education

Department of
Education
FREE STATE PROVINCE

PHYSICAL SCIENCES
SUMMARIES, TERMS, DEFINITIONS, ACTIVITIES

GRADE 10

APRIL 2020

This document consists of 206 pages.

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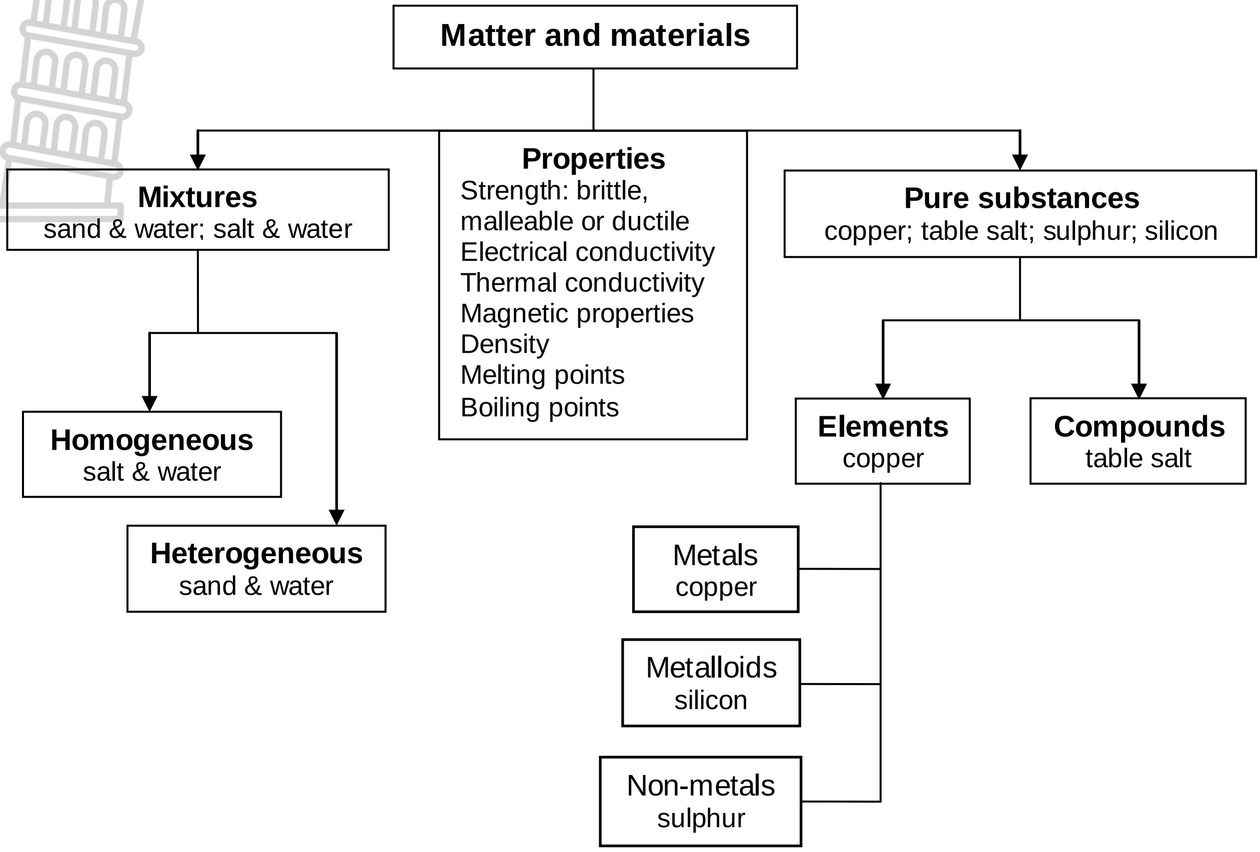
SUMMARIES, TERMS, DEFINTIONS AND ACTIVITIES

Topic 1: Matter & classification



Important terms/definitions	
Pure substance	A substance (element or compound) that contains only one kind of matter.
Boiling point	The temperature of a liquid at which its vapour pressure equals the external (atmospheric) pressure.
Chromatography	A method of separating and identifying certain substances.
Compound	A pure substance consisting of two or more different elements.
Density	The mass per unit volume of a substance.
Heterogeneous mixture	A mixture in which components can be easily identified. An example is a mixture of sand and water.
Homogeneous mixture	A mixture of which the composition is uniform. An example is a solution of salt and water.
Electrical conductor	A material that allows the flow of charge.
Electrical insulator	A material that does not allow the flow of charge.
Element	A pure chemical substance consisting of one type of atom.
Metalloids/semi-metals	An element with properties intermediate between those of a metal and a non- metal.
Melting point	The temperature at which a solid changes to the liquid phase.
Pure substance	A substance that cannot be separated into simpler pieces by physical methods.
Thermal conductor	A material that allows heat to pass through easily.
Thermal insulator	A material that does not allow heat to pass through easily.

Table 1: Chemical and everyday names of well-known compounds

Chemical name	Everyday name	Chemical name	Everyday name
ammonium carbonate	smelling salts	carbon disulphide	carbon bisulphide
ammonium nitrate	fertiliser	hydrogen oxide	water
ammonium sulphate	fertiliser	hydrogen chloride	hydrochloric acid
calcium carbonate	marble	hydrogen sulphate	sulphuric acid
calcium sulphate	plaster of Paris	hydrogen nitrate	nitric acid
magnesium sulphate	Epsom salts	ethanoic acid	acetic acid
sodium chloride	table salt	hydrogen carbonate	carbonic acid
calcium hydroxide	slaked lime	hydrogen sulphite	sulphurous acid
sodium hydrogen carbonate	baking soda	hydrogen nitrite	nitrous acid
sodium hydroxide	caustic soda	copper(II)sulphate	blue vitriol
sodium carbonate	washing soda	calcium oxide	quicklime
potassium hydroxide	caustic potash	carbon dioxide	carbonic acid gas

Table 2: Positive and negative ions

POSITIVE IONS

+1 symbol	Name	+2 symbol	name	+3 symbol	Name
H^+	hydrogen	Be^{2+}	beryllium	Al^{3+}	aluminium
Li^+	lithium	Mg^{2+}	magnesium	Fe^{3+}	iron(III)
Na^+	sodium	Ca^{2+}	calcium	Cr^{3+}	chromium(III)
K^+	potassium	Sr^{2+}	strontium	As^{3+}	arsenic(III)
Ag^+	silver	Ba^{2+}	barium	Sb^{3+}	antimony(III)
Hg^+	mercury(I)	Sn^{2+}	tin(II)	Bi^{3+}	bismuth(III)
Cu^+	copper(I)	Pb^{2+}	lead(II)		
NH_4^+	ammonium	Zn^{2+}	sink		
H_3O^+	hydronium (oxonium)	Fe^{2+}	iron(II)		
		Hg^{2+}	mercury(II)		
		Mn^{2+}	manganese		
		Ni^{2+}	nickel		
		Cd^{2+}	cadmium		
		Cr^{2+}	chromium(II)		
		Cu^{2+}	copper(II)		

NEGATIVE IONS

–1 symbol	Name	–2 symbol	Name	–3 symbol	Name
F^-	fluoride	O^{2-}	oxide	N^{3-}	nitride
$C\ell^-$	chloride	S^{2-}	sulphide	PO_4^{3-}	phosphate
Br^-	bromide	CO_3^{2-}	carbonate		
I^-	iodide	SO_4^{2-}	sulphate		
OH^-	hydroxide	SO_3^{2-}	sulphite		
NO_3^-	nitrate	CrO_4^{2-}	chromate		
NO_2^-	nitrite	$Cr_2O_7^{2-}$	dichromate		
CN^-	cyanide	$S_2O_3^{2-}$	thiosulphate		
HCO_3^-	hydrogen carbonate	MnO_4^{2-}	manganate		
HSO_4^-	hydrogen sulphate				
$C\ell O_3^-$	chlorate				
MnO_4^-	permanganate				
IO_3^-	iodate				
CNS^-	thiocyanate				
CH_3COO^-	ethanoate (acetate)				

Daily task 1.1: Classwork/Homework

1. Draw the following table in your workbook and classify each of the items as a pure substance, homogeneous mixture or heterogeneous mixture. In each case supply a reason for your answer.

	Item	Pure substance, homogeneous mixture or heterogeneous mixture	Reason
1.1	tap water		
1.2	stainless steel		
1.3	air		
1.4	diamond		
1.5	brick wall		
1.6	vegetable soup		
1.7	aluminium foil		
1.8	tea		
1.9	wood		
1.10	oxygen		
1.11	tea and sugar		
1.12	iodine crystals		
1.13	polystyrene		
1.14	Copper		
1.15	brass		
1.16	9 ct gold earring		
1.17	platinum ore		

Daily task 1.2: Classwork/Homework

1. Write down the names of the following compounds:

1.1 $KMnO_4$ 1.2 K_2CO_3 1.3 $KCℓ$ 1.4 $FeCℓ_2$
1.5 Na_2SO_4 1.6 $FeCℓ_3$ 1.7 Na_2S 1.8 Na_2SO_3

2. Write down the formula of each of the following compounds:

2.1 ammonium nitrate 2.2 zinc oxide 2.3 cobalt(II) chloride
2.4 zinc sulphide 2.5 magnesium chloride 2.6 calcium nitrate
2.7 copper(II) sulphate 2.8 potassium chromate 2.9 potassium nitrate

Daily task 1.3: Classwork/Homework/Practical investigation

1. In your own words, explain the difference between a conductor, insulator and a semi-conductor.

2. The following materials are supplied: a piece of wire, a ruler, a pen and a pencil. Plan an investigation to indicate which of the items are conductors and which are insulators. The following steps will help you with your planning:

Step 1: Ask an investigative question – what do you want to determine during this investigation?
Step 2: Hypothesis – Make a prediction by guessing which materials are conductors and which are insulators.
Step 3: List of apparatus – Supply a list of all the apparatus you will need for the investigation. Explain what each of the listed items will be used for.
Step 4: Method – Write down how you will test the materials for conduction. Use a circuit diagram to show how you will set up the apparatus.

<u>Daily task 1.4: Classwork/Homework/Practical investigation</u>

A learner collects the materials listed in the table below in order to investigate some of their physical properties. Three of the observations made during the investigation are shown (as YES or NO) in the table, whilst others are represented by the letters (a) to (f).

Material	**Conduction of electricity**	**Shiny / Metallic**	**Ductile**
Copper rod	Yes	Yes	(a)
Sodium chloride crystals		(b)	
Magnesium strip	Yes		(c)
Sulphur lump	(d)	(e)	
Carbon powder			(f)

1. To investigate the conductivity of the materials, the learner connects the materials alternately in a closed circuit containing a battery and a light bulb.

   For this investigation, write down:

1.1 The independent variable
1.2 The dependent variable
1.3 An investigative question
2. Briefly describe how you will test whether the above materials are:
2.1 Shiny or not
2.2 Ductile or not
3. Write down the observations, represented by the letters (a) to (f) in the above table, that the learner should make. Copy the letter (a) to (f) into your answer book. Next to each letter, only write down YES or NO.
4. Give TWO reasons why lightning conductors are made of copper.
5. State TWO other physical properties of magnesium not investigated in this investigation.

Topic 2: States of matter and the kinetic molecular theory

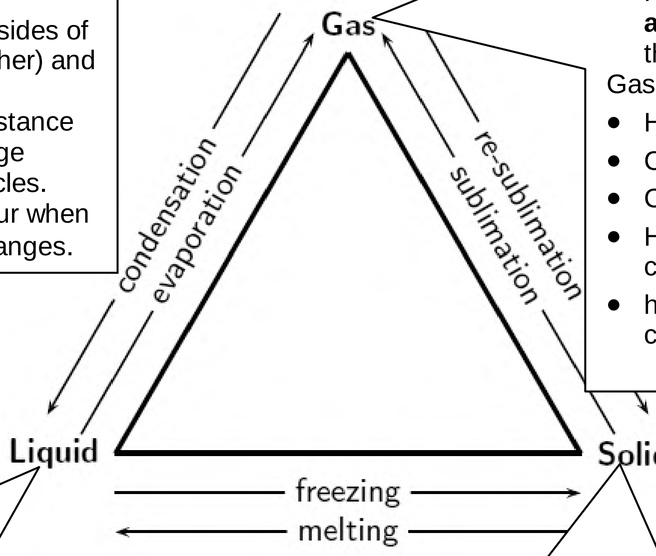
Kinetic Molecular Theory

1. Matter consists of small particles.
2. The particles are in constant motion.
3. There are forces of attraction between the particles.
4. Particles collide (with the sides of the container and each other) and exert pressure.
5. The temperature of a substance is a measure of the average kinetic energy of the particles.
6. A phase change may occur when the energy of particles changes.

Phases of matter
Gases, liquids, solids

Particles in gases:
- Are **very far apart**
- **Move** around **in all directions**
- Have weak **forces of attraction** between them

Gases:
- Have very low density
- Can be compressed
- Can flow
- Have the shape of their container
- have the size of their container



Particles in liquids:
- Are **close together,** but not as close as they are in solids.
- Can **move around** in any direction and are **not fixed in position**.
- Have **quite strong forces of attraction** between them but not as strong as in solids.

Liquids:
- Have a medium density
- Cannot be compressed
- Can flow
- Have the shape of their container
- Have a fixed size

Particles in solids:
- Vibrate about **fixed positions**.
- Have **strong forces** of attraction between them.
- Are **closely packed**.

Solids:
- Have a high density
- Cannot be compressed
- Do not flow
- Have a fixed shape
- Have a fixed size

Important terms/definitions	
Boiling point	The temperature of a liquid at which its vapour pressure equals the external (atmospheric) pressure. (Typically boiling points are measured at sea level. At higher altitudes, where atmospheric pressure is lower, boiling points are lower. The boiling point of water at sea level is 100 °C, while at the top of Mount Everest it is 71 °C.
Brownian motion	The random movement of microscopic particles suspended in a liquid or gas, caused by collisions between these particles and the molecules of the liquid or gas. (This movement is named for its identifier, Scottish botanist Robert Brown (1773-1858)).
Condensation	The process during which a gas or vapour changes to a liquid, either by cooling or by being subjected to increased pressure.
Deposition (Re-sublimation)	Deposition is a process in which a gas transforms into a solid. The reverse of deposition is sublimation.
Diffusion	The movement of atoms or molecules from an area of higher concentration to an area of lower concentration.
Evaporation	The change of a liquid into a vapour at a temperature below the boiling point. (Note: Evaporation takes place at the surface of a liquid, where molecules with the highest kinetic energy are able to escape. When this happens, the average kinetic energy of the liquid is lowered, and its temperature decreases.)
Freezing	The process during which a liquid changes to a solid by the removal of heat.
Freezing point	The temperature at which a liquid (releasing sufficient heat), becomes a solid.
Melting	The process during which a solid changes to a liquid by the application of heat.
Melting point	The temperature at which a solid, given sufficient heat, becomes a liquid. (For a given substance, the melting point of its solid form is the same as the freezing point of its liquid form, and depends on such factors as the purity of the substance and the surrounding pressure.)
Sublimation	The process during which a solid changes directly into a gas without passing through an intermediate liquid phase.

Daily task 2.1: Classwork/Homework

1. Matter exists as three phases: gases, liquids or solids
1.1 Compare these three phases in a table with regard to the movement of the constituent particles, distance between the particles and the forces between the particles.
1.2 List a few substances that occur in each of the following phases at room temperature:
1.2.1 Solid
1.2.2 Liquid
1.2.3 Gas

2. Give one word/term for each of the following descriptions:
2.1 Ice changes to water
2.2 Water changes to ice
2.3 Water changes to water vapour
2.4 Water vapour changes to water

3. Explain each of the phase changes in Question 2 in terms of the kinetic theory.

Daily task 2.2: Classwork/Homework/Data-interpretation

1. The following table shows the melting and boiling point of five substances.

	Water	Ethanol	Chlorine	Bromine	Phosphorus
Melting point (°C)	0	-114	-102	-7	44
Boiling point (°C)	100	78	-34	59	280

Which of these substances:
1.1 Has the lowest boiling point?
1.2 Are solids at room temperature (25 °C)?
1.3 Are liquids at room temperature (25 °C)?
1.4 Are gasses at room temperature (25 °C)?

2. Consider the metal iron.
2.1 Will liquid iron boil?
2.2 Is the temperature at which liquid iron boils larger than the boiling point of water?
2.3 Is iron still iron after it has evaporated?
2.4 What can you deduce about the forces of attraction between the particles in iron (iron atoms) and the particles in water (water molecules)?

3. Explain the following use: In places where it snows, the traffic department pours salt on snow-covered roads.

4. Explain each of the following in terms of the kinetic molecular model of matter:
4.1 A metal power/laundry line which hang droop on a very warm day
4.2 Water that vanish out of an open container
4.3 The need for gaps in railway lines

Daily task 2.3: Classwork/Homework/Data-interpretation

Container **A** contains 1 ℓ of water and container **B** contains 1 ℓ of petrol. Both containers are left open at a temperature of 25 °C. After 50 minutes, half of the liquid in one of the containers has disappeared.

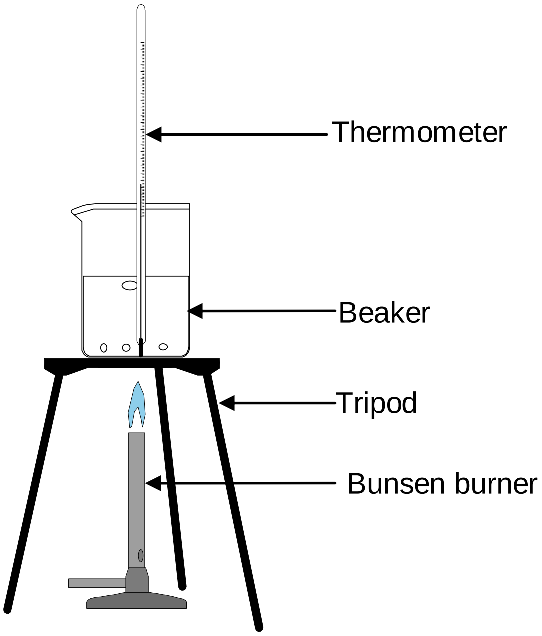
1. Identify the container in which half of the liquid has evaporated. Give a reason for your answer.
2. What happened to the liquid that disappeared?
3. How does the average kinetic energy of the molecules in container **A** compares to that of the molecules in container **B**?
4. Use the kinetic theory to explain why the liquid in one of the containers has disappeared, but not in the other. Use drawings in your explanation.
5. What can be done to prevent the liquid from disappearing?
6. If left long enough, the liquid in both containers will disappear. Explain.

Experiment 1A: Heating curve of water

Aim: To obtain the heating curve of water.

Apparatus:
1. A glass beaker
2. Crushed ice
3. Thermometer
4. Burner/ heat source

Method:
1. Set up apparatus as shown in the diagram.
2. Place at least 100 g (100 mℓ) ice in the glass beaker.
3. Measure and record the temperature.
4. Melt the ice over a slow flame whilst stirring it continuously. Take the temperature 2 minutes until the water boils.
5. Take the temperature readings for another 4 minutes after reaching boiling point.



Hint: It is advisable to first test how long it takes to melt the ice and boil the water before deciding on the time interval. Depending on the heat source, intervals for taking the temperature may vary from 30 s to 2 minutes.)

Results
1. Draw the following table in your workbook and record the results in the table.

Time (s)	Temperature (°C)	Observation (What do you see in the ice mixture?)
0	0	

2. Draw a graph of temperature versus time.

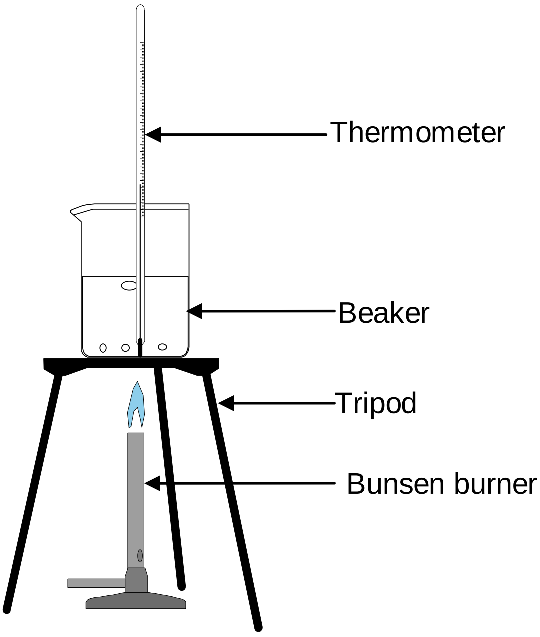
Questions
1. Identify the:
1.1 Dependent variable
1.2 Independent variable
2. What happened to the water's temperature while the ice was melting?
3. What happened to the temperature after all the ice had melted?
4. What happened to the water's temperature while the water was boiling?
5. Water underwent different phase changes during the investigation. Redraw the following table in your workbook. Summarise all the changes in the table.

