$H_{2\,(g)}$: explodes (popping sound for a test tube full)

$O_{2\,(g)}$: ignites a glowing splinter

Q2 Write word and symbol equations for the reaction

Water reacts to form hydrogen gas + oxygen gas

$$H_2O \rightarrow 2H_{2(g)} + O_{2(g)}$$

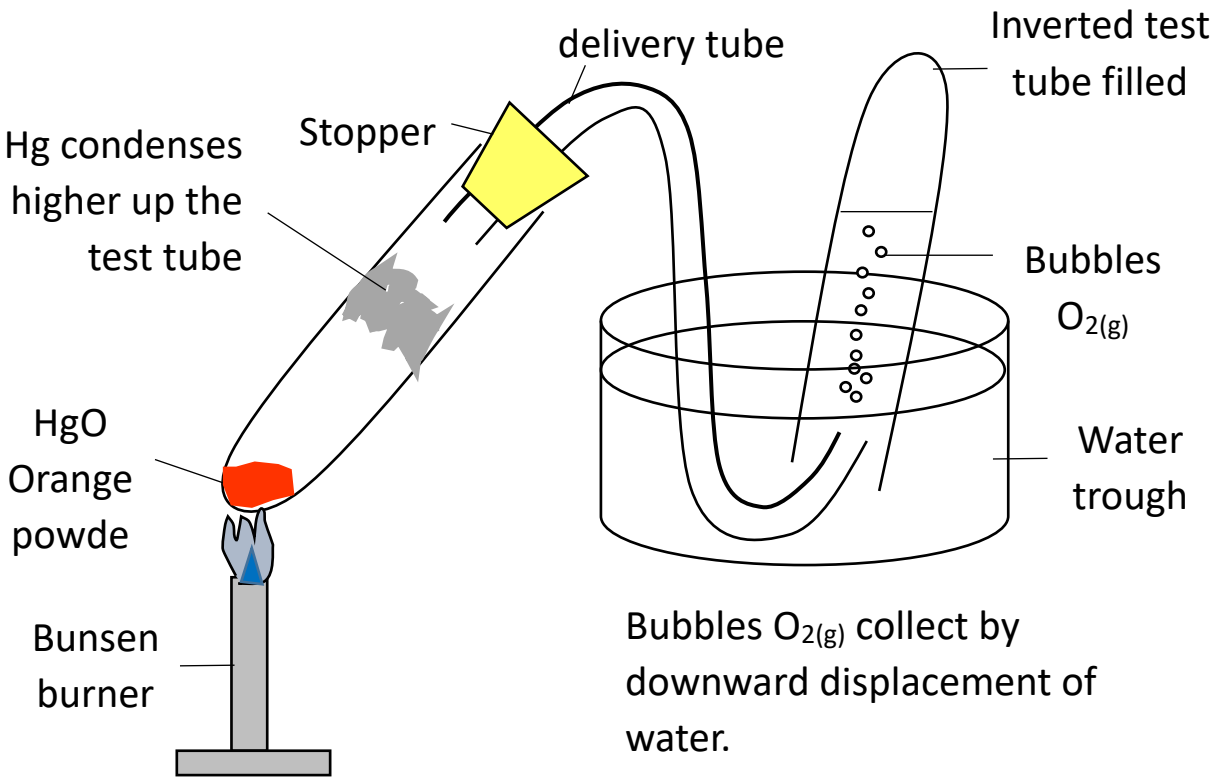
Q3. What is the purpose of the few drops of sulphuric acid in the water?

It helps conduct the electricity through the water

L9 e.g. 5. Thermal Decomposition of Mercury Oxide (VIDEO) pupil p11

Annotate the schematic diagram of the experimental set up below:

- *Describe what you observe as the test tube containing the mercury oxide is heated.*
- *Write word and symbol equations for the reaction*



Word equation: mercury oxide reacts to form mercury + oxygen

Symbols: $HgO_{(s)} \xrightarrow{\Delta} Hg_{(l)} + O_{2(g)}$

Question: Why would it be unwise to do this demonstration without the delivery tube bubbling through water?

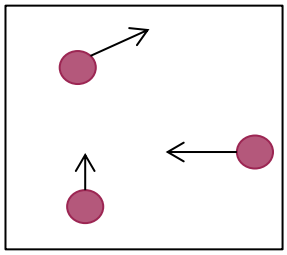
L1: Topic 5 Particle Model of Matter p89 – 114

Matter is made of small moving particles (microscopic).

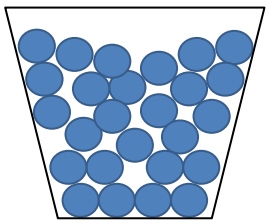
- Heating a substance causes the particles to move faster and therefore it expands
- Cooling " " " " " " " slower " " " contracts

Temperature is a measure of the average kinetic (moving) energy of the particles.