Process	Reaction equation for the phase change	Was energy released or absorbed during the change?
Melting		
Evaporation		
Condensation		

6. Use the information in the table to explain the following phenomena:
6.1. On a cold morning, the car's windows mist up more quickly.
6.2. Our bodies cool down faster when we sweat than when a breeze is blowing.

Experiment 1B: Cooling curve of water

Aim: To obtain the cooling curve of water.



Apparatus:

1. A glass beaker
2. Crushed ice
3. Thermometer
4. Burner/ heat source

Method:

1. Set up apparatus as shown in the diagram.
2. Heat the water until it boils.
3. Remove the burner and allow the water to cool down, whilst measuring the temperature every 2 minutes.
4. Place the beaker in an ice bath (or the freezer) when it reaches room temperature.
5. Measure and record the temperature every 4 minutes until the water reaches 0 °C.

Results

1. Draw the following table in your workbook and note the results in the table.

Time (s)	**Temperature (°C)**	**Observation (What do you see in the ice mixture?)**

2. Draw a graph of temperature versus time.

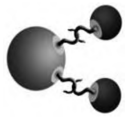
Topic 3: The atom: basic building block of all matter

The atom
Basic building block of all matter

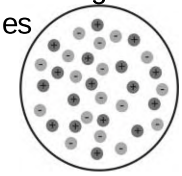
Models

Democritus
Smallest particles in matter - atoms

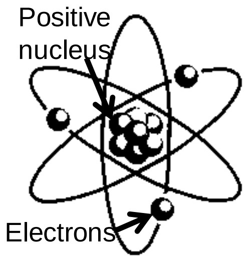
Dalton
Atoms are solid spheres



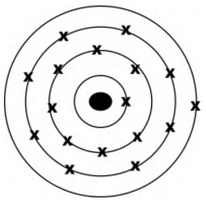
Thomson
Equal number of positive & negative particles



Rutherford

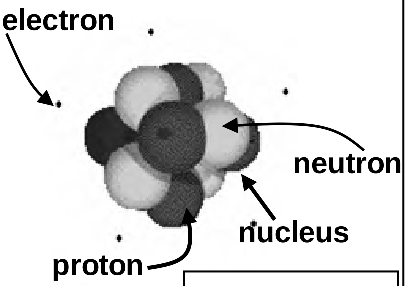


Bohr
Electrons in orbits



Structure

Modern atomic theory



$^{39}_{19}K$

A
Mass number

$A = Z + N$

Z
Atomic number

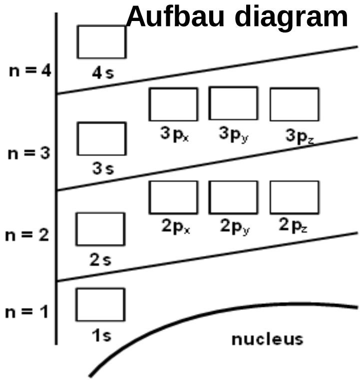
Isotopes

$^{12}_{6}C$ & $^{14}_{6}C$

Electron configuration

Element	1s	2s	2px	2py	2pz	3s
H	↑					
He	↑↓					
Li	↑↓	↑				
C	↑↓	↑↓	↑	↑		
N	↑↓	↑↓	↑	↑	↑	
O	↑↓	↑↓	↑↓	↑	↑	
F	↑↓	↑↓	↑↓	↑↓	↑	
Ne	↑↓	↑↓	↑↓	↑↓	↑↓	
Na	↑↓	↑↓	↑↓	↑↓	↑↓	↑

Aufbau diagram



Particle	Mass (kg)	Atomic mass (u)	Charge (C)	Relative charge
proton	$1,67 \times 10^{-27}$	1	$1,6 \times 10^{-19}$	+1
neutron	$1,67 \times 10^{-27}$	1	0	0
electron	$9,1 \times 10^{-31}$	$\frac{1}{2000}$	$-1,6 \times 10^{-19}$	–1

Important terms/definitions	
Atomic number (Z)	The number of protons in the nucleus of an atom.
Atomic orbital	The most probable region around the nucleus where electrons will be found.
Electrons	Negative particles occupying space around nucleus.
Excited state	When an electron gains energy and moves into higher energy level.
Ground state	The lowest energy state of an electron.
Hund's rule	No pairing in *p* orbitals before there is not at least one electron in each p orbital.
Ionisation energy	The energy needed to remove an electron(s) from an atom in the gaseous phase.
Isotope	Atoms of the same element with the same atomic number, but different mass numbers due to a difference in the number of neutrons.
Mass number (A)	The sum of protons and neutrons in the nucleus.
Neutrons	Neutral particles in the atomic nucleus.
Nucleons	The particles in the nucleus of an atom i.e. protons and neutrons.
Pauli's exclusion principle	Maximum two electrons per orbital provided that they spin in opposite directions.
Protons	Positive particles in the atomic nucleus.
Quantised energy level	An energy level that can only have specific amounts of energy.
Relative atomic mass	The mass of an atom of an element on a scale where carbon-12 has a mass of 12.
Valence electrons	Outer electrons; electrons in the highest filled energy level of an atom.

Daily task 3.1: Classwork/Homework

1. Name the particles found in the atom which:
1.1 Carry no electrical charge
1.2 Has the smallest mass of all
1.3 Carry one positive electrical charge
1.4 Carry one negative electrical charge
1.5 Occur in the nucleus of the atom

2. Define the following terms:
2.1 Nucleons
2.2 Mass number
2.3 Atomic number
2.4 Relative atomic mass

3. Copy the table below into your answer book and complete the open spaces.

	Element	Atomic number	Number of protons	Number of electrons	Number of neutrons	Mass Number
${}^{6}_{12}X$						
${}^{8}_{16}X$						
${}^{15}_{31}X$						
${}^{16}_{31}X$						
${}^{16}_{32}X$						

4. Use the table completed in QUESTION 3 to answer the following questions.
4.1 What relationship exists between the atomic number of an element and the number of protons in a neutral atom of the element?
4.2 State ONE similarity and ONE difference between the 4th and 5th elements in the table.
4.3 What do we call atoms of elements with the same atomic number but different mass numbers?
4.4 Use the periodic table and write down the names of the first three elements in the table.

5. Use the $^{A}_{Z}X$ notation to represent each of the following atoms:
5.1 Uranium-235
5.2 Calcium-40

Daily task 3.2: Classwork/Homework

1. Redraw the following table in your workbook. Complete all the cells with the necessary information.

Element	**Symbol**	**Mass number**	**Atomic number**	**Nucleons**	**Protons**	**Neutrons**	**Electrons**
Magnesium	Mg			24			12
Magnesium	Mg^{2+}		12			12	
	O^{2-}	16	8				
	Na^{+}	23			11		
	S		16	32			
Potassium		39	19				
	Br^{-}					45	36
	Fe^{3+}	56			26		

2. The control rods in nuclear reactors often contain boron. Natural boron is composed of 20% B-10 ($^{10}{}_{5}B$) and 80% B-11 ($^{11}{}_{5}B$).
2.1 Do a calculation to indicate that the relative atomic mass of boron is 10,8.
2.2 What is the composition of the nucleus of each of these isotopes?

Daily task 3.3: Classwork/Homework

1. A mass spectrum of natural uranium indicates that 1% of the uranium atoms have a mass of 235 and that 99% have a mass of 238. Use this experimental information to determine the relative atomic mass of uranium.

2. Carbon's relative atomic mass is 12,011. Determine the percentage occurrence of each of the isotopes if we assume that carbon occurs only as C-14 and C-12 (Tip: Assume that *x*% C-12 and y% is C-14.)

3. Naturally occurring chlorine consists of two stable isotopes 75% $C\ell^{35}_{17}$ and 25% $C\ell^{37}_{17}$.
Calculate the mass of the average chlorine atom on the relative atomic mass scale.

Daily task 3.4: Classwork/Homework

1. Draw Aufbau diagrams for all the elements in Period II (from Li to Ne) and Period III (Na to Ar). Indicate the following next to each of the Aufbau diagrams of the elements:
1.1 Number of the highest filled energy level
1.2 Number of the period in the periodic table
1.3 Number of valence electrons
1.4 Number of inner electrons (core electrons)
1.5 Group number in the periodic table
1.6 Electron configuration (sp notation)

2. Use your answers in Question 1 to answer the following questions.
2.1 What is the relationship between the group number and the number of valence electrons?
2.2 What is the relationship between the period number and the number of highest filled energy level?
2.3 Explain the following: Elements in the same group of the Periodic Table have the same chemical properties.
2.4 The noble gases are so called because they do not bond easily with other elements or with each other. Look at the electron structure of the two noble gases in Periods II and III and provide a possible explanation for this unreactivity.

Experiment 2: Flame tests

Aim: To identify metals using their flame colours.

Background

Why do some metal cations give different characteristic flame colours?

- The outermost electrons in some metallic elements are loosely held and can be excited to higher energy levels when heated.
- When the excited electrons (unstable state) fall down to the lower energy level to obtain stability, a characteristic light is emitted. For most group I and II metals, the range of wavelengths of these emitted light are around that of the visible spectrum. As a result the visible radiations could colour the flames in different colours when some metallic cations are heated at high temperatures in a Bunsen flame.

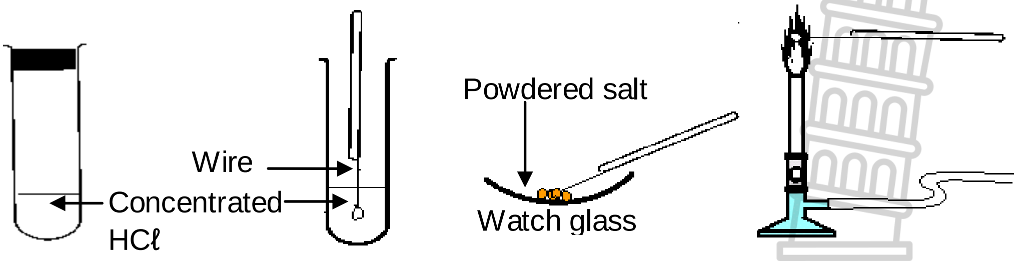
Apparatus & chemicals

Looped platinum / nichrome wire OR wooden splints OR cotton swabs
Wash bottle with distilled water
Bunsen burner
Concentrated hydrochloric acid
Watch glass
Metal salts: $LiC\ell$, $NaC\ell$, $KC\ell$, $CuC\ell_2$, $BaC\ell_2$ and $CaC\ell_2$

Method

1. Clean the platinum or nichrome loop. Dip the wire into hydrochloric acid, followed by rinsing with distilled water. Test the cleanliness of the loop by inserting it into a gas flame. If a burst of colour is produced, the loop is not sufficiently clean.

   OR
   Wooden splints or cotton swabs offer an inexpensive alternative to wire loops. Soak the wooden splints overnight in distilled water. Pour out the water and rinse the splints with clean water, being careful to avoid contaminating the water with sodium (from sweat on your hands). Take a damp splint or cotton swab through the flame. Do not hold the sample in the flame as this would cause the splint or swab to ignite.
2. Dip the clean wire (or wooden splint or cotton swab) into a small amount of powdered metallic salt in a watch glass.
3. Hold the wire (or wooden splint or cotton swab) in the cooler part of a non-luminous flame, i.e. the bottom of the flame. Then move the wire (or wooden splint or cotton swab) to the edge of the flame.
4. Observe the characteristic colour of the flame when the wire (or wooden splint or cotton swab) is in the edge of the flame.
5. Clean the wire as describe in step 1 above and test a second metallic salt OR use a new splint or cotton swab and test a second metallic salt.



Results

Record your observation in the table below.

Metal salt	Flame colour

Notes to the teacher

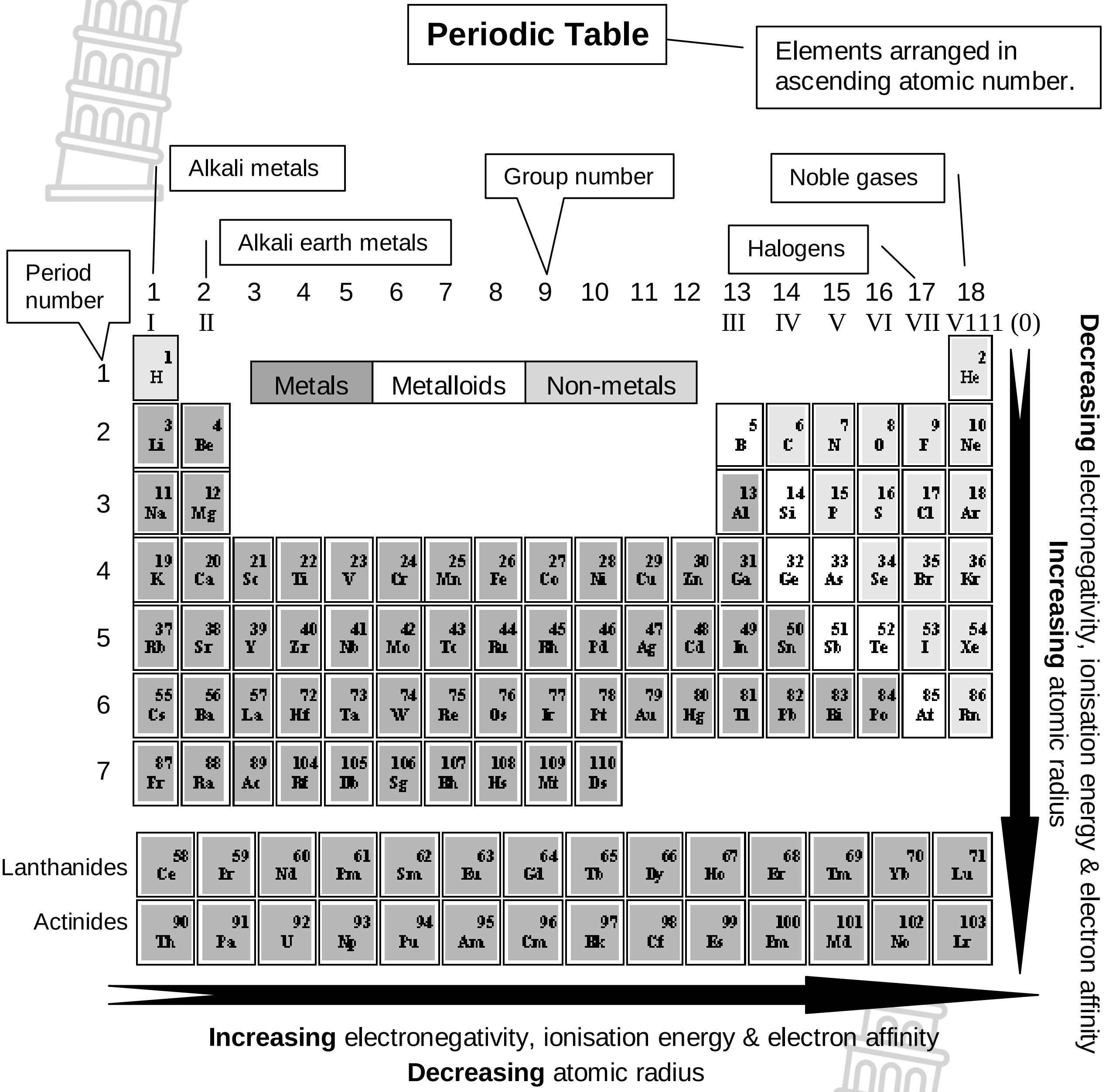
Limitations of the flame test

- The test cannot detect low concentrations of most ions.
- The brightness of the signal varies from one sample to another. For example, the yellow emission from sodium is much brighter than the red emission from the same amount of lithium.
- Impurities or contaminants affect the test results. Sodium, in particular, is present in most compounds and will colour the flame. Sometimes a blue glass is used to filter the yellow colour of sodium.
- The test cannot differentiate between all elements. Several metals produce the same colour. Some compounds do not change the colour of the flame at all.

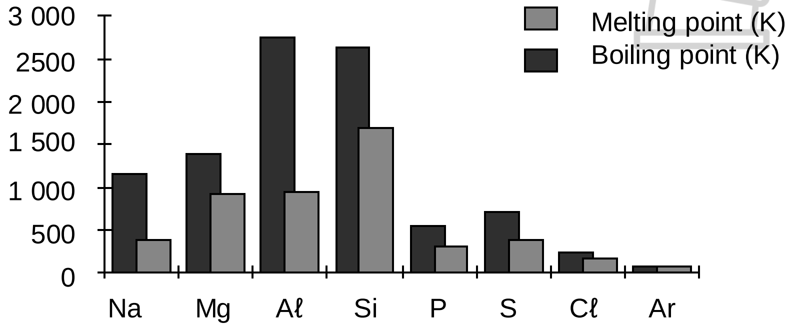
Characteristic flame colours of metal cations

Metal ion	Flame colour	Metal ion	Flame colour
Lithium ion Li^+	deep red	Calcium ion Ca^{2+}	brick red
Sodium ion Na^+	golden yellow	Strontium ion Sr^{2+}	Blood red
Potassium ion K^+	Lilac	Barium ion Ba^{2+}	apple green
Rubidium ion Rb^+	Bluish red	Copper(II) ion Cu^{2+}	bluish green
Caesium ion Cs^+	blue		

Topic 4: Periodic Table



Melting point & boiling points of elements in period 3



Important terms/Definitions:	
Atomic number	Number of protons in the nucleus of an atom.
Atomic radius	Radius of an atom. (The distance from the atomic nucleus to the outermost stable electron in an atom.)
Boiling point	The temperature of a liquid at which its vapour pressure equals the external (atmospheric) pressure.
Density	The mass per unit volume of a substance.
Electron affinity	The energy released when an electron is attached to an atom or molecule to form a negative ion.
Electronegativity	The tendency of an atom in a molecule to attract bonding electrons closer to itself.
First ionisation energy	Energy needed to remove the first electron from an atom in the gaseous phase.
Group	Vertical columns in the periodic table. Some groups have names.
Ion	A charged particle made from an atom by the loss or gain of electrons.
Ionisation energy	Energy needed to remove an electron(s) from an atom in the gaseous phase.
Melting point	The temperature at which a solid, given sufficient heat, becomes a liquid.
Period	Horizontal rows in the periodic table.
Periodicity	The repetition of similar properties in chemical elements, as indicated by their positioning in the periodic table. (With increasing atomic number, the electron configuration of the atoms displays a periodic variation.)

Daily task 4.1: Classwork/Homework

Consider the first 18 elements in the periodic table. From these elements, choose the element that matches the following requirements:

1. The most reactive metal
2. A non-metal that can form four bonds
3. A yellow solid that is a non-metal
4. A noble gas with two protons
5. The lightest alkali metal
6. A member of the alkali earth metals with 12 neutrons
7. A metalloid in group III
8. A gas in period 2 that is used in combustion reactions
9. A semiconductor in period 3
10. A noble gas with the electron configuration $1s^22s^22p^63s^23p^6$
11. Its diatomic molecules forms the most abundant gas in the atmosphere
12. A halogen in period 3
13. A yellowish gas that forms an ion with a -1 charge
14. A light, silvery metal with a valency of 3
15. An element with 4 protons
16. The element with the smallest atoms
17. An element with the notation $^{31}_{15}Q$
18. A non-metal that is a liquid at room temperature

Daily task 4.2: Classwork/Homework

The letters **A** to **H** in the table below represents eight elements from period 3 in the periodic table. Study the information in the table below and answer the question that follow.

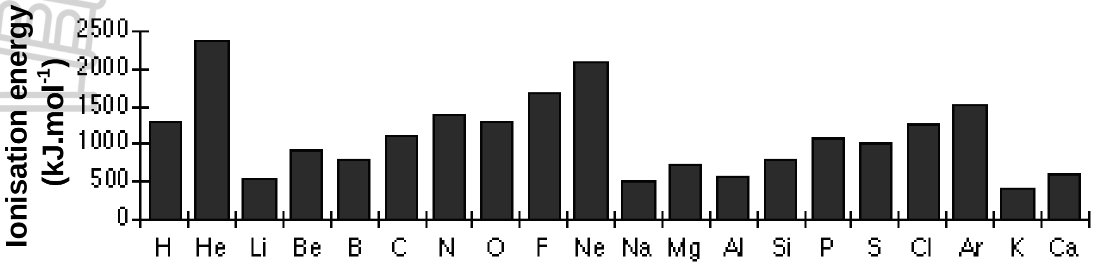
Element	**Physical properties**	**Melting point (°C)**	**Electrical conductivity**
A	Hard, greyish shiny solid	1 410	Semiconductor
B	Very light silver metal	660	Good conductor
C	Colourless gas	-189	Non conductor
D	Very reactive yellow solid	590	Non conductor
E	Extremely soft, silver metal	98	Good conductor
F	Soft, yellow solid	114	Non conductor
G	Yellow-green gas	-101	Non conductor
H	Slightly hard silver metal	650	Good conductor

1. Write down the letter of the element that represents:
1.1 The metalloid
1.2 An unreactive non-metal
1.3 A very reactive metal
2. Describe the trend in electrical conductivity across period 3.
3. Elements **E** and **H** react with oxygen to form oxides. Write down the respective chemical formulae of these oxides.
4. Arrange the elements **A** to **H** in the sequence that they appear in period 3 in the periodic table.

Daily task 4.3: Classwork/Homework/Data-interpretation

1. The graph below shows the first ionisation energies of the first 20 elements in the periodic table.

First ionisation energies of the first 20 elements



1.1 Define the term *first ionisation energy*.
1.2 What does *periodicity* of ionisation energy mean?
1.3 Which three elements have the lowest first ionisation energies? In which group of the periodic table do these elements occur?
1.4 Which group's elements have the highest first ionisation energy?
1.5 Arrange the elements on the graph in order of decreasing tendency to lose electrons.
1.6 Which of the metals or non-metals will preferably form positive ions? Justify your answer with data from the graph.

2. Refer to the table below which gives the melting and boiling points of a number of elements.

Element	Melting point (°C)	Boiling point (°C)
copper	1 083	2 567
magnesium	650	1 107
oxygen	-218,4	-183
carbon	3 500	4 827
helium	-272	-268,6
sulphur	112,8	444,6

2.1 Write down the symbol of each element and next to it the phase in which each element occurs at room temperature.
2.2 Which of these elements has the strongest forces between its atoms? Give a reason for your answer.
2.3 Which of these elements has the weakest forces between its atoms? Give a reason for your answer.

Topic 5: Chemical bonding

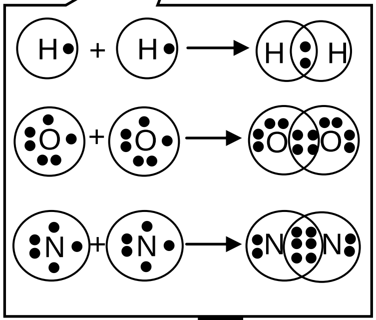
Chemical bonding

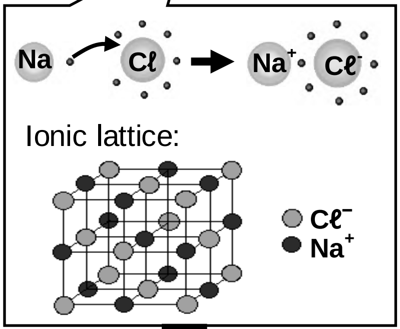
Simultaneous attraction between two nuclei. Energy of combined atoms is lower than that of individual atoms – higher stability

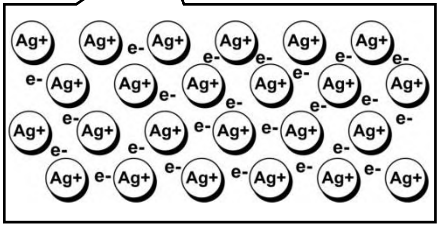
Covalent bond
Sharing of electrons between non-metallic atoms to form molecules

Ionic bond
Transfer of electrons from a metallic atom to a non-metallic atom

Metallic bond
Between metallic atoms
Positive ions and a sea of delocalised valence electrons

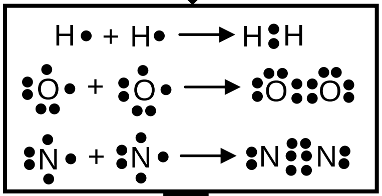


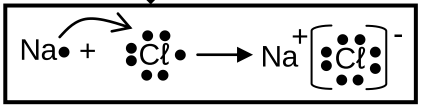




Represented with
Lewis structures

A structural formula in which valence electrons are represented by dots; two dots between atoms represent a covalent bond.





Not part of prescribed content

Couper structures

H-H	**Single bond**
O=O	**Double bond**
$N\equiv N$	**Triple bond**

Revision

- Cation and the anion tables done in grade 9.
- Names of compounds.
- Relative molecular mass for covalent molecules.
- Relative formula mass for ionic compounds.

Important terms/definitions	
Anion	A charged particle made from an atom by the gain of electrons.
Cation	A charged particle made from an atom by the loss of electrons.
Crystal lattice	An orderly three-dimensional arrangement of particles (ions, molecules or atoms) in a solid structure
Ion	A charged particle made from an atom by the loss or gain of electrons.
Lewis diagram / Lewis structure	A structural formula in which valence electrons are represented by dots; two dots between atoms represent a covalent bond. Also known as electron-dot formula or Lewis formula or electron diagrams.
Molecule	Group of two or more atoms that are covalently bonded and function as a unit.
Valence electrons	Outer electrons; electrons in the highest filled energy level of an atom.

Daily task 5.1: Classwork/Homework

1. Draw Lewis structures for each of the following elements:
1.1 H
1.2 He
1.3 Na
1.4 Ne
1.5 $C\ell$
1.6 S
1.7 C
1.8 O
1.9 K
1.10 Mg
1.11 Si
1.12 Br
2. Water exists as the H_2O molecule. Use Aufbau diagrams for oxygen and hydrogen, as well as Lewis structures to explain the existence of the H_2O molecule.
3. PH, PH_2 or PH_3? Use Aufbau diagrams and predict which one of the three is the correct formula. Explain the formation of the correct molecule with a Lewis structure.
4. What is the valency of carbon? Illustrate the formation of the methane molecule (CH_4) using Lewis structures.

Daily task 5.2: Classwork/Homework

1. Draw a Lewis structure and a Couper structure for each of the following molecules:
1.1 carbon dioxide
1.2 chlorine
1.3 hydrogen chloride
1.4 ammonia

2. Potassium bromide is a white crystalline solid.
2.1 Which two elements make up potassium bromide?
2.2 What are the relative positions of these two elements on the periodic table?
2.3 How many valence electrons does each of these elements have?
2.4 What is the valency of each of these two elements?
2.5 What type of bond will form between these two elements?
2.6 Illustrate the formation of this bond using Lewis structures. Briefly explain how the bond will form.

3. Explain the difference between an ionic bond and a covalent bond.

4. Name the type of bonds that hold particles together in each of the following:
4.1 Na(s)
4.2 $CuSO_4$(s)
4.3 iron
4.4 potassium chloride
4.5 A water molecule

Daily task 5.3: Classwork/Homework

1. Write down the names of the following compounds:
1.1 $K_2Cr_2O_7$
1.2 Na_2CO_3
1.3 $KC\ell O_3$
1.4 $FeSO_4$
1.5 $Ca_3(PO_4)_2$
1.6 $CrC\ell_3$
1.7 NH_4NO_3
1.8 $Pb(NO_3)_2$
1.9 $Na_2S_2O_3$

2. Write down the formula of each of the following compounds:
2.1 ammonium sulphate
2.2 mercury(II) oxide
2.3 nickel chloride
2.4 sodium sulphite
2.5 sodium sulphide
2.6 potassium nitrite
2.7 iron(III) sulphate
2.8 potassium nitrate

3. Use Aufbau diagrams to explain why argon does not bond chemically, while chlorine always occurs as a compound in which it is bonded either to itself or to other elements.

4. Calculate the relative molecular mass of:
4.1 H_2O
4.2 $HC\ell$
4.3 NH_3
4.4 H_2

5. Calculate the relative formula mass of:
5.1 $NaC\ell$
5.2 $CuSO_4$
5.3 $K_2Cr_2O_7$
5.4 $Fe(NO_3)_2$

Daily task 5.4: Homework project

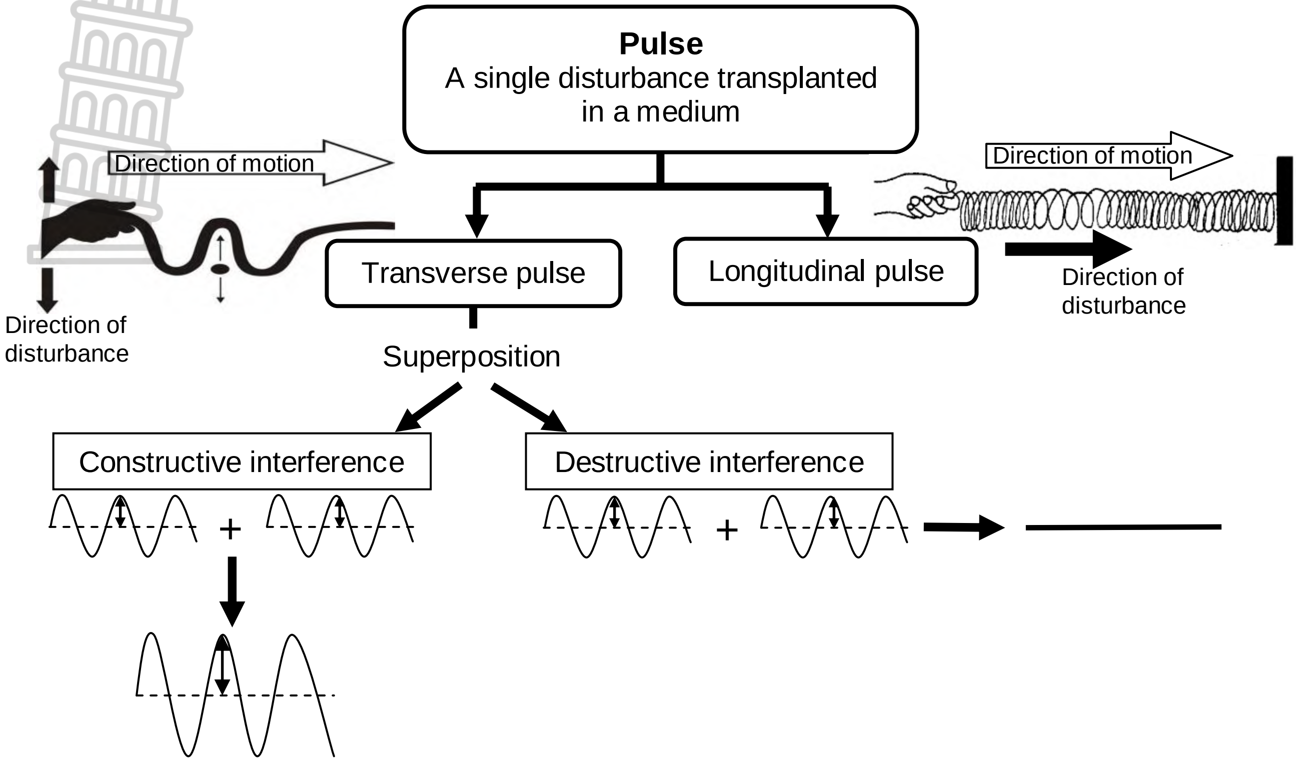
Build a model to represent each of the molecules listed below. Use any suitable materials to depict the atoms in the molecules. Polystyrene balls, jelly tots or marshmallows will work well as ‘atoms’. Toothpicks or wires may be used to indicate the bonds between the atoms. Be creative!

List of molecules: H_2O; NH_3; $HC\ell$; O_2; N_2; CH_4; $C\ell_2$

Before handing in the project, take note of the following:

- Mount the structures onto cardboard or wood or any suitable background.
- Write the formula, the name and the Lewis structure of the molecule at each structure.
- Make sure that your name is also on the cardboard or wood.
- Correctness, punctuality, neatness and originality will be used as criteria for this project.

Topic 6: Transverse pulses on a string or spring



Important terms/definitions	
Amplitude	The maximum displacement of a particle from its equilibrium position.
Constructive interference	A phenomenon where the crest of one wave overlaps with the crest of another wave to produce a wave of increased amplitude.
Destructive interference	A phenomenon where the crest of one wave over- laps with the trough of another, resulting in a wave of reduced amplitude.
Interference	A phenomenon where similar waves with a regular phase relationship pass through the same region at the same time.
Longitudinal pulse	A pulse whose particles vibrate parallel to the direction of the pulse's motion.
Pulse	A single disturbance in a medium.
Superposition	The algebraic sum of the amplitudes of two pulses that occupy the same space at the same time.
Transverse pulse	A pulse whose particles vibrate perpendicular to the direction of the pulse's motion.

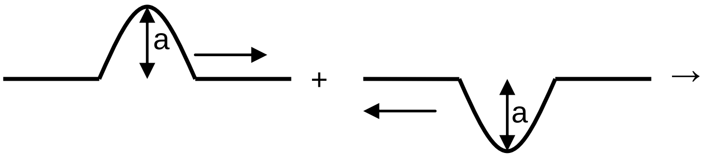
Daily task 6.1: Classwork/Homework

1. Define each of the following terms:
1.1 Pulse
1.2 Transverse pulse
1.3 Transverse wave
1.4 Amplitude
1.5 Interference.

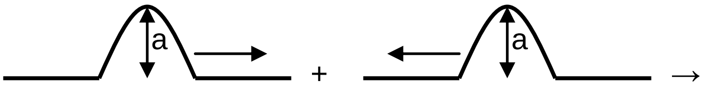
2. Differentiate between:
2.1 Constructive interference.
2.2 Destructive interference.

3. Copy and complete the diagrams below to show how two pulses that reach the same point in the same medium superpose.

3.1



3.2



Experiment 3: Constructive and destructive interference

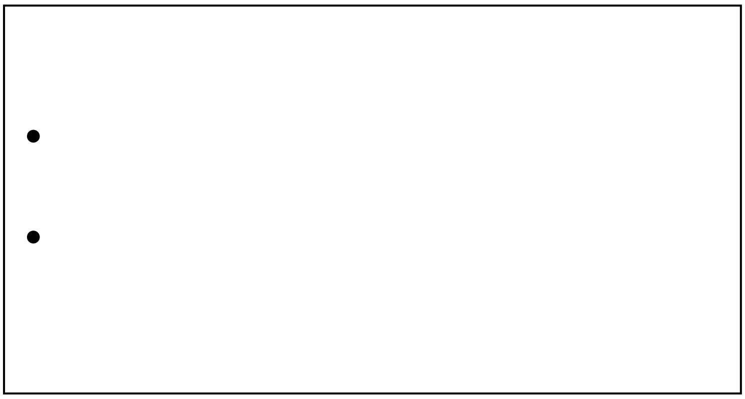
Aim: Observation of the interference of circular waves coming from two vibrating point sources.

Apparatus
Ripple tank

Method
Raise the vibrating beam so that the beads just touch the water in the ripple tank.

Results

1. Draw the pattern observed when the beads are vibrating.

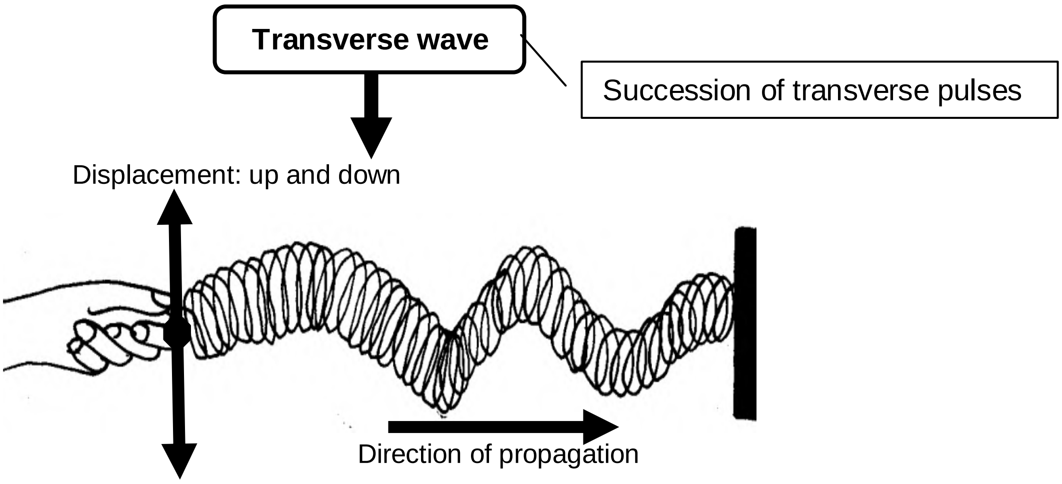


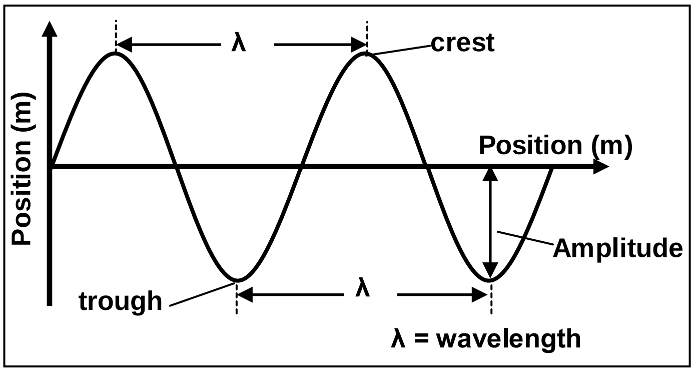
Label the nodal lines (lines joining points of destructive interference) and the light lines or antinodes (lines joining points where constructive interference takes place.) This pattern is called an interference pattern.

Questions

1. How will the number of nodal lines change if the distance between the two sources is increased?
2. How will the number of nodal lines change if the frequency of the vibrating beads is increased?
3. What will happen to the interference pattern if the two beads are not vibrating in time with each other?

Topic 7: Transverse waves





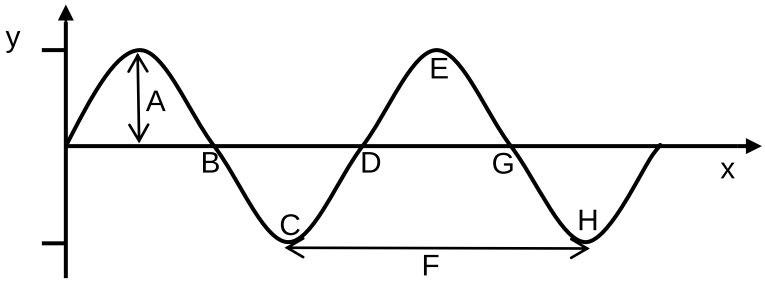
Important terms/definitions	
Crest	The highest point (peak) on a (sine) wave.
Frequency	The number of cycles/vibrations per unit time.
Period	The time taken for one complete cycle of an oscillation or vibration.
Point in phase	Two points on a wave that move exactly in the same way at the same time e.g. two crests or two troughs.
Transverse wave	A wave in which the disturbance is at right angles to the direction of propagation (motion) of the wave.
Trough	The lowest point (valley) on a (sine) wave.
Wavelength	The distance between two successive points in phase.
Wave speed	The distance travelled by a point on a wave per unit time.