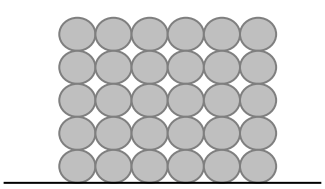
3 phases:



Fills the container



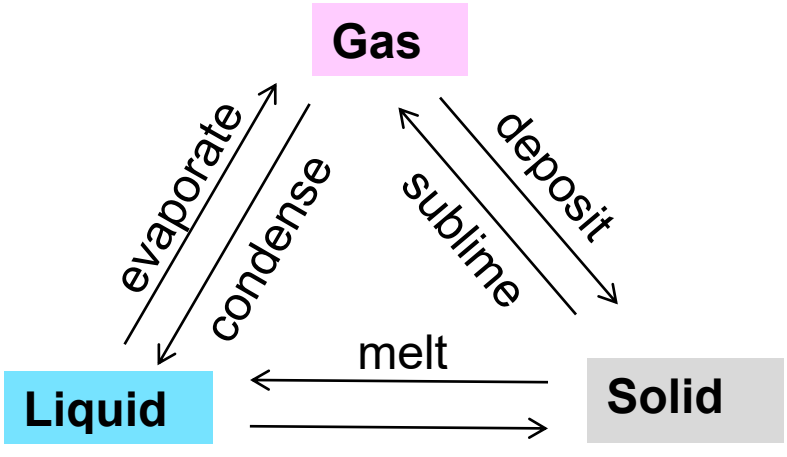
Takes shape of container



Holds its shape

	Gas	Liquid	Solid
Spaces between	Large Compressible	Very Small. Lying on top of each other Incompressible	Very small. Tightly packed together in regular pattern Incompressible
Energy & Movement	Most energy, Fast & random (free). Diffusion is fast	Can slide over each other. Fluid. Can be poured. Diffusion is slow	Lowest energy, Vibrate around a fix point. No diffusion
Attractive forces	Weak, Negligible ≈ 0	Stronger	Strongest

Phase Changes p96



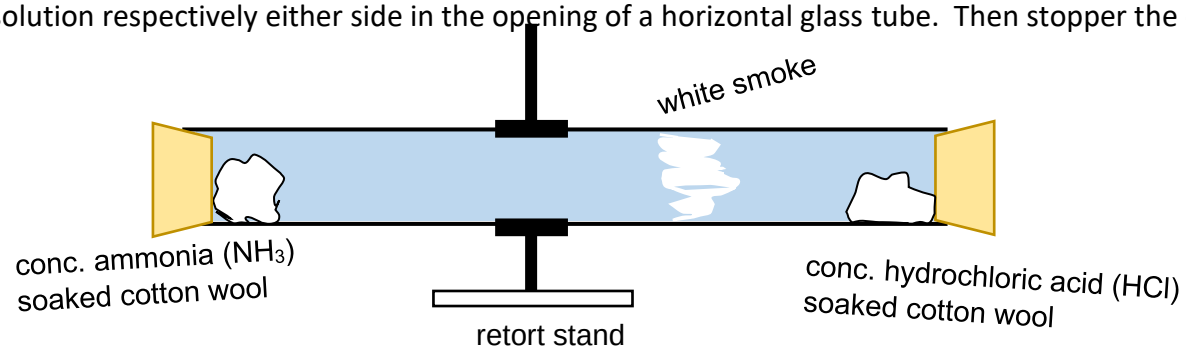
L2. 1. Diffusion in Gases: p94

Aim: to compare diffusion in Gases and in Liquids

Demo: Method:

why gases can be compressed but liquids cannot.

Simultaneously put some cotton wool dipped in concentrated hydrochloric acid and ammonia solution respectively either side in the opening of a horizontal glass tube. Then stopper the ends.



Observation:

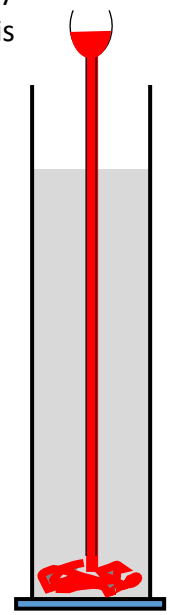
After about 30 seconds one sees white smoke first forming on the side closer to the HCl side of the tube. After a while it settles on the bottom. At that stage the white smoke has also formed all through the tube.

Background information:

Fumes of ammonia gas and hydrogen chloride gas are formed from their concentrated solutions on the cotton wool. When these gases come in contact, they make white smoke. Smoke is small solid particles suspended in the air. This smoke is called ammonium chloride (NH_4Cl).

Explanation:

So, the two gases have diffused though the air and first met where the smoke first appears. The ammonia molecules are smaller (have less mass) than the hydrogen chloride molecules and thus diffuse faster.



2. Diffusion in Liquids:

Method:

Gently allow a small amount of dye to run down a narrow tube into a cylinder of water. Carefully remove the tube thus trying to avoid the dye mixing.

Observation: Apart from a little mixing when withdrawing the tube the concentrated red dye remains at the bottom. It takes weeks for the dye to fuse throughout the cylinder.

Conclusion: (talks to the aim) Diffusion is much faster in gases that in liquids

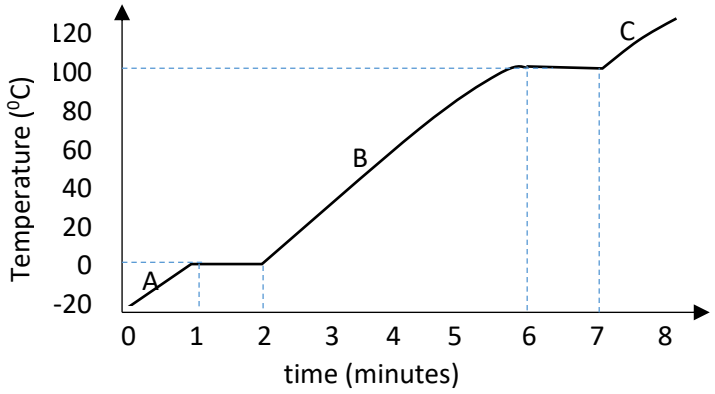
Explanation: Gas particles are far apart and moving fast. So, it is easier and quicker to pass through each other. Liquid particles are right on top of each other with very small spaces between them. They are slow moving compared to gas particles

3 Solids: Diffusion does NOT occur.

COVID 19 is spread via droplets of saliva breathed out by people. These float in the air and are carried by air currents and diffuse through the air. Droplets are very small. They are microscopic and cannot be seen by the naked eye. You are at risk of breathing these in. Hence the **wearing of masks**. When the droplets fall on surfaces they remain there and can be spread when you touch the surface. Hence the **sanitising** of your hands and surfaces

L3. **Heating Curve of Water:** From ice until it boils

You saw in the practical that heating a substance causes the temperature to rise until the phase change occurred. This resulted in a heating curve like the one shown here.



Questions - Answer them:

1 Identify the phases of the substance labelled A,B & C

A= solid, B=liquid & C= gas

2 What is happening between: 1-2 minutes? *Melting*

and 6-7 minutes? *Boiling*

3 Are phase changes physical or chemical changes? *Physical Changes*

4 It is still being heated during these times in Q2 above. Why then does the temperature not rise during these times?

The heat goes into breaking the forces of attraction between the water particles

5 When the salt was added to the ice it caused the temperature to drop way below 0^0C. Sometimes as low as -15^0C. Why?

It takes energy to pull the salt particles apart when it dissolves. It takes this energy from the ice. Because the ice is losing energy it's temperature drops.

Home Lesson 8:

Read p 89-93 and revise the concepts from this lesson

Lesson 10: **Density** p98-105

$D = \frac{mass}{volume}$ i.e. $D = \frac{m}{v}$

Unit: $g.cm^{-3}$ for small amounts or $kg.m^{-3}$ for large amounts

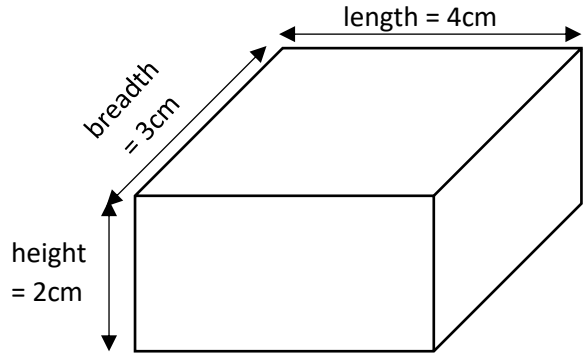
e.g. water, D=1.0 $g.cm^{-3}$ or 1000 $kg.m^{-3}$

- Objects **more** dense than water sink & less dense float.

- A Pure substance has a specific density value. Therefore, measuring the density of an unknown substance can be used to identify it**.**

e.g. Consider the diagram of an oblong block of unknown substance of mass 60g with the dimensions shown in the diagram below:

1 Calculate its density.
2 Use the table of density values to determine what substance it is.
3 Does it sink or float in water?



Vol = lxbxh = 4x3x2 = 24 cm^3

D=m/v = 60/24 = 2,5 $g.cm^{-3}$

It's made of glass.