Daily task 7.1: Classwork/Homework

1. Define each of the following terms:
1.1 Wavelength
1.2 Frequency of a wave
1.3 Period
1.4 Crest
1.5 Trough
1.6 Wave speed

2. Differentiate between two points on a wave that are:
2.1 In phase
2.2 Out phase

3. Study the diagram of a transverse wave below and answer the questions that follow.

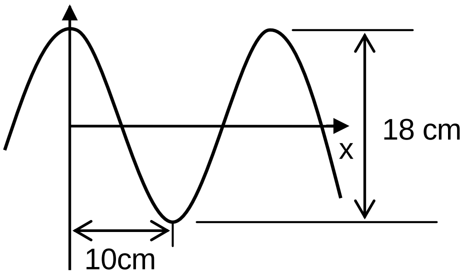


3.1 Label the parts A, C, E and F
3.2 Use the letters A to H to indicate two points on the wave that are:
3.2.1 In phase
3.2.2 Out of phase

Daily task 7.2: Classwork/Homework

1. Calculate the period of a wave whose frequency is 50 Hz.
2. Calculate the frequency of a wave if its period is 0,5 s.
3. Calculate the speed of a periodic wave disturbance that has a frequency of 3,5 Hz and a wavelength of 0,7 m.
4. The speed of a transverse wave in a string is 15 $m\cdot s^{-1}$. If the source's frequency is 6 Hz, calculate its wavelength.
5. Calculate the speed of a wave, wavelength 0,015 m, if 40 peaks pass a certain point in 20 s.
6. Five pulses are generated in a tank of water every 0,1 s. Calculate the speed of propagation of the wave if the wavelength of the surface wave is 1,2 cm.
7. A cork on the surface of a pond bobs up and down two times per second on ripples having a wavelength of 8,5 cm. If the cork is 10 m from the shore, how long does it take a ripple passing the cork to reach the shore?

8. A wave travelling in the positive *x*-direction has a frequency of 25 Hz. The wave is shown in the figure below.



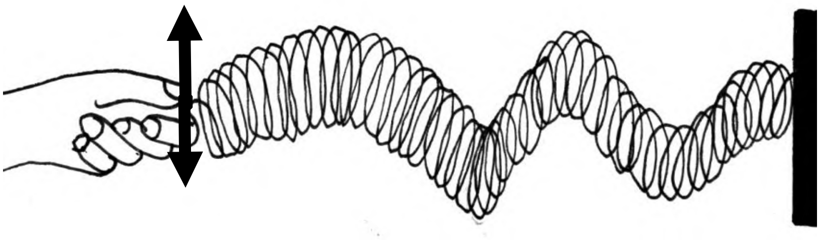
Calculate its:
8.1 Amplitude 8.2 Wavelength 8.3 period 8.4 speed

Experiment 4: Generation of transverse pulses/waves in a slinky

Aim: To generate transverse pulses in a slinky.

Method

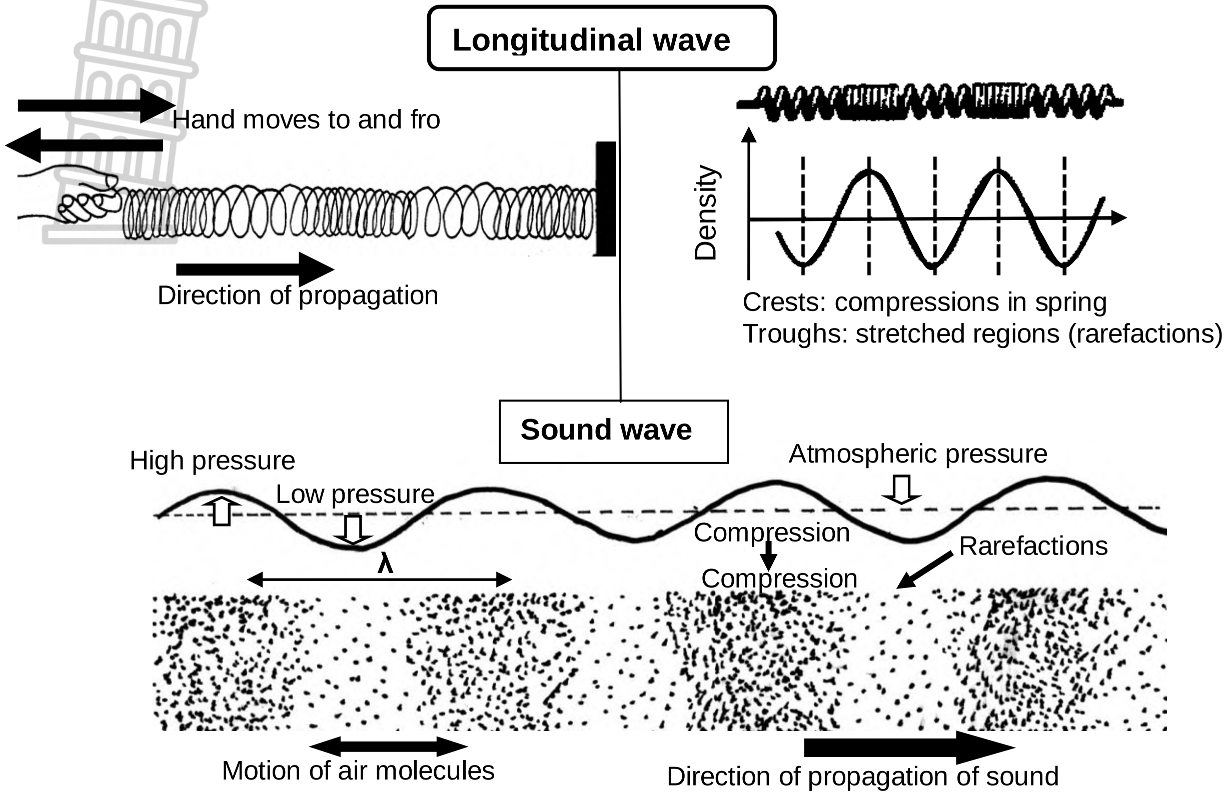
1. Place a slinky on the floor or on the table.
2. Connect one end of the slinky to a fixed end.
3. Tie a coloured ribbon to one of the coils. The ribbon represents a particle of the slinky where the wave moves through.
4. Now move the spring up and down as illustrated below.



Questions

1. In which direction does the ribbon move?
2. In which direction does the wave move?
3. Formulate a definition for a transverse wave.

Topic 8: Longitudinal waves



Important terms/definitions	
Amplitude	The maximum displacement of a particle from its equilibrium position.
Compression	The region of high pressure in a longitudinal wave.
Frequency	The number of vibrations/oscillations per unit time (one second).
Longitudinal wave	A wave in which the disturbance/displacement (from the position of rest) is parallel to the direction of propagation (motion) of the wave.
Period	The time taken for one complete cycle of an oscillation or vibration.
Rarefaction	The region of low pressure in a longitudinal wave.
Wavelength	The distance between two successive points in phase.
Wave speed	The distance travelled by a point on a wave per unit time.

Daily task 8.1: Classwork/Homework

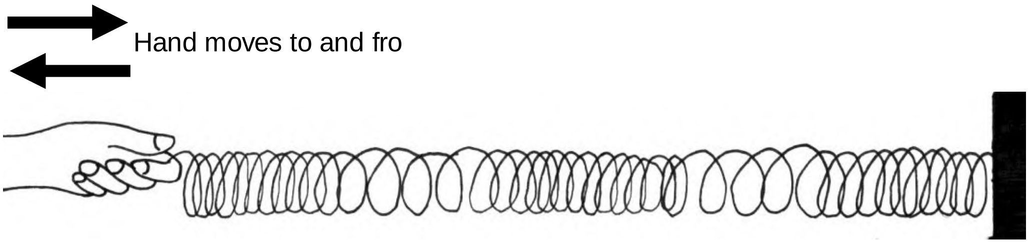
1. The speed of sound in air at 20°C is 343 m·s^{-1}. Calculate the wavelength of a sound wave with a frequency of 18 Hz.
2. Calculate the frequency of sound waves of wavelength 3 m. Take the speed of sound in air to be 330 m·s^{-1}.
3. Longitudinal waves in a spring have a wavelength of 25 cm. If the frequency of vibration of the spring is 50 Hz, calculate the speed of the waves.

Experiment 5: Generation of longitudinal pulses/waves in a slinky

Aim: To generate longitudinal pulses in a slinky.

Method

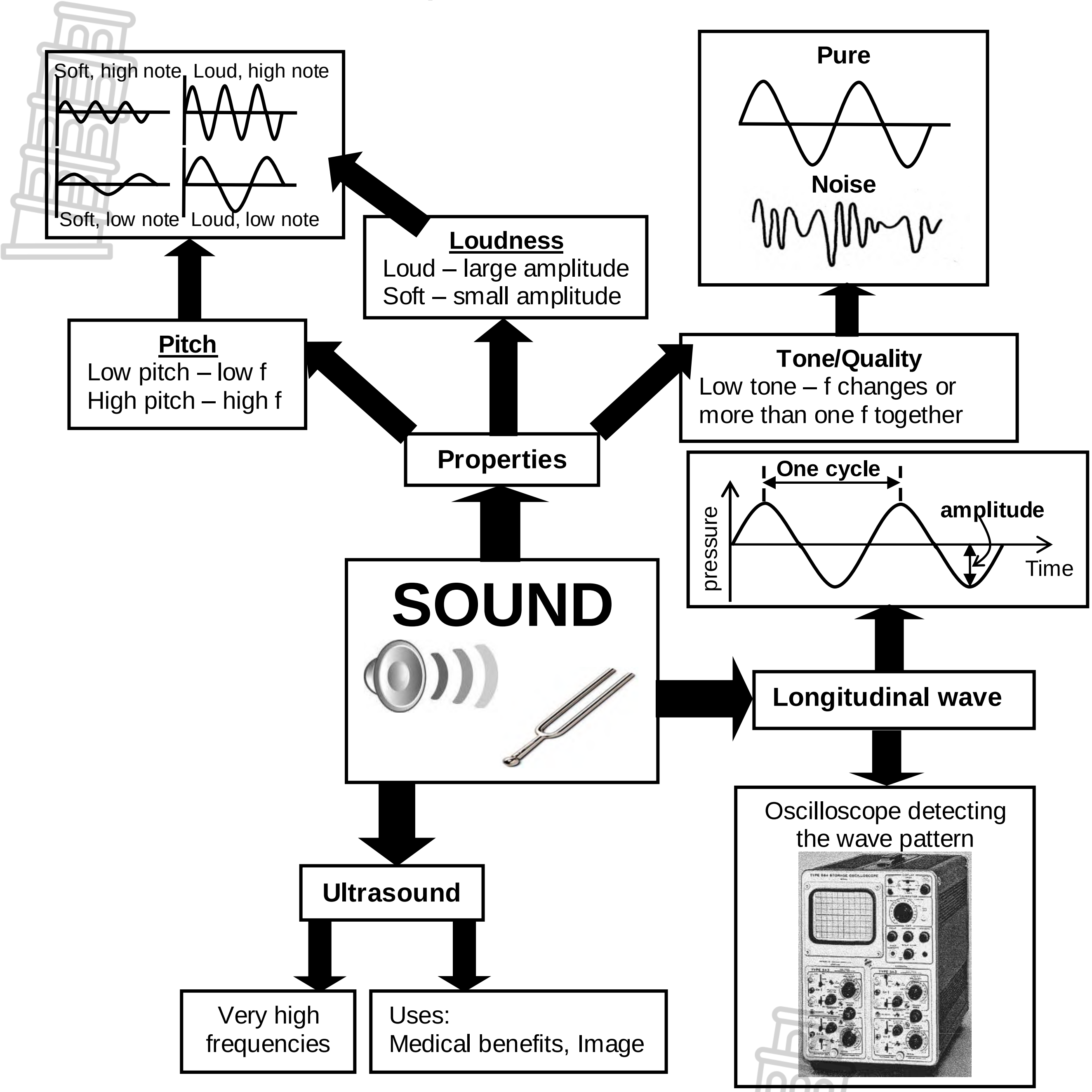
1. Place a slinky on the floor or on the table.
2. Connect one end of the slinky to a fixed end.
3. Tie a coloured ribbon to one of the coils. The ribbon represents a particle of the slinky where the wave moves through.
4. Now move the spring to and fro as illustrated below.



Questions

1. In which direction does the ribbon move?
2. In which direction does the wave move?
3. Formulate a definition for a longitudinal wave.

Topic 9: Sound



SOUND

Properties

Pitch
Low pitch – low f
High pitch – high f

Loudness
Loud – large amplitude
Soft – small amplitude

Tone/Quality
Low tone – f changes or more than one f together

Longitudinal wave

Oscilloscope detecting the wave pattern

Ultrasound

Very high frequencies

Uses:
Medical benefits, Image

Important terms/definitions	
Amplitude	Maximum displacement from the position of rest.
Frequency	Number of vibrations produced by a vibrating body in one second. The SI unit of frequency is Hertz (Hz).
Loudness	A subjective term describing the strength of the ear's perception of a sound. Loudness is directly proportional to amplitude.
Pitch	The effect produced in the ear due to the sound of a particular frequency. Pitch is directly proportional to frequency.
Ultrasound	Ultrasonic vibrations have frequencies higher than 20 000 Hz.
Wavelength	Distance between two consecutive points in phase.

Daily task 9.1: Classwork/Homework

1. The lower limit of frequency that can be heard by the average human is about:
   A 2 Hz
   B 20 Hz
   C 200 Hz
   D 2 000 Hz

2. Which ONE of the following materials transplants sound the best?
   A Air
   B Steel
   C Water

3. An airtight bell-jar is inverted on a platform connected to a vacuum pump. An electric bell fitted into the jar is operating, but its sound cannot be heard. This is because sound cannot travel through:
   A Vacuum
   B Air
   C Glass

4. The number of sound vibrations per second is the:
   A Period
   B Frequency
   C Amplitude
   D Wavelength

5. Which ONE of the following will produce sound with the highest pitch?
   A A mosquito
   B Women
   C Men
   D A lion

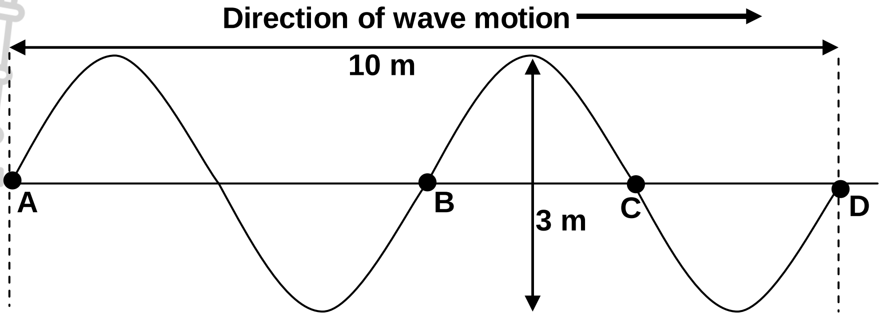
6. Echoes are often heard when talking in empty rooms.
6.1 What is meant by *echo*?
6.2 What are the conditions necessary for an echo to be heard?
6.3 Why do echoes produced in an empty auditorium usually decrease when it is full of audience?

7. A boy fires a gun and hears the echo 2 seconds later. If he is 480 m away from a wall, calculate the speed of sound in air.

8. A girl claps and hears the echo after reflection from a cliff which is 660 m away. If the velocity of sound in air is 330 m s^{-1}, calculate the time taken for the echo to travel to the girl.

Daily task 9.2: Classwork/Homework

1. Refer to the following sketch of a longitudinal wave, where the frequency of the wave is 50 Hz. **A, B, C** and **D** are points on the wave.



1.1 Calculate the time that the wave takes to travel the distance AB.
1.2 Calculate the wavelength of this wave.
1.3 Calculate the amplitude of this wave.
1.4 Are points A and B on the wave in phase? Explain your answer
1.5 Calculate the speed of this wave.

2. Find the word/term in column **B** that completes the word/term in column **A**. Only write down the symbol representing the word/tem in column **B** next to the question number.

	COLUMN A	**COLUMN B**	
2.1	Sound	A	Has a frequency greater than 20 000 Hz
2.2	The speed of a sound wave	B	Needs a medium to transplant
2.3	Ultra sound	C	Is an echo
2.4	Reflection of sound	D	Is directly proportional to the pitch of the sound
2.5	Frequency of sound	E	Increases in a denser medium

3 The pulse rate of Lance Armstrong during the Tour de France cycle race was found to be 45 beats in one minute. Calculate the:
3.1 Frequency of his heartbeat
3.2 Period of his heartbeat.

4. A rifle shot is fired in a valley between two parallel walls. The echo from one wall is heard 3 s later and the echo from the other wall is heard 8,3 s later.
The velocity of sound at 0 °C is 330 m s^{-1} and the temperature in the valley is 10 °C. For every 1 °C rise in temperature, the velocity of sound increases by 0,61 $m \cdot s^{-1}$.
Calculate the width of the valley.

5.
5.1 A fundamental/harmonic/overtone note is the lowest note obtained on blowing gently across the top of a test-tube.

5.2 True or False: Sound can be reflected as well as refracted.

5.3 Echoes are caused by _______ of sound.

5.4 The loudness of sound depends on the _______.

5.5 The effect produced in the ear due to the sound of a particular frequency is called the _______.

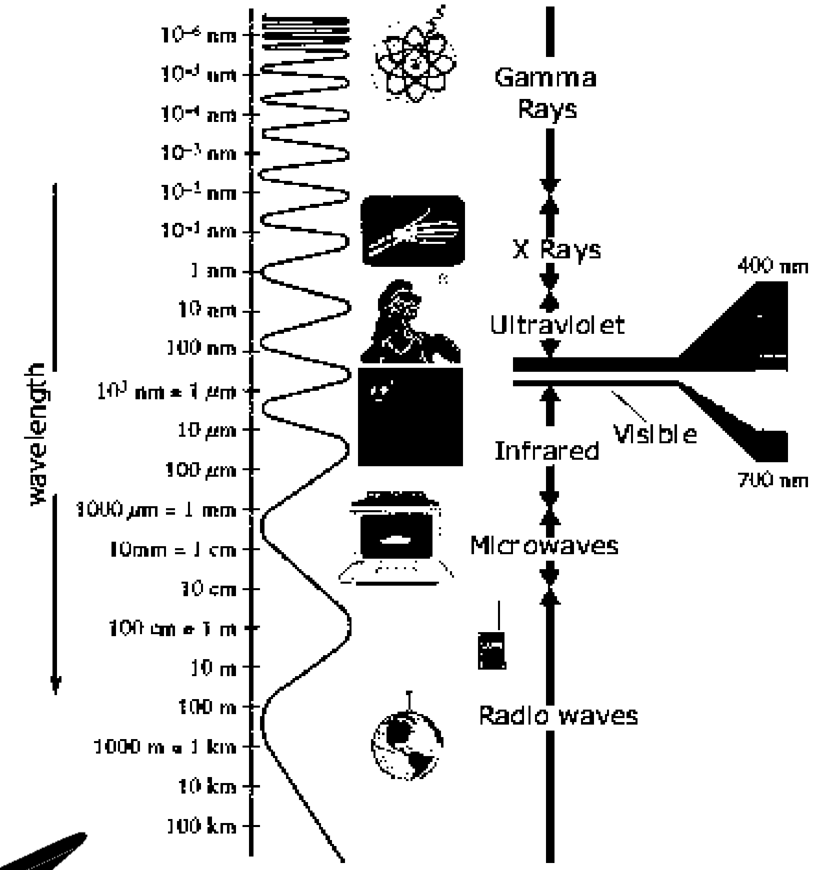
5.6 The maximum displacement of a vibrating body from its mean position is called _______.

5.7 The pitch of a note depends on the _______ of the vibrations.

Topic 10: Electromagnetic radiation

ELECTROMAGNETIC RADIATION

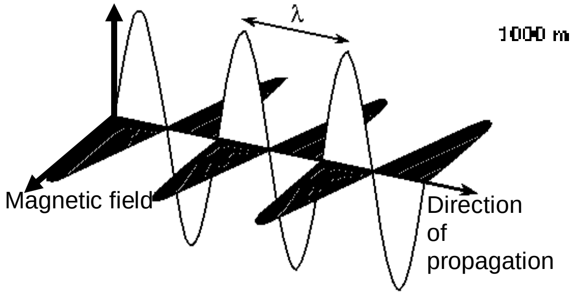
EM Spectrum



Dual nature (particle motion as well as wave motion

Particle nature
(photons) in interaction with matter.
Energy of particle:
$E = hf = \frac{hc}{\lambda}$

Wave nature
When generated and in propagation



Important terms/definitions	
Photons	Packets of energy of which light is composed.

Properties of electromagnetic radiation

Electromagnetic waves:

- Originate from oscillating electric charges
- Propagate as electric and magnetic fields that are perpendicular to each other
- Can travel through a vacuum
- Have a speed of 3 x 10^8 m·s^{-1}

Daily task 10.1: Classwork/Homework/Data-interpretation

Use the above of the electromagnetic spectrum to answer the following questions.

1. Which type of EM radiation has the:
1.1 Longest wavelength?
1.2 Shortest wavelength?
1.3 Highest energy?
1.4 Lowest frequency?

2. Give one word for each of the following descriptions.
2.1 The type of radiation that can travel through flesh, but not through bones. It therefore casts a shadow of bones.
2.2 The type of radiation that causes the skin to become brown.
2.3 Visible light with the longest wavelength.

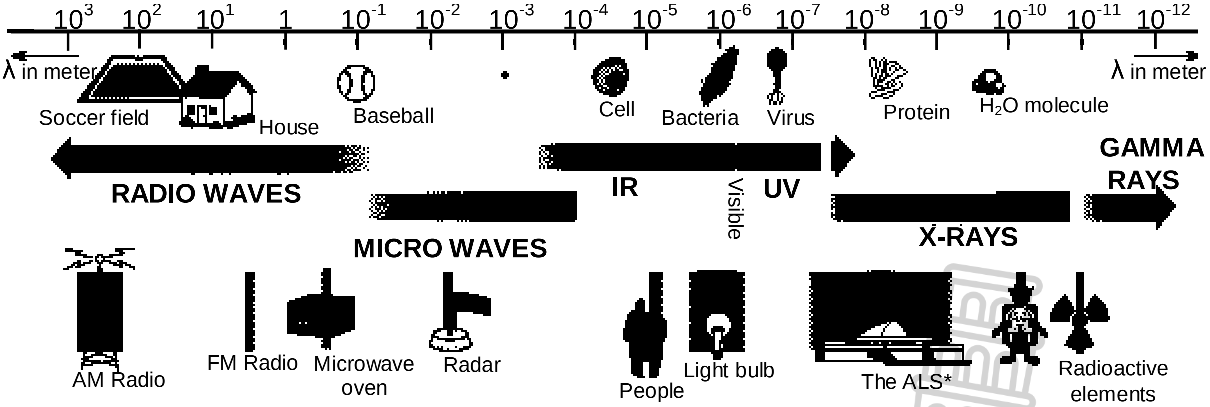
3. Use the wave equation v = fλ to answer the following questions.
3.1 Calculate the highest frequency that radio waves can have.
3.2 Calculate the lowest frequency that gamma rays can have. (1 nm = 1×10^{-9} m)
3.3 What is the main difference between radio waves and gamma rays?
3.4 Radio waves tend to move around objects, while gamma rays tend to move through objects. Give a possible explanation for this phenomenon.

4. What frequencies of light are visible to the human eye? (1 nm = 1×10^{-9} m)

5. Calculate the highest energy associated with X rays.

Daily task 10.2: Classwork/Homework/Data-interpretation

1. The electromagnetic spectrum covers a wide range of wavelengths and photon energies. Light used to "see" an object must have a wavelength about the same size as or smaller than the object. Study the picture of the electromagnetic spectrum. See if you can find answers to the questions.



1.1 What kind of electromagnetic radiation has the shortest wavelength? And the longest?
1.2 What kind of electromagnetic radiation could be used to "see" molecules? And a cold virus?
1.3 Why can't you use visible light to "see" molecules?
1.4 Some insects, like bees, can see light of shorter wavelengths than humans can see. What kind of radiation do you think a bee sees?

2. List at least four properties that all EM waves have in common.

3. How do the different types of EM radiation differ?

4. Which type of EM radiation can be considered the most harmful to people? Explain your choice.

***** ALS The Advanced Light Source, a division of Berkeley Lab, is a national user facility that generates intense light for scientific and technological research.

Can Animals Sense Earthquakes and Tsunamis?

Animals often seem to know things that people don't. So far there have been few reports of animals sensing the devastating earthquake and tsunami that struck Japan in 2011, but with the thousands of missing people and looming threat of nuclear disaster, the focus has understandably not been on animals. In time, we might learn more about how the animals of Japan reacted to this recent geological nightmare.

We do know that animals in areas affected by the 2004 Indian Ocean tsunami most certainly did seem to sense that something disastrous and dangerous had happened. Witnesses report wild animals such as elephants and monkeys moving towards higher ground as well as anxiety and distress in cattle, dogs and other domestic animals. Given the destructiveness of that disaster, surprisingly few dead animals were recovered.

Can animals predict natural disasters? While this might seem odd, if you think about the fact that many species naturally have senses that far more acute than those possessed by humans, it seems less strange. Elephants can respond to and produce infrasound — sound at a lower frequency than human beings can hear. Other mammals with a similar capability include certain types of whales. Wild animals in particular need to have excellent senses of smell, sight, hearing and even the ability to sense minute vibrations, because those senses help them survive. Many species perceive and use electromagnetic fields that are imperceptible to humans to navigate or find prey.

As odd as this seems, whether it's simply the acuteness of the five known senses or a sixth sense that we humans don't possess, there's nothing paranormal or unnatural about it. In fact, some researchers are studying the abilities of animals to sense such disasters so they can be used as an early warning system.

From: Animal planet blogs.discovery.com/animal_oddities/2011/03/can-animals-sense-earthquakes-and-tsunamis.htm

Topic 11: Particles substances are made of

Atoms
Smallest particles of which all substances are made

Noble gases
The only substances found in atomic form

Covalent bonds
- **Sharing of electrons** between two atoms
- Between non-metallic elements
- **To form separate molecules:** oxygen, water, petrol, CO_2, S_8, C_{60}
- **To form giant repeating lattices of atoms:** diamond, graphite, SiO_2, some boron compounds

Ionic Bonds
- **Transfer of electrons** from one atom to another to form positive and negative ions
- **Ionic** substances (or salt or ionic compound) are formed
- Usually composed of both metallic elements and non-metallic elements
- Examples: sodium chloride, potassium permanganate

Metallic bonds
- **Metallic atoms lose their outer electrons** to form a lattice of regularly spaced positive ions and delocalized valence electrons
- The resulting collection of atoms is called a metal.
- Examples are copper, zinc, iron

Chemical structure
- **Ionic structures Giant ionic lattices e.g. NaCℓ**
- **Covalent structures**
  - **Giant molecular structures** (Covalent network lattice or giant atomic lattice or giant covalent lattice) e.g. diamond
  - **Molecular structures**
    - **Small molecules** Simple molecules e.g. CO_2, H_2O
    - **Big molecules** Macromolecules e.g. polymers, DNA
- **Metallic structures Giant metallic lattices e.g. Cu**

Chemical structure	Particles	Chemical Bonding
Giant ionic lattice	Ions	Ionic bonding
Giant molecular lattice (Giant covalent, covalent network or giant atomic lattice if preferred)	Atoms	Covalent bonding
Giant metallic lattice	Metal ions with delocalized valence electrons	Metallic bonding
Molecular lattice (Simple covalent - small & big molecules)	Molecules	Covalent bonding between atoms to form molecules and Intermolecular forces between molecules

Important terms/definitions	
Allotrope	Different crystal structures (forms) of the same element. Example: buckyballs, graphite and diamond are all allotropes (allotropic forms) of carbon.
Buckminster-fullerene (buckyballs)	A form of carbon that contains molecules having 60 carbon atoms arranged at the vertices of a polyhedron with hexagonal and pentagonal faces (like a soccer ball). (It occurs naturally in soot.)
Covalent bonding	A chemical bond formed when electrons are shared between two atoms.
Crystal lattice	Orderly three-dimensional arrangement of particles (ions, atoms, molecules) in a solid structure.
Diamond	A crystal structure of carbon in which each carbon atom is the center of a tetrahedron formed by its nearest neighbours.
Empirical formula	A chemical formula that indicates the composition of a compound in terms of the relative numbers and kinds of atoms in the simplest ratio.
Glass	Hard substance, usually brittle and transparent, composed mainly of silicates and an alkali fused at high temperature.
Graphite	A blackish soft allotropic form of carbon in hexagonal crystalline form. (Used in pencils, crucibles, and electrodes, as a lubricant, as a moderator in nuclear reactors, and, in a carbon fibre form, as a tough lightweight material for sporting equipment.)
Ion	A charged particle made from an atom by the loss or gain of electrons.
Ionic bond	A chemical bond formed when electrons are transferred from one atom to another resulting in an electrostatic attraction between positive and negative ions.
Matter	Anything that has mass and occupies space.
Metallic bond	A chemical bond formed due to the electrostatic attraction between positive ions and delocalised valence electrons in a metal.
Molecular formula	A chemical formula that indicates the actual numbers and kinds of atoms in a molecule, but not the chemical structure.
Molecule	A group of two or more atoms that are covalently bonded and act as a unit in chemical reactions.
Quartz	Second most abundant mineral in the Earth's crust, present in many rocks. It consists of silica, or silicon dioxide (SiO_2).

<u>Daily task 11.1: Classwork/Homework</u>

1. Give one word/term for each of the following descriptions:
1.1 The type of chemical bond that is usually formed between metallic and non-metallic elements
1.2 The elements that do not react because atoms have complete outer energy levels
1.3 Forces of attraction between molecules
1.4 Forces of attraction between atoms within a molecule
1.5 The type of chemical bond formed between metallic atoms
1.6 An equal sharing of two electrons by two non-metallic atoms
1.7 Electrons in a metal that are no longer attached to the metallic atoms
1.8 A bond formed when one atom gains control of the electron pair so that the two atoms become oppositely charged
1.9 An orderly three-dimensional arrangement of particles
1.10 An unequal sharing of two electrons by a pair of bonding atoms

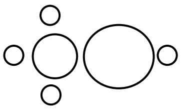
2. Explain the difference between each of the following concepts:
2.1 An atom and an ion
2.2 A molecule and an ion
2.3 A molecule and a compound

Daily task 11.2: Classwork/Homework

1. Use fluorine (F_2) and potassium bromide (KBr) to explain the difference between a covalent bond and an ionic bond.
2. What type of bond (covalent, ionic or metallic) will be present in each of the following substances?

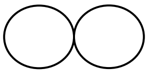
2.1 Potassium chloride
2.2 A lump of lead
2.3 Magnesium oxide
2.4 Carbon dioxide
2.5 A copper wire

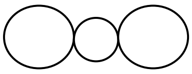
3. In the accompanying diagram, circles of different sizes are used to represent the atoms in CH_3OH.

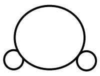


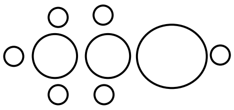
Using the above diagram as key, write down the formula represented by each of the following:

3.1 

3.2 

3.3 

3.4 

3.5 

4. Use circles of different sizes to represent the following molecules with diagrams.

4.1 O_2
4.2 H_2O
4.3 C_8H_{18}

5. Consider the substances below. Classify each as a giant molecular, an ionic, a metallic or a molecular structure.

5.1 Ammonia gas (NH_3)
5.2 Zinc (Zn)
5.3 Graphite (C)
5.4 Nitric acid (HNO_3)
5.5 Neon gas (Ne)

Daily task 11.3: Practical investigation

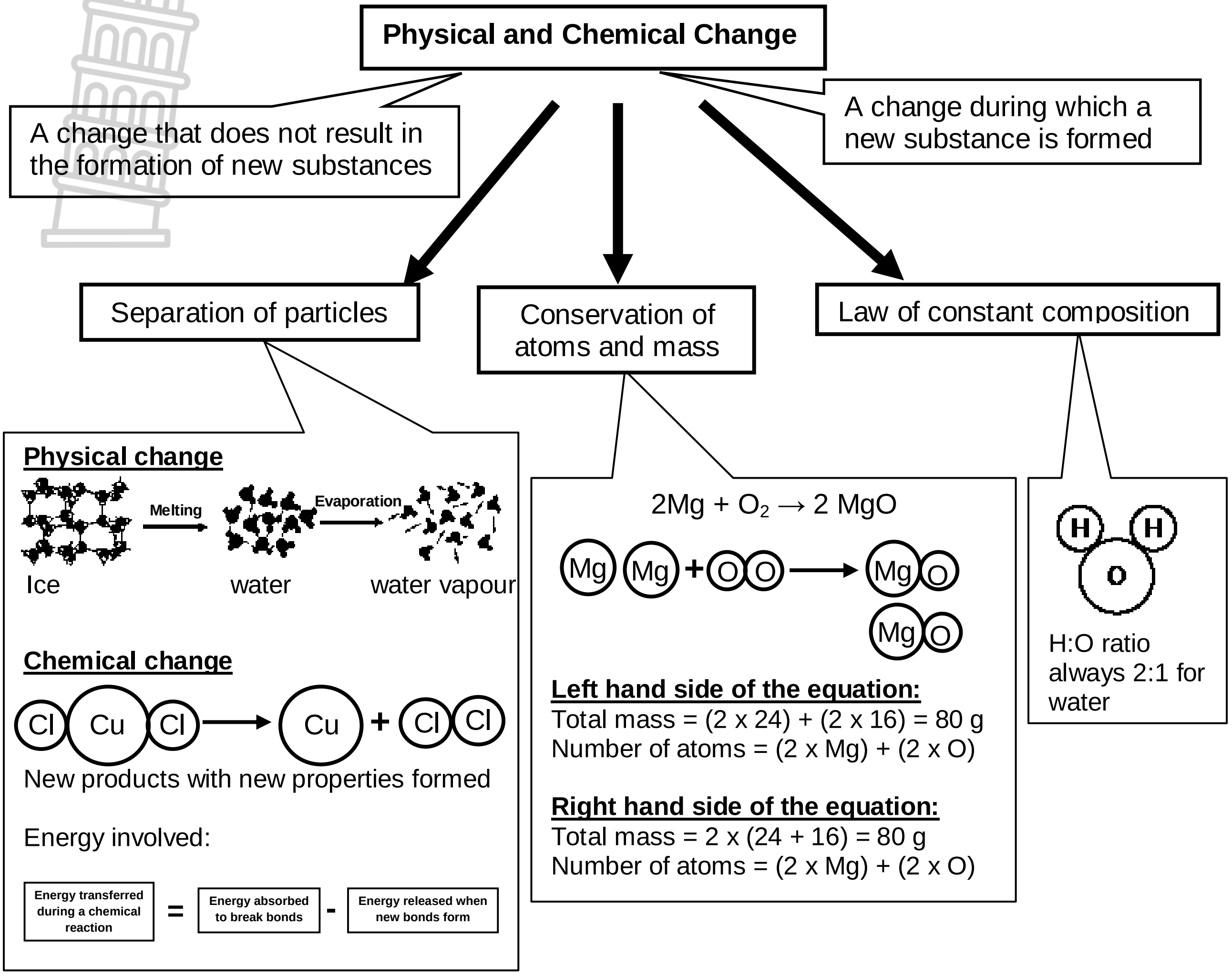
Thabiso places grey iron filings and yellow sulphur powder in a cup and stir it thoroughly for a few minutes. She then holds a magnet close to the mixture and observes that all the grey matter is attracted to the magnet, whilst the yellow powder stays in the cup.

1. Write down an investigation question for this investigation.
2. List all the apparatus that Thabiso needs.
4. Write down the method that Thabiso uses.
5. Is the separation method used by Thabiso a physical or a chemical change? Give a reason for your answer.
6. Classify the above mixture as homogeneous or heterogeneous.

Thabiso again mixes the iron filings and sulphur powder in a test tube and heats the mixture until the contents glow red hot. She then allows the test tube and its contents to cool down. When investigating the contents of the test tube, she finds a solid lump of grey matter that is not attracted to the magnet.

7. Write an investigation question for this investigation.
8. List all the apparatus needed.
9. Write down a method that Thabiso can follow when conducting this investigation.
10. Give a reason why the new product is non-magnetic.
11. What evidence is there to show that a chemical reaction occurred?

Topic 12: Physical and Chemical Change



Physical and Chemical Change

A change that does not result in the formation of new substances

A change during which a new substance is formed

Separation of particles

Conservation of atoms and mass

Law of constant composition

Physical change

Chemical change

New products with new properties formed

Energy involved:

Energy transferred during a chemical reaction = Energy absorbed to break bonds - Energy released when new bonds form

$2Mg + O_2 \rightarrow 2\ MgO$

Left hand side of the equation:
Total mass = (2 x 24) + (2 x 16) = 80 g
Number of atoms = (2 x Mg) + (2 x O)

Right hand side of the equation:
Total mass = 2 x (24 + 16) = 80 g
Number of atoms = (2 x Mg) + (2 x O)

H:O ratio always 2:1 for water

Important terms/definitions	
Atom	The smallest particle which matter consists of.
Catalyst	A substance that speeds up the rate of a chemical reaction without undergoing a change itself.
Chemical change	A change during which a new substance with new properties is formed.
Decomposition reaction	A chemical reaction during which a reactant forms two or more products.
Endothermic reaction	A chemical reaction that absorbs energy.
Exothermic reaction	A reaction that releases energy.
Law of conservation of mass	Matter cannot be created or destroyed in a chemical reaction. The total mass of reactants equals total mass of products.
Law of conservation of energy	Energy can be created or destroyed, but it can only be transformed from one form to another.
Law of constant composition	A particular compound always has the same elements joined together in the same proportions by mass.
Mass	The amount of matter in a body.
Physical change	A change that does not result in the formation of new products.
Synthesis reaction	A chemical reaction during which two or more simple reactants combine to form a more complex product.

Experiment 6: Heating of iron and sulphur

Aim: To investigate the properties of substances before and after a chemical reaction

Apparatus & chemicals

- Iron filings
- Sulphur (powder or flowers of sulphur)
- Magnet
- Test tube
- Bunsen burner or hot plate or stove
- Spatula

Method

1. Prepare a mixture containing iron powder and sulphur powder in the ratio 7:4 by mass. Do this by weighing out 7 g of iron powder and 4 g of finely powdered sulphur onto separate pieces of filter paper.
2. Mix the two powders by pouring repeatedly from one piece of paper to the other.
3. Note the appearance of the pure elements and the mixture.
4. Wrapping the end of a small bar magnet in a paper tissue and dip it into a teaspoon-sized heap of the mixture on a watch glass. Record your observations.
5. Place about 2 g of the mixture into a test-tube.
6. Insert a plug of mineral wool (mineral fibre) into the mouth of the test-tube. Clamp the test-tube as shown in the diagram.
7. Heat the powder mixture at the base of the test-tube – gently at first and then more strongly (use a blue flame throughout).
8. Heat until an orange glow is seen inside the test-tube. Immediately stop heating. Observe what happens inside the test tube.
9. Allow the tube to cool down. Once cool, it is possible to break open the test-tube to show the appearance of the product. It is advisable to wear protective gloves.
10. Bring the magnet close to the product. Record your observations.

Results

1. Redraw the following table into your work book, record your observations and complete the rest of the table.

	Iron filings	Sulphur powder	Product after heating
Magnetic or non-magnetic			
Appearance			
Metal or non-metal			
Formula/Symbol			
Element/compound			

2. The test tube is heated until an orange glow is visible. What do you observe immediately after removal of the heat?

Questions

1. Briefly describe how the mixture if iron filings and sulphur can be separated. Is this a physical or a chemical change?
2. Write down a balanced equation for the reaction that takes after heating the mixture in the test tube.
3. Write down the name of the product formed in the reaction.
4. Is this reaction exothermic or endothermic? Give a reason for your choice.
5. Is this reaction a physical or a chemical change? Give a reason for your answer.
6. Classify the reaction that takes place as either a synthesis or a decomposition.

Experiment 7: Reaction of lead(II) nitrate and potassium iodide

Aim: To observe the product formed when lead(II) nitrate reacts with potassium iodide

Apparatus & chemicals

- Eye protection (goggles)
- Test tube
- Trough with water
- Spatula
- Lead(II) nitrate (toxic, dangerous for the environment)
- Potassium iodide (low hazard)

Method 1

1. Add one spatula of lead(II) nitrate into the test tube.
2. Add one spatula of potassium iodide to the lead(II) nitrate in the test tube.
3. Close the test tube with a stopper and shake vigorously.