It sinks 'cos its more dense than water

Substance	**Density ($g.cm^{-3}$)**
Iron	7,8
Wood	0,5 - 0,8
Glass	2,5
Mercury	13,5
Ice	0,9
Polystyrene	0,03

Tasks:

1 Read the case study on p101 and summarise it in your notebook.
2 Read case study and do Activity 12 p105.

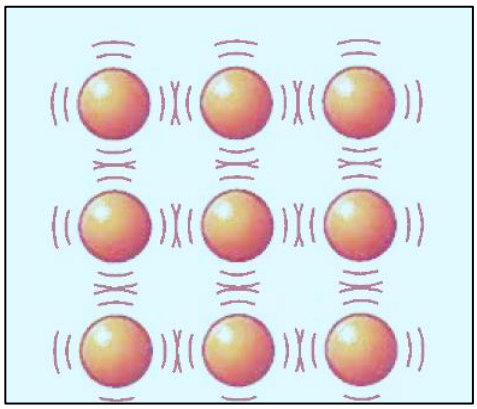
<u>Practical</u> (hands on) Your teacher will demonstrate how to use a spring scale & triple beam balance.

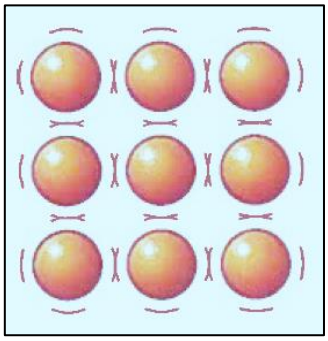
1. *Measure the masses of the two blocks (wood and steel) using both methods.*
2. *Measure dimensions of the blocks (rectangular prisms) and calculate their volumes*
3. *Calculate their densities and predict whether they would float or sink in water.*
4. *Predict how deep the floating one will sink when lowered into water. Now do it.*

<u>Lesson 11</u>: Expansion and contraction p106-109

Do **Activity** 13 p 107 *Your teacher may demonstrate the ball and ring apparatus.*

Explain *why substances expand when heated and contract when cooled in terms of the Particle Model or Matter.*





When heated: particles vibrate / move more.

∴ Require more space & move further apart.

∴ Expand.

When cooled: particles vibrate/ move less.

∴ Require less space.

∴ Contract.

- Particles themselves don't expand

Applications:

- A thermometer works by the liquid inside expanding as the temperature increases
- Expansion gaps are left between sections of railway lines and bridges, otherwise they would buckle when the temperature rises too high.

<u>Home lesson 11</u>:

- *Read Case Study on Smoking p95*
- Read p108-109 and DO Activity 14
- Explain why water pipes can burst in cold climates.

Ice in the pipe expands when it freezes causing the pipes to burst.

Water is the only substance to expand when freezing. Other substances contract.

Expanding means less density and therefore ice floats.If it wasn't for this lakes would freeze from the bottom up and eventually freeze completely killing all aquatic life

<u>Lesson 12</u>: Gas Pressure p110

pupil p19

Particles of gas move fast and bump into each other and the sides of the container they are in. These collisions exert a force which is the cause of gas pressure.

Questions:

1. Explain, using the particle model of matter, what happens when a car gets a flat tyre.
   When the gas particles leak out of the tyre there are fewer particles making fewer collisions. Thus there is insufficient pressure to keep the tyre inflated

2. Why do some party balloons float?

   Some party balloons are filled with Helium (He) gas. Helium is less dense than air and hence floats. The mass number of Helium is 4 whilst the mass number of diatomic molecules of oxygen O_2 is 32 and nitrogen molecule N_2 is 28.

3. Answer the question on p112-114 as practice for the exams.

Normal air pressure is 100 kPa (kilopascals). You may not be aware of air pressure but it is very dramatic when the air isn't there.

Demonstrations: Your teacher will demonstrate:

1. What happens when a cool drink tin is placed upside down in cold water after some water was boiled in it first. Write an explanation for why this occurs.
2. When a balloon is stretched over the mouth of a bottle that containers aluminium foil and a solution of caustic soda. The chemical reaction produces hydrogen gas. If enough hydrogen is produced and fills the balloon it will float.

- Why does it float?
- What happened when it a burning candle touched the balloon?
- Write a chemical equation for the reaction of the explosion.

1. The boiling water expels the air from the can. Cooling it rapidly by inverting it in cold water causes the water vapour in the tin to condense. The pressure in the can drops dramatically and the air pressure of the atmosphere squashes the can.

2. Hydrogen is less dense than air. It is the least dense gas. The mass number of the diatomic H_2 molecule is only 2. It exploded when ignited by the flame.

   $H_{2(g)} + O_{2(g)} \rightarrow 2H_2O$