Method 2

1. Add one spatula of lead(II) nitrate into the test tube and add enough water to make a clear solution.
2. Add one spatula of potassium iodide into the test tube and add enough distilled water to make a clear solution.
3. Pour the contents of one test tube into other.

Results

Record all observations made in the table below.

Method 1	Method 2

Questions

1. Which procedure results in the faster reaction? Refer to the kinetic theory to explain this observation.
2. Lead(II) iodide is a yellow insoluble solid. Write down a balanced equation for the reaction that takes place in both procedures.
3. Is the above reaction a physical or chemical change? Give a reason for your answer.
4. Briefly describe how the solid product formed in Method 2 can be retrieved from the solution.
5. How will the total mass of the reactants compare to that of the products? Briefly explain.

Daily task 12.1: Classwork/Homework

1. Explain the difference between the following concepts in your own words.

1.1 A chemical and a physical change

1.2 Exothermic and endothermic reactions

2. Classify, with reason, each of the following changes as chemical or physical.

2.1 With pressure and heat graphite becomes a diamond.

2.2 An egg is cooked.

2.3 A tree dies.

2.4 Lightning makes ozone (O_3) from oxygen (O_2). The ozone then reverts to oxygen.

3. Copy the following table in your workbook and classify each of the following changes as a physical or a chemical change.

Change	Chemical or physical?
Digesting an apple	
Burning wood	
Bad odour released by a skunk	
Making a volcano with baking soda and vinegar	
Freezing water	
Rusting of a nail	
Carbon dioxide dissolves in water	
Table salt dissolves in water	

Experiment 8: Preparation of oxygen from H_2O_2

(Teacher demonstration)

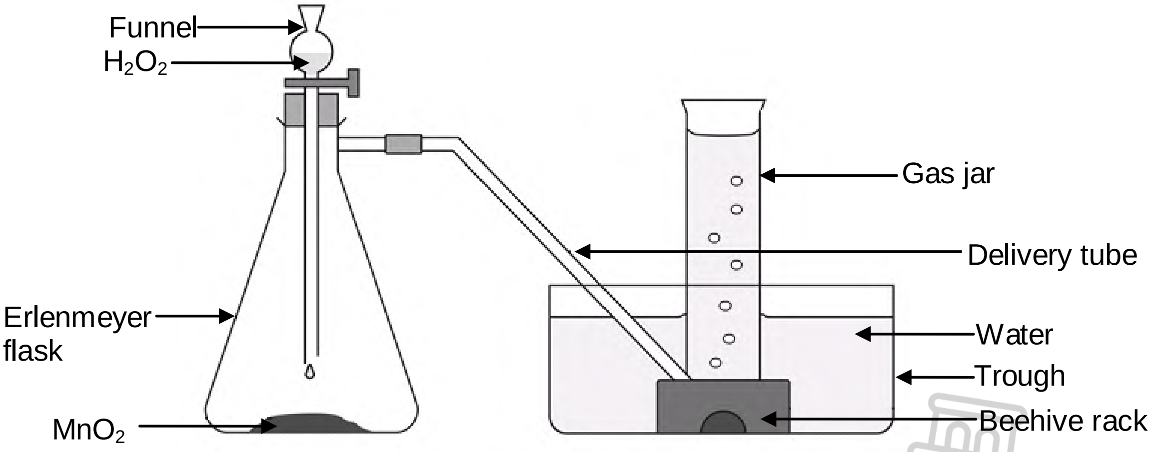
Aim: To prepare oxygen and collect it by the downward displacement of water

Apparatus & chemicals

- 20% - 30% hydrogen peroxide solution (H_2O_2)
- Manganese dioxide (MnO_2)
- Round-bottomed flask or Erlenmeyer flask with a rubber stopper with two holes fitting tightly
- Delivery tube
- Gas jar
- Beehive rack
- Trough with water
- Spatula

Method

1. Place one teaspoon (approximately 10 g) of manganese dioxide in a 500 cm^3 flask.
2. Add 10 cm^3 of water.
3. Use a rubber stopper with two holes, through which a thistle funnel (or dropping funnel) and a delivery tube have been fitted, to close the flask. Alternatively a flask with a side-arm can be used as shown in the diagram below.
4. Fill the funnel with 20% to 30% hydrogen peroxide solution. (Use a fresh solution.)
5. Fill a clean gas jar with water from the glass trough and invert it over the beehive rack.
6. Carefully allow the hydrogen peroxide to run from the funnel so that the oxygen can be collected in the gas jar. **Be careful:** If O_2 is released too quickly the stopper will shoot out.



Results

1. Oxygen is a colourless gas. Write down an observation that you can make in order to know that a gas is indeed released.
2. Describe a test that you can perform to identify the gas as oxygen.

Questions

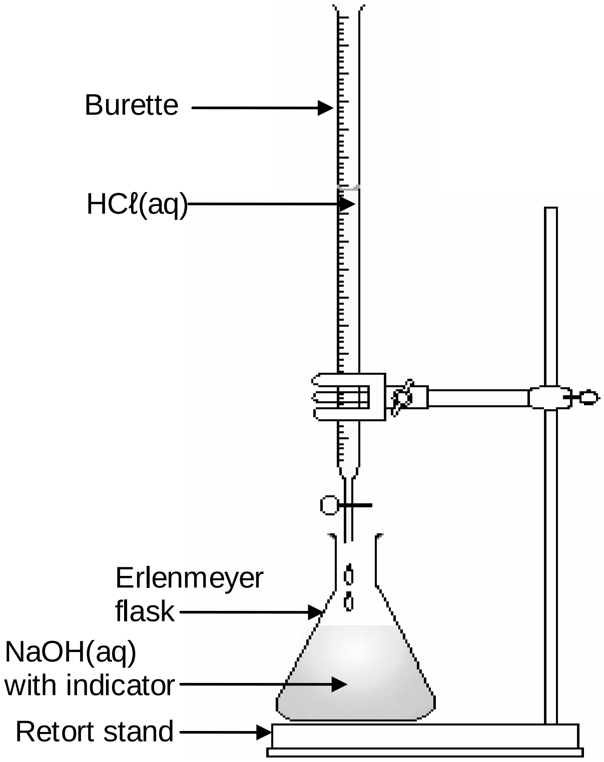
1. Write down a balanced equation for the reaction that takes place.
2. Is the above reaction a physical or chemical change? Give a reason for your answer.
3. After completion of the reaction, all the manganese dioxide is still present. What was the role of manganese dioxide in this reaction?
4. Which other substance remained in the flask after the reaction is completed? Assume that all the hydrogen peroxide has reacted.
5. Oxygen is collected by the downward displacement of water. Briefly explain the meaning of this statement.
6. Show with a calculation that mass is conserved during the decomposition of hydrogen peroxide.
7. Classify this reaction as either a synthesis or a decomposition reaction.

Experiment 9: The reaction of hydrochloric acid and sodium hydroxide

Aim: To investigate the reaction of hydrochloric acid and sodium hydroxide

Apparatus & chemicals

- Hydrochloric acid solution (Add 20 cm^3 of concentrated hydrochloric acid to 60 cm^3 of distilled water.)
- Sodium hydroxide solution (Dissolve 12 g of sodium hydroxide crystals in 100 cm^3 of distilled water.)
- Retort stand
- Measuring cylinder
- Burette
- Erlenmeyer flask
- Thermometer
- Bromothymol blue indicator



Method

1. Rinse the burette with a little bit of the hydrochloric acid solution. Fill it to the zero mark with hydrochloric acid. Use a funnel when filling the burette.
2. Use a pipette to place 20 cm^3 of the sodium hydroxide solution in the Erlenmeyer flask.
3. Add 5 – 7 drops of the bromothymol to the sodium hydroxide solution in the Erlenmeyer flask.
4. Measure the temperature of the solution in the flask.
5. Slowly run 3 cm^3 of acid from the burette into the flask whist stirring the solution with the thermometer. Record the temperature after addition of the 3 cm^3 of acid.
6. Repeat the procedure by adding further quantities of 3 cm^3 acid until the indicator changes colour. Measure the temperature after the addition of each 3 cm^3 of acid.
7. Add another three quantities of 3 cm^3 acid after the colour change and record these temperatures.

Results

1. Copy the table below into your work book and record your results.

Volume of HCℓ(aq) added (cm^3)	Colour of solution with indicator	Temperature (°C)
0		

2. Draw a graph of temperature versus volume of acid added. Use a graph paper. Choose an appropriate scale on each axis and label the axes. Plot the point and draw the graph.
3. Calculate the total change in temperature.

Questions

1. This is an example of the reaction between an acid and a base to form a salt and water. Write down a balanced equation for the reaction that takes place.
2. Is this reaction exothermic or endothermic? Give a reason for your answer.
3. Briefly describe the shape of the graph. Give reasons for the change in shape after at a certain volume of acid added.
4. Was there any change in temperature after the indicator changes colour? Give a reason for this observation.
5. Write down the name of the salt formed in this reaction.
6. Show with a calculation that mass is conserved in this chemical reaction.

Topic 13: Representing chemical change

Chemical equations

A chemical equation is a way to describe what happens during a chemical reaction. Chemical equations are written as follows:

- Symbols indicate elements, ionic or covalent compounds, aqueous solutions, ions, or particles.
- An arrow points to the right to indicate the action of the reaction.
- There are also reversible reactions, i.e. reactions during which the products reassemble to form the original reactants. Reversible reactions are symbolised in chemical equations by a double arrow (⇌).
- The substances to the left of the arrow are the reactants, i.e. the substances that are going to react.
- The substances to the right of the arrow are the products, i.e. the substances that have been produced by the reaction.
- The phases of the reactants and products are indicated in brackets after the formula of the compound. Solids are indicated as (*s*), liquids as (*ℓ*), gases as (*g*) and solutions in water as (*aq*).

Steps for balancing of chemical equations

Step 1: Write down a word equation for the reaction.
Nitrogen + hydrogen → ammonia
Step 2: Write down the correct molecular formulae.
$N_2 + H_2 \rightarrow NH_3$
Step 3: Balance by adding coefficients in the equation (if necessary).
$N_2 + 3\ H_2 \rightarrow 2\ NH_3$
Step 4: Add state symbols.
$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

Daily task 13.1: Classwork/Homework

1. Consider the reaction $Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$.
1.1 State the law of conservation of mass.
1.2 Show with calculations that mass is conserved in this reaction.
1.3 Are atoms conserved in this reaction? Give a reason for your answer.
1.4 Are molecules/formula units conserved in this reaction? Give a reason for your answer.
1.5 Use the formula of silver sulphide to explain what is meant by *The Law of Constant Proportions.*

2. Balance each of the following chemical reactions.
2.1 $Mg + O_2 \rightarrow MgO$
2.2 $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
2.3 $H_2SO_4 + Mg \rightarrow MgSO_4 + H_2$
2.4 $BaC\ell_2 + Na_2SO_4 \rightarrow BaSO_4 + NaC\ell$
2.5 $P_4 + O_2 \rightarrow P_2O_5$
2.6 $CaCO_3 \rightarrow CaO + CO_2$
2.7 $Fe + O_2 \rightarrow Fe_2O_3$
2.8 $HgO \rightarrow Hg + O_2$
2.9 $Cu + AgNO_3 \rightarrow Cu(NO_3)_2 + Ag$
2.10 $(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + H_2O$

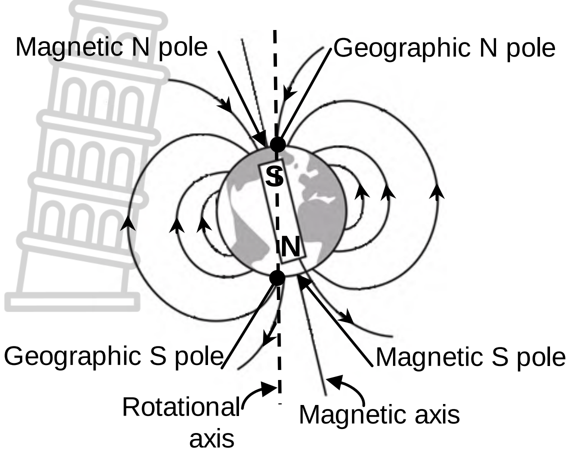
3. Use relative atomic masses to prove that the balanced chemical equations above adhere to the *law of conservation of mass*.

Daily task 13.2: Classwork/Homework

Write balanced chemical equations for the following equations:

1. hydrogen + oxygen → water
2. methane + oxygen → carbon dioxide + water
3. silver nitrate + sodium chloride → silver chloride + sodium nitrate
4. sulphur dioxide + oxygen → sulphur trioxide
5. nitric acid + copper → copper(II) nitrate + nitrogen dioxide + water
6. iron(III) oxide + carbon monoxide → iron + carbon dioxide

Topic 14: Magnetism



Earth's magnetic field

Permanent magnets: Hard iron
Temporary magnets: Soft iron

Ferromagnetic materials
Iron, nickel, cobalt & their alloys

Strongly attracted by magnets & are magnetised easily

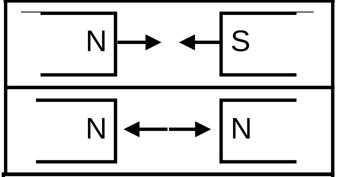
Magnetic materials

Materials that are attracted by magnets.

Magnetism

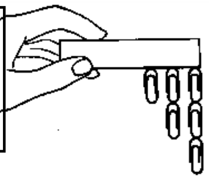
Magnets

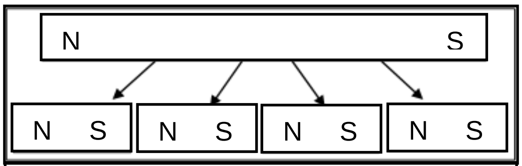
N pole and a S pole



Like poles repel
Unlike poles attract

Force strongest at poles
Non-contact force





When cut, each piece has a N pole and S pole

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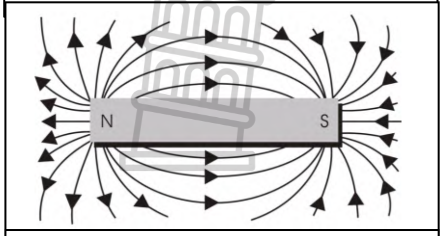
Magnetic field

Region in space where another magnet or ferromagnetic material will experience a force.

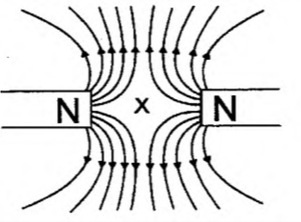
Points in direction of the force on a free N pole at a point in field.

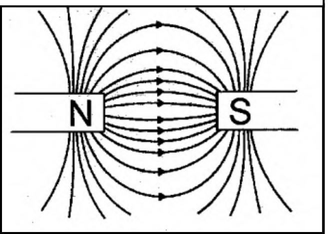
Represented with field lines
Magnetic field lines:

- Never cross
- Are imaginary lines
- Are continuous
- Point from N to S
- Are closest together at poles where field is strongest



Magnetic field pattern around a bar magnet





Important terms/definitions	
Angle of declination	Angle between the magnetic N pole and geographic N pole (true north) of the earth.
Aurora Borealis (Northern lights)	An atmospheric phenomenon consisting of bands of light at the N pole caused by charged solar particles following the earth's magnetic lines of force.
Ferromagnetic material	Materials that are strongly attracted by magnets and easily magnetised. Iron, cobalt, nickel and their alloys.
Geographic north pole	Point in the northern hemisphere where the rotation axis of the earth meets the surface.
Magnetic axis	The straight line joining the N pole and the S pole of a magnet.
Magnetic field	A region in space where another magnet or ferromagnetic material will experience a force.
Magnetic north pole	The point where the magnetic field lines of the earth enters the earth. It is direction in which the N pole of a compass points.
Magnetic south pole	The point where the magnetic field lines of the earth leaves the earth.
Magnetic storms	A disturbance in the Earth's outer magnetosphere, usually caused by streams of charged particles given off by solar flares.
Magnetosphere	A region surrounding the earth (extending from about one hundred to several thousand kilometres above the surface) in which charged particles are trapped and their behaviour is dominated by the earth's magnetic field.
Non-contact force	A force exerted on an object without touching the object.
Solar wind	A stream of radioactive and charged particles send into space at high speeds due to reactions on the sun.

Experiment 10: The magnetic field around a bar magnet

Aim: To investigate the magnetic field around a bar magnet

Apparatus

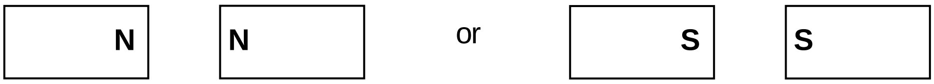
- Two bar magnets
- Iron filings
- Sheet of paper
- Small compasses

Method & results

1. Magnetic field around a bar magnet
1.1 Place a sheet of paper on top of a bar magnet.
1.2 Sprinkle iron filings evenly over the sheet of paper.
1.3 Tap the paper lightly with your finger until a clear pattern can be observed.
1.4 Draw the outlines of the bar magnet and the pattern of the iron filings in the form of curved lines in your workbook.

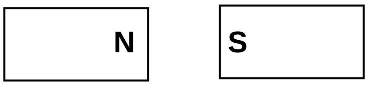
2. Direction of the field lines
2.1 Place the small compasses at various positions on the sheet of paper on top of the magnet.
2.2 In which direction do the field lines point, with reference to the south pole and the north pole of the magnet as indicated by the compass? Indicate the direction of the magnetic field lines on the sketch in your workbook.

3. Magnetic field between two north poles and two south poles
3.1 Place two bar magnets with their north poles or their south poles near each other.



3.2 Place a sheet of paper on top of the magnets.
3.3 Sprinkle iron filings evenly over the sheet of paper.
3.4 Tap the paper lightly with your finger until a clear pattern can be observed.
3.5 Draw the outlines of the bar magnets and the pattern of the iron filings in the form of curved lines in your workbook.

4. Magnetic field between a north pole and a south pole
4.1 Place two bar magnets with the north pole of one magnet and the south pole of the other magnet near each other.



4.2 Place a sheet of paper on top of the magnets.
4.3 Sprinkle iron filings evenly over the sheet of paper.
4.4 Tap the paper lightly with your finger until a clear pattern can be observed.
4.5 Draw the outlines of the bar magnets and the pattern of the iron filings in the form of curved lines in your workbook.

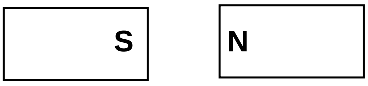
Daily task 14.1: Classwork/Homework

1. What is meant by *the N pole of a magnet*?

2. Define the term *magnetic field*.

3. Explain what will be observed in each of the following cases:
3.1 The N pole of a magnet is brought close to the N pole of another magnet
3.2 The S pole of a magnet is brought close to the N pole of another magnet

4. Draw the magnetic field lines for the following arrangement of two bar magnets.



5. Which of the following objects will be attracted by a magnet?
5.1 R2 coin
5.2 Glass
5.3 Graphite in a pencil
5.4 Copper wire
5.5 Iron nail
5.6 Wooden block

6. Some materials are known as ferromagnetic materials.
6.1 Define the term *ferromagnetic material.*
6.2 Write down the names of the three ferromagnetic materials that occur on the periodic table.

Daily task 14.2: Classwork/Homework

1. You are supplied with a metal rod which you are told is a magnet. You are requested to find out which side of the rod is the N pole of the magnet.
1.1 Name one other apparatus that you will need.
1.2 Briefly describe how you will use the apparatus to determine the N pole of the magnet.
1.3 Give the names of TWO substances that could be used to make a magnet.

2. Which of the following materials could be used to make the needle of a pocket navigating compass?
Magnesium; soft iron; aluminium; steel; brass

3. Explain the difference between a hard magnetic material and a soft magnetic material.

4. The earth's magnetosphere is important for life on earth.
4.1 Define the term *magnetosphere.*
4.2 Explain how the magnetosphere helps to maintain life on earth.

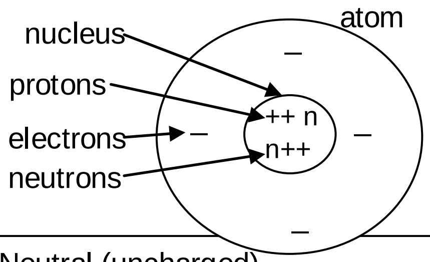
Topic 15: Electrostatics

ELECTROSTATICS

Study of charges at rest

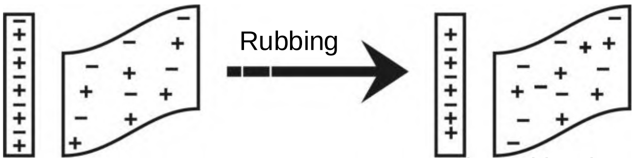
Two kinds of charge
Positive: electron deficient
Negative: excess of electrons

All matter consist of atoms



Neutral (uncharged)
Number of protons = number of electrons

Charging objects
By contact: Electrons transferred from one object to another.



Glass rod: neutral
Woollen cloth: neutral

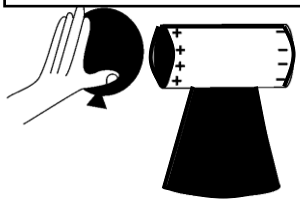
Glass rod: positive (e- lost)
Woollen cloth: negative (e^- gained)

When the glass rod is rubbed (comes in contact) with the woollen cloth, electrons are transferred from the rod to the cloth. The rod has an electron deficit and is positive. The cloth has an excess of electrons and is negative.

Electrostatic forces
Like charges: Repel
Unlike charges: Attract

Electrostatic forces
Charged object on neutral object by polarisation

Polarisation of charge
Negatively charged balloon repels electrons in can towards far end.



Tribo-electric series

Materials
Dry skin of humans
Leather
Rabbit fur
Glass
Human hair
Nylon
Wool
Lead
Cat hair
Silk
Aluminium
Paper
Cotton (neutral)
Steel (neutral)
Wood (practically neutral)
Amber
Rubber
Nickel, Copper
Brass, Silver
Gold, Platinum
Polyester
Foam plastic
Cling wrap
Polyurethane (type of plastic)
Polyethylene (Scotch tape)
Polypropylene (type of plastic)
Vinyl (PVC) (type of plastic)

Stronger positive

Stronger negative

Conservation of charge

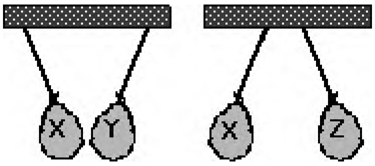
Charge cannot be created or destroyed. It can only be transferred from one object to another.

Charge quantisation

All charges are multiples of the smallest charge i.e. the charge on one electron: $1{,}6 \times 10^{-19}$ C

Important terms/definitions	
Electrons	Negative particles occupying space around nucleus.
Elementary charge	An indivisible unit of charge i.e.1,6 x 10^{-19} C.
Neutrons	Neutral particles in the atomic nucleus.
Protons	Positive particles in atomic nucleus.
Polarisation (of charge)	The partial or complete polar separation of positive and negative electric charge in a system.
Quantization (of charge)	Division of charge in smaller units
Principle of conservation of charge	Charge cannot be created or destroyed. It can only be transferred from one object to another.
Principle of charge quantization	Every stable and independent object has a charge that is an integer multiple of the elementary charge.
Triboelectric charging (Triboelectric effect)	A type of contact electrification in which certain materials become electrically charged after they come into contact with another different material and are then separated (such as through rubbing). The polarity and strength of the charges produced differ according to the materials.

Daily task 15.1: Classwork/Homework

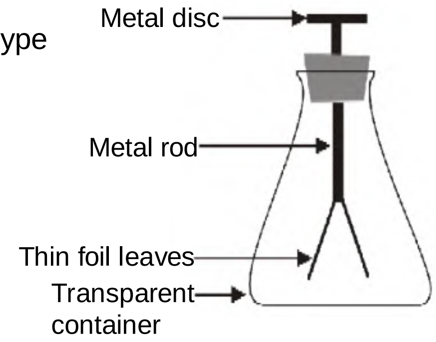


1. Balloons **X**, **Y** and **Z** are hanging as shown.
   If balloon **X** is positively charged, balloon **Z**:
   A Must be positively charged
   B Must be negatively charged
   C Must be neutral
   D Could be either negatively charged or neutral
   E Could be either positively charged or neutral

2. Two small IDENTICAL metal spheres, **P** and **R**, on insulated stands carry changes of $+ 5 \times 10^{-9}$ C and $- 3 \times 10^{-9}$ C respectively.

2.1 Which sphere has a(n):
2.1.1 Excess of electrons
2.1.2 Shortage of electrons
2.2 Calculate the number of electrons that was transferred during charging of sphere **P**. Were these electrons removed from or added to sphere **P**?
2.3. The spheres are now brought into contact and then separated again.
2.3.1 State the principle of conservation of charge in words.
2.3.2 Calculate the new charge on each sphere after separation.

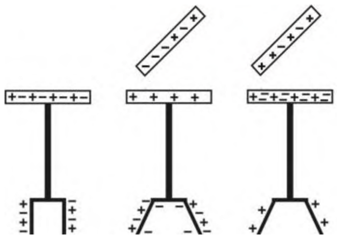
Experiment 11: Charging by contact



Aim: To use an electroscope to indicate charge and to indicate type of charge.

Apparatus
Electroscope
Glass or Perspex rod
Woollen cloth
(Use the triboelectric series to select materials available to obtain the desired charge)

Method, Results & Conclusion



1. Neutral electroscope

1.1 Charge a glass rod by rubbing it with a woollen cloth.
1.2 Hold a positively charged rod near the disc of the electroscope.
What do you observe?
Sketch your observation (similar to the accompanying diagram for a negative rod held close to a neutral electroscope).
1.3 Remove the charged glass rod. What do you observe?
1.4 Repeat the procedure with a negatively charged rod.
1.5 What was the function of the electroscope in this experiment?

3. Positively charged electroscope

2.1 Charge an electroscope by touching it with a positively charged glass rod. It may be necessary to drag the glass rod across the disc.
Explain how the electroscope obtained a positive charge.
Sketch your observation after the glass rod has been removed.
2.2 Charge a glass rod by rubbing it with a woollen cloth and hold it near the disc of the charged electroscope.
What do you observe?
Sketch your observation.
2.3 Explain your observation in step 2.2.
2.4 What effect do two positively charged objects have on each other?
2.5 Rub a PVC rod with a woollen cloth and hold it near to the disc of a positively charged electroscope.
What do you observe?
Sketch your observation.
2.6 What is the charge on the PVC rod? Explain your answer.
2.7 How can this electroscope be used to indicate the charge on an object with an unknown charge?

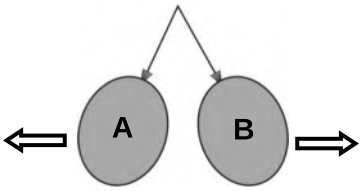
Questions

1. Give TWO functions of an electroscope.
2. Why are the disc, rod and leaves of the electroscope made from metal?
3. Explain how you would charge an electroscope negatively by means of contact. Use the Triboelectric Series to choose materials that will result in a negative charge on the rod. Illustrate your explanation with the necessary sketches.
4. What do you predict will happen when a charged glass rod is held near to negatively charged electroscope? Explain your answer.
5. What do you predict will happen when a charged PVC rod is held near the disc of an electroscope? Explain your answer.
6. Your teacher will now demonstrate this experiment. Test your predictions by observing the demonstration.

Daily task 15.2: Classwork/Homework

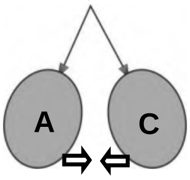
1. A glass rod is positively charged by rubbing it with a silk cloth. During the charging process, …
   - A electrons are transferred from the glass rod to the silk cloth.
   - B electrons are transferred from the silk cloth to the glass rod.
   - C protons are transferred from the glass rod to the silk cloth.
   - D protons are transferred from the silk cloth to the glass rod.

2. Learners investigate two types of charges and the effect these charges have on each other. They rub two inflated balloons, **A** and **B**, with a woollen cloth. When holding the two balloons close to each other, the balloons REPEL each other, as shown below.



REPULSION

They then rub a third balloon, **C**, with cling wrap and hold it close to balloon **A**. They observe that the two balloons ATTRACT each other, as shown below.



ATTRACTION

2.2 How did the balloons become charged?

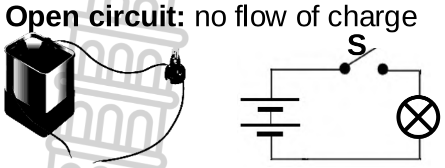
2.2 Write down a conclusion that the learners can draw concerning the charge(s) on:

2.2.1 Balloon **A** and balloon **B**

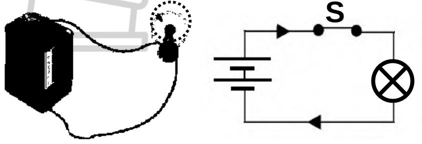
2.2.2 Balloon **A** and balloon **C**

Topic 16: Electric circuits

Open circuit: no flow of charge



Closed circuit: charges flow

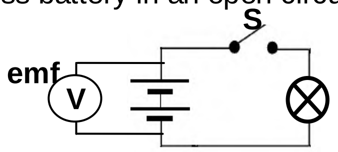


Current:

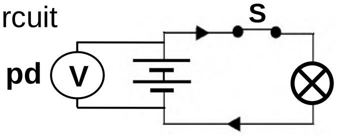
Rate of flow of charge: $I = \frac{Q}{\Delta t}$

Unit: ampere (A)
Measuring instrument:
ammeter - connected in series
Conventional current:
from positive to negative

Emf of battery: potential difference across battery in an open circuit



Potential difference of battery:
Potential difference across battery in a closed circuit



Potential difference
Unit: volt (V)
Measuring instrument:
voltmeter - connected in parallel

Resistance
Opposition to flow of charge
Unit: ohm (Ω)
Resistance is the ratio of potential difference across a resistor to the current through it: $R = \frac{V}{I}$

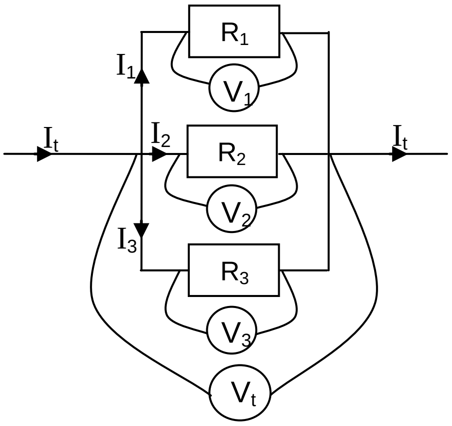
Electric circuits

Parallel circuit

More than one pathway for charges
One or more branches

Resistors in parallel

1. Current dividers
   $I_t = I_1 + I_2 + I_3$
2. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
3. Potential difference everywhere the same: $V_t = V_1 = V_2 = V_3$

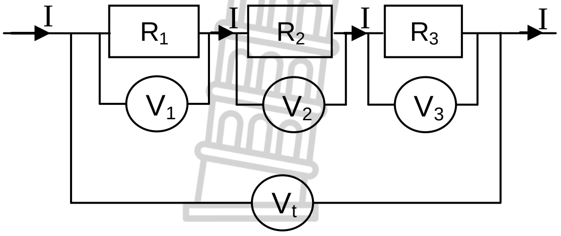


Series circuit

Only one pathway for charges
No branches

Resistors in series

1. Potential dividers
   $V_t = V_1 + V_2 + V_3$
2. $R_{total} = R_1 + R_2 + R_3$
3. Current everywhere the same



Important terms/definitions	
ampere (A)	The unit of measurement of electric current.
coulomb (C)	The unit of measurement of electric charge. Definition: The current is one ampere when a charge of one coulomb passes a given point in a conductor one second.
Electric current	The rate of flow of charge. ($I = \frac{Q}{\Delta t}$)
Emf	The potential difference (voltage) measured across the terminals of a battery when no charge flows through the battery.
ohm (Ω)	Unit of measurement of resistance. Definition: One ohm is one volt per ampere.
Potential difference	The potential difference between the ends of a conductor is equal to the energy transferred (from electrical to other forms of energy) per unit electric charge flowing through it. ($V = \frac{W}{Q}$)
Resistance	Resistance is the ratio of the potential difference across a resistor to the current in the resistor.
volt (V)	The unit of measurement of potential difference.
Voltmeter	The instrument used to measure potential difference. A voltmeter is connected in parallel and has a very high resistance.
Ammeter	The instrument used to measure electric current. An ammeter is connected in series and has a very low resistance.

Daily task 16.1: Homework/Classwork

1. Which ONE of the following statements regarding conventional current is TRUE?
   A The direction of the current is the same as the direction of the flow of electrons.
   B The direction of the current is perpendicular to the flow of electrons.
   C The direction of the current is opposite to the direction of flow of electrons.

2. Which ONE of the following is the unit of measurement of electric current?
   A volt
   B coulomb
   C ohm
   D ampere

3. A charge of 5 C passes through a conductor in 3 s. Calculate the current in the conductor. Give the answer to two decimal places.

4. The current in a wire is 3 A. Calculate the charge that flows through the wire in 1 minute.

5. Calculate the time that 84 C must flow through a copper wire to register a current of 7 A.

6. A variable resistor and a battery are connected in a circuit. How will the current in the circuit change if the resistance of the circuit is doubled?
   A Doubles
   B Halves
   C Remains the same

7. Which ONE of the following statements is NOT true?
   A Potential difference (voltage) is inversely proportional to resistance.
   B Potential difference (voltage) is directly proportional to current.
   C Current is inversely proportional to resistance.

Daily task 16.2: Homework/Classwork

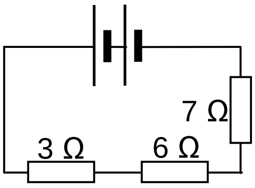
1. Which ONE of the following will produce the highest resistance?
   A Two 1 ohm resistors in series
   B Two 2 ohm resistors in series
   C Three 3 ohm resistors in parallel
   D Two 1 ohm resistors in parallel

2. Which ONE of the following correctly describes the resistance of a circuit?

   Resistance is the:

   A Rate at which charge flow through a wire
   B Product of current and potential difference (voltage)
   C Opposition that the conductor have to flow of charge
   D Force of gravity applied on a wire

3. Calculate the total resistance of the circuit represented by the circuit diagram alongside.



4. A learner connects a battery, a wire, a voltmeter and an ammeter to form a circuit. The reading on the voltmeter is 4 V and the reading on the ammeter is 3 A.
4.1 How must the learner connect the ammeter in the circuit?
4.2 How must the learner connect the voltmeter to measure the potential difference between the ends of the wire?
4.3 Calculate the total resistance of the circuit.

5. Study the circuit diagrams given below.

Diagram 1

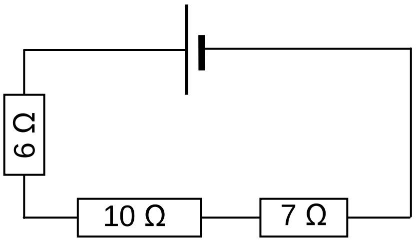
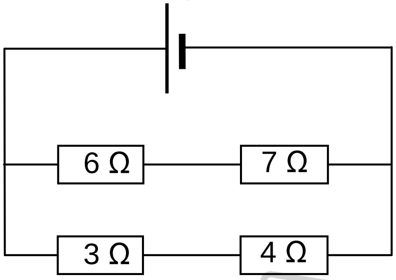
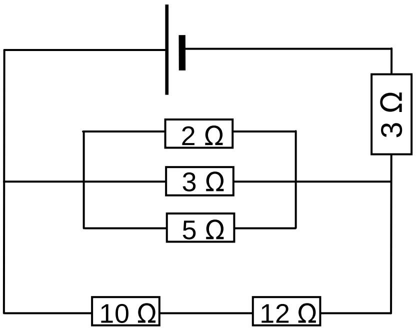


Diagram 2



Calculate the total resistance of the circuit in:
5.1 Diagram 1
5.2 Diagram 2

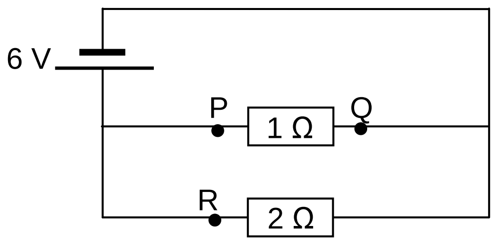
6. Calculate the total resistance in the circuit represented in the diagram below.



Daily task 16.3: Homework/Classwork

Answer QUESTIONS 1 and 2 by referring to diagram 1 alongside.

Diagram 1



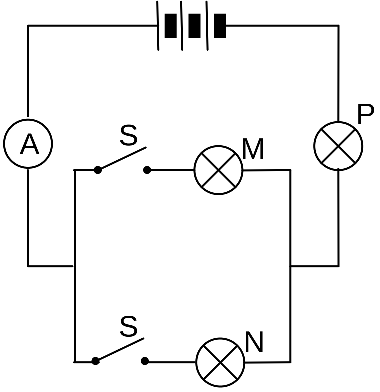
1. Which ONE of the following correctly shows the potential per coulomb charge at each of points P, Q, and R?

A 6 J; 6 J; 6 J B 3 J; 3 JV; 0 J
C 6 J; 0 J; 6 J D 1 J; 2 JV; 3 J

2. Which ONE of the following correctly represents the electric current at each of points P, Q, and R?

A 4,5 A; 4,5 A; 4,5 A B 6 A; 6 A; 3 A C 6 A; 3 A; 4,5 A D 2,5 A; 1,5 A; 6,5 A

3. In the circuit diagram below, three identical bulbs are connected as shown. The ammeter, connecting wires and battery have negligible resistance. Study the diagram and then answer the questions that follow

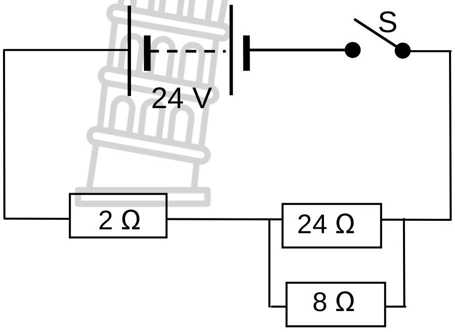


3.1 Switches S_1 and S_2 are open. Which bulbs, if any, will light up?
3.2 Switch S_1 is closed and S_2 is open. Compare the brightness of bulbs M, N and P.
3.3 *Switches S_1 and S_2 are closed*. Compare the potential differences across bulbs M, N and P.

For QUESTIONS 3.4 and 3.5, choose the correct answer from those given in the brackets.

3.4 Adding bulbs in parallel causes the:
3.4.1 Resistance of the circuit to (increase/decrease/remain the same)
3.4.2 Potential difference across the battery to (increase/decrease/ remain the same)
3.5 Parallel circuits can be regarded as (current/potential) dividers.

4. Consider the following circuit diagram.
4.1 Copy the circuit diagram into your workbook, but add symbols to show how to connect a voltmeter to measure the potential difference across the battery and how to connect an ammeter to measure the current through the battery. Show the direction of the current passing through the battery using a labelled arrow.

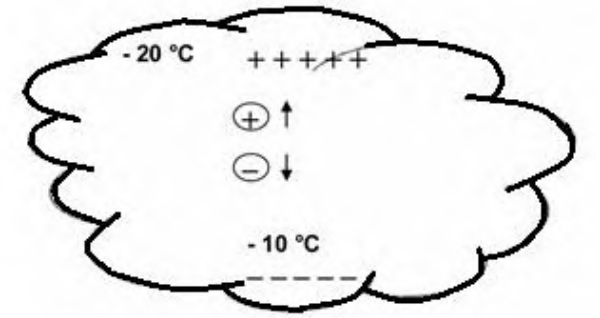


4.2 Calculate the equivalent resistance of the resistors connected in parallel.
4.3 Calculate the total resistance of the circuit.
4.4 If the potential difference across the 2 Ω resistor is 6 V, deduce the potential difference across the parallel combination.
4.5 A charge of 18 C flows through the battery in 6 s.
4.5.1 Calculate the current that passes through the battery.
4.5.2 Deduce the current passing through the 8 Ω resistor if the current passing through the 24 Ω resistor is 0,75 A.

Daily task 16.4: Homework/Classwork

1. During a thunderstorm, strong air currents inside clouds rub ice crystals against each other. This results in a separation of charge and hence a potential difference. The potential difference between the top and the bottom of a storm cloud can be millions of volts. Friction leaves the top of the cloud positively charged and the bottom of the cloud negatively charged. Generally, low lying clouds have a temperature of – 10 °C at the bottom and – 20 °C at the top.

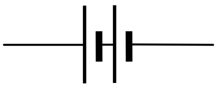
When lightning strikes, negative charge from th
air to the ground. A lightning flash usually consi
another. The temperature inside a flash can be



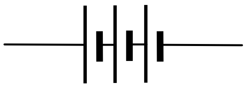
1.1 Define the following terms:
1.1.1 Electric current
1.1.2 Potential difference
1.2 Explain why ice crystals are formed in the clouc
1.3 In one of the lightning flashes 75 A of electric current passes from the bottom of the cloud to the ground below in 1,5 s. Calculate the amount of charge that passes from the cloud to the ground in the lightning flash.
1.4 The potential difference between the bottom of the cloud and the ground is 2 000 000 V. Use your answer from QUESTION 4.3 to calculate the amount of heat energy produced during the lightning flash.

2. The diagrams (A, B and C) below show identical cells connected in different ways.

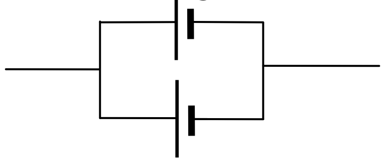
A



B

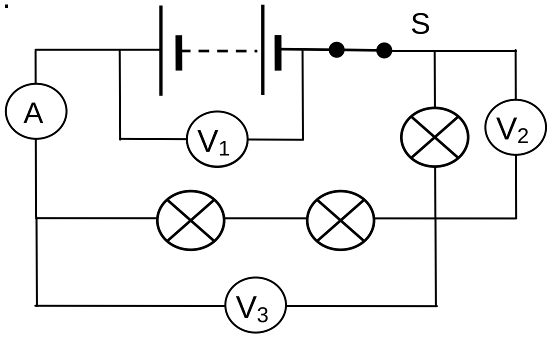


C



Which diagram represents the cells that:
2.1 Will let a bulb glow the brightest
2.2 Last the longest

3. In the accompanying circuit diagram, the three bulbs are identical and the reading on voltmeter V_1 is 12 V.

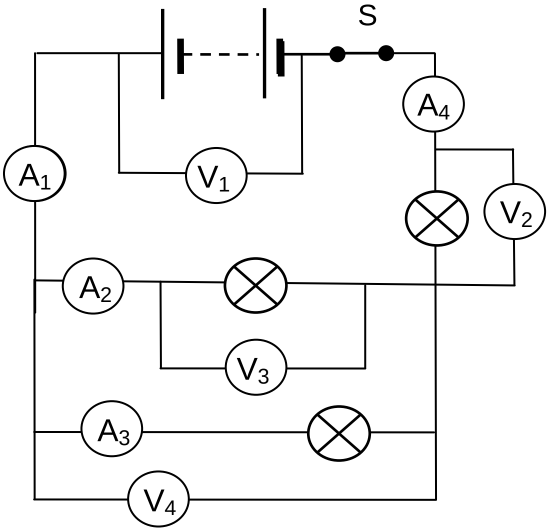


Determine the reading on voltmeter:
3.1 V_2
3.2 V_3

Daily task 16.5: Homework/Classwork

1. Three identical bulbs are connected in a circuit as shown alongside. Compare the readings on:

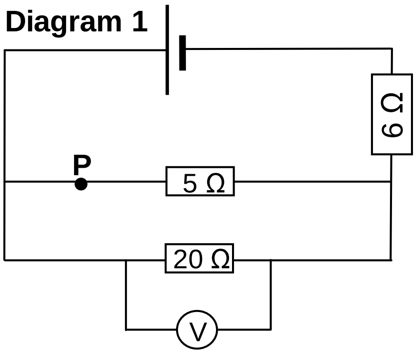
1.1 A_1, A_2 and A_3
1.2 A_1 and A_4
1.3 A_2 and A_3
1.4 V_1 and V_4
1.5 V_1, V_3 and V_4
1.6 V_1, V_2 and V_4
1.7 V_1, V_2 and V_3
1.8 V_3 and V_4



2. Consider diagram 1 alongside.

The current at point **P** is measured to be 1,6 A. Determine the potential difference (voltage) of the battery.

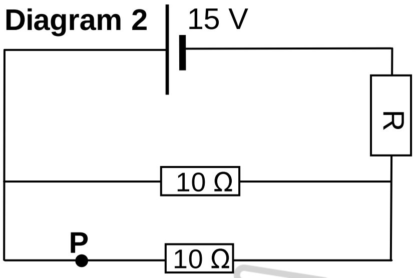
Diagram 1



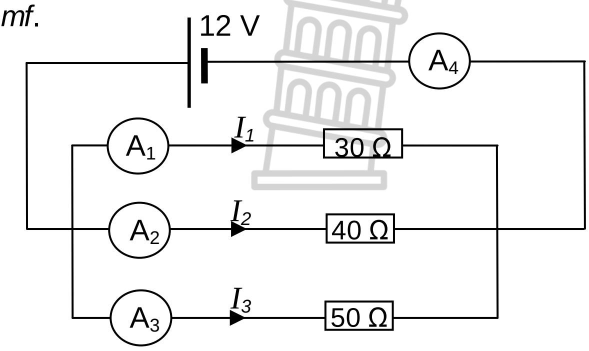
3. Consider diagram 2 alongside.

The current at point **P** is measured as 0,5 A.
Determine the resistance of **R**.

Diagram 2



4. The accompanying circuit diagram shows three resistors connected to a cell.
4.1 The emf of the cell is 12 V. Define the term *emf*.
4.2 Are the resistors connected in series or in parallel?
4.3 Calculate the:
4.3.1 Total resistance of the circuit
4.3.2 Current through the 30 Ω resistor
4.3.3 Current through the 40 Ω resistor
4.3.4 Current through the 50 Ω resistor
4.4 Calculate the total current in the circuit.



5. A circuit consists of a 10 ohm resistor and carries a current of 5 A. Calculate the potential difference (voltage) across the resistor.

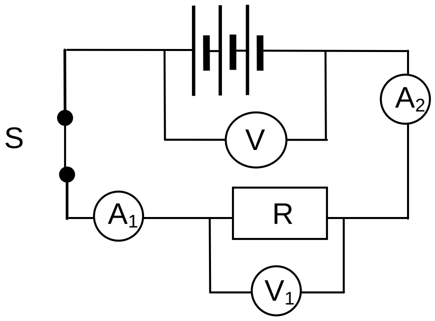
6. A 6 V power source is connected to a conductor with resistance of 4 Ω. Calculate the current in the conductor.

Experiment 12: A circuit with an ammeter in series and a voltmeter in parallel

Aim: Set up a circuit to measure the current through and the potential difference across a light bulb or resistor.

Apparatus

- Three 1,5 V cells
- A resistors
- Two voltmeters or else one voltmeter can be moved to different positions in the circuit
- One or two ammeters
- Conducting wires
- Switch
- Circuit board if available



Method

1. Set up the circuit as shown in the accompanying diagram.
2. Connect a voltmeter (V) across the three cells and take the reading.
3. Connect the other voltmeters (V_1) as shown in the diagram. Take the reading on each voltmeter. Alternatively one voltmeter can be moved from one position to the other.
4. Move the ammeter to different positions in the circuit or else connect a second ammeter on the opposite side of the cell as shown in the diagram. Take the readings on the ammeter(s) in two different positions in the circuit.

Results/Observations

Redraw the following table in your practical book and record the results obtained.

Voltmeter reading V (V)	Voltmeter reading V_1 (V)	Ammeter reading A_1 (A)	Ammeter reading A_2 (A)

Interpretation/Conclusion

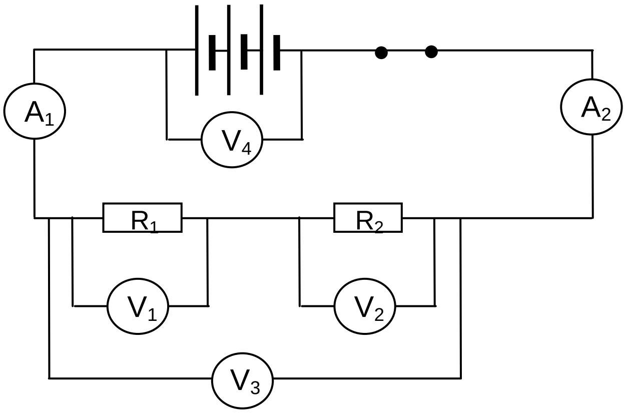
1. How do the ammeter readings compare when the switch is closed? What conclusion can be drawn regarding the current in a series circuit?
2. How do the voltmeter readings compare when the switch is closed? What conclusion can be drawn from these readings?
3. How do we connect an ammeter in a circuit?
4. How do we connect a voltmeter in a circuit?

Experiment 13: Resistors in series

Aim: To compare the potential differences across two resistors in series with the sum of the potential differences across each of the two resistors and to compare the currents measured at different positions in the circuit.

Apparatus

- Three 1,5 V cells
- Two resistors
- Four voltmeters or else one voltmeter can be moved to different positions in the circuit
- One or two ammeters
- Conducting wires
- Switch
- Circuit board if available



Method:

1. Set up the circuit as shown in the accompanying diagram.
2. Connect a voltmeter (V_4) across the three cells and take the reading.
3. Connect the other three voltmeters (V_1, V_2 and V_3) as shown in the diagram. Take the reading on each voltmeter. Alternatively one voltmeter can be moved from one position to the other.
4. Move the ammeter to different positions in the circuit or else connect a second ammeter on the opposite side of the cell as shown in the diagram. Take the readings on the ammeter(s) in two different positions in the circuit.
5. Repeat the procedure. If available, two different resistors may be used.

Results/Observations

Redraw the following table in your practical book and record the results obtained.

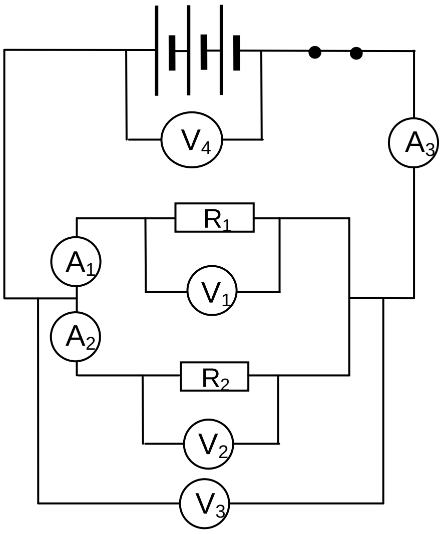
	Voltmeter reading V_4	**Voltmeter reading V_1**	**Voltmeter reading V_2**	**Voltmeter reading V_3**	**Ammeter reading A_1**	**Ammeter reading A_2**
Trial 1						
Trial 2						

Interpretation/Conclusion

1. For this investigation, write down the:
1.1 Investigative question
1.2 Hypothesis
2. How does the ammeter readings compare? What conclusion can be drawn regarding the current in a series circuit from these readings?
3. How do the voltmeter readings compare? What conclusion can be drawn from these readings?

Experiment 14: Resistors in parallel

Aim: To compare the potential differences across resistors in parallel with the potential differences across each of the resistors in parallel and to compare the current in each branch with the main current in the circuit.



Apparatus

- Three 1,5 V cells
- Two resistors
- Four voltmeters or else one voltmeter can be moved to four different positions
- Three ammeters or else one ammeter can be moved to three different positions
- Conducting wires
- Switch
- Circuit board if available

Method:

1. Set up the circuit as shown in the accompanying diagram.
2. Connect the four voltmeters as shown or else move one voltmeter to the different positions in the circuit Voltmeter V_4 measures the potential difference across the three cells, voltmeters V_1 and V_2 measure the potential difference across resistors R_1 and R_2 respectively, and voltmeter V_3 measures the potential difference across the combination of resistors R_1 and R_2.
3. Connect an ammeter (A_1 and A_2) in each of the parallel branches to measure the current in each branch. Alternatively one ammeter can be moved from one position to another. Connect an ammeter (A_3) to measure the total current in the circuit.
4. Repeat the procedure. If available, two different resistors may be used.

Results/Observations

Redraw the following table in your practical book and record the results obtained.

	Voltmeter reading V_4	**Voltmeter reading V_1**	**Voltmeter reading V_2**	**Voltmeter reading V_3**	**Ammeter reading A_1**	**Ammeter reading A_2**	**Ammeter reading A_3**
Trial 1							
Trial 2							

Interpretation/Conclusions:

1. For this investigation, write down the:
1.1 Investigative question
1.2 Hypothesis
2 How does the ammeter readings compare? What conclusion can be drawn regarding the current in a parallel circuit?
3 How do the voltmeter readings compare? What conclusion can be drawn from these readings?

Topic 17: Vectors and scalars

Physical Quantities

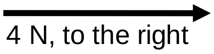
Vector
A physical quantity with magnitude and direction. (Example: force)

Scalar
A physical quantity with magnitude only. (Example: time)

Graphical representation
- Line drawn to scale
- Arrowhead to indicate direction

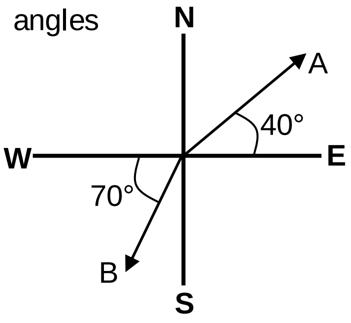
Example:

Vector: 4 N to the right
- Choose a scale: 1 cm = 1 N
- Draw a line 4 cm long
- Add an arrow to indicate the direction to the right
- Label the vector



Direction of vectors
The direction of a vector can be indicated by one of the following:

1. Use the points of the compass as reference from which to measure angles



Direction of vector A:
40° north of east or 50° east of north
E 40° N or N 50° E
Direction of vector B:
70° south of west or 20° west of south
W 70° S or S 20° W

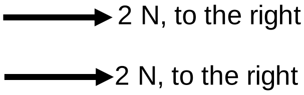
2. Measure angles clockwise from a reference direction, usually north
   Direction of vector A: 50°
   Direction of vector B: 200°.

3. Use another vector or a fixed point as reference e.g. 30 m at an angle of 20° to the bank of the river.

4. Use words/phrases such as upward, downward, to the left, to the right, in

Properties
Equality:
- Same magnitude
- Same direction

Equal vectors:



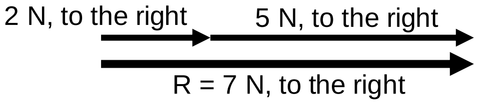
Unequal vectors:
- Different magnitude and different direction
- Same magnitude, different direction
- Different magnitude, same direction

Vector addition:

Example 1:

2 N to the right + 5 N to the right:

Scale drawing:



Resultant (R or F_{net}) = 7 N to the right

Calculation:

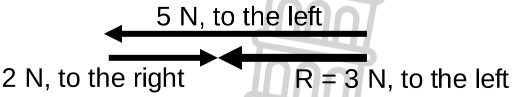
To the right as positive:

2 N + 5 N = 7 N

Example 2 (Subtraction)

2 N to the right + 5 N to the left:

Scale drawing:



Resultant (R or F_{net}) = 3 N to the left

Calculation:

To the right as positive:

2 N + (- 5 N) = - 3 N ∴ 3 N to the left

Important terms/definitions	
Displacement	The change in position of an object from a point of reference. (Length and direction of the straight line drawn from the beginning to the endpoint.)
Distance	The total path length travelled by an object.
Force	Any influence which tends to change the motion of an object.
Mass	The amount of matter in an object.
Resultant	A single vector having the same effect than two or more vectors acting together.
Scalar	A physical quantity with magnitude only.
Tail-to-head method	Used to determine the resultant of two or more vectors - draw the first vector anywhere you wish, and then draw the second vector with its tail at the head of the first vector. If there are more vectors to be added draw each one with its tail at the head of the preceding one. The resultant is a vector drawn from the tail of the first vector to the head of the last vector. It does not matter in which order you add them
Vector	A physical quantity with magnitude and direction.
Weight	The force of attraction of the earth on an object.

LIST OF VECTORS		
Physical quantity	**Symbol**	**Unit of measurement**
Force	F	newton (N)
Weight	w	newton (N)
Acceleration	a	metre per second squared ($m\cdot s^{-2}$)
Velocity	v	metre per second ($m\cdot s^{-1}$)
Displacement (change in position in straight line)	x/y	metre (m)

LIST OF SCALARS		
Physical quantity	**Symbol**	**Unit of measurement**
Temperature	T	kelvin (K) / degrees celcius (°C)
Mass	m	kilogram (kg)
Time	t	second (s)
Volume	V	cubic decimetre (dm^3)
Distance	D	metre (m)

The head-to-tail method to determine the sum of two or more vectors

1. Choose a scale and indicate it on a sheet of paper, e.g. SCALE: 1 cm = 20 m. The best choice of scale is one that will result in a diagram that is as large as possible, yet fits on the sheet of paper.
2. Pick a starting location and draw the first vector *to scale* in the indicated direction. Label the magnitude and direction of the vector on the diagram.
3. Starting from where the head of the first vector ends, draw the second vector *to scale* in the indicated direction. Label the magnitude and direction of this vector on the diagram.
4. Repeat steps 2 and 3 for all vectors that are to be added
5. Draw the resultant from the tail of the first vector to the head of the last vector. Label this vector as **Resultant** or simply **R**.
6. Using a ruler, measure the length of the resultant and determine its magnitude by converting to real units using the scale (e.g. if the length is 4,4 cm:

   $4{,}4\text{ cm} \times \dfrac{20\text{ m}}{1\text{ cm}} = 88\text{ m}$).

Daily task 17.1: Homework/Classwork

1. Define the following terms:
1.1 Vector
1.2 Scalar
1.3 Resultant

2. Distinguish between displacement and distance in words and with the aid of a sketch.

3. Which ONE of the following terms does not fit with the rest?
A distance B force C time D speed

4. Two forces K and P act on an object which does move. Which statement is correct?

The two forces:
A Are equal
B Act in the same direction
C Act in opposite directions
D Are equal and act in opposite directions

5. Choose a relevant scale to represent the following vectors graphically:
5.1 10 N, 30°
5.2 35 N, N50°W
5.3 94 N, 20° north of east
5.4 43 N to the left
5.5 223 N east

Daily task 17.2: Homework/Classwork

1. Use a calculation to determine the resultant of the following pairs of forces:
1.1 25 N, 0° and 34 N, 180°
1.2 54 N to the right and 60 N to the right

2. Use the tail-to-head method to determine the resultant of the following pairs of forces:
2.1 25 N, 0° and 34 N, 180°
2.2 54 N to the right and 60 N to the right
2.3 60 N, 90° and 80 N, 30°

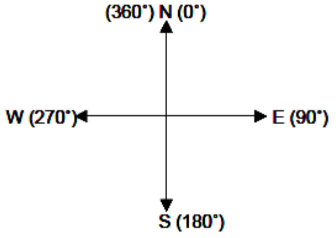
3. Four forces of magnitudes 10 N, 8 N, 6 N and 4 N act on the same point on an object. The directions of the forces are 0°; 90°; 135° and 270° respectively. Use the tail-to-head method to determine the resultant of these forces.

Topic 18: Motion in one dimension

MOTION IN ONE DIMENSION

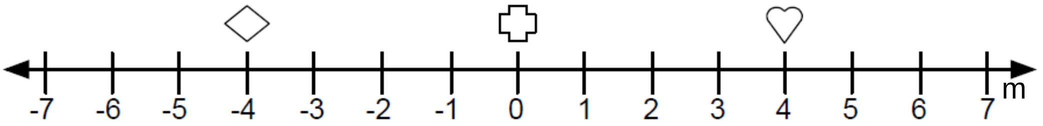
Motion in one direction

Frame of reference



Position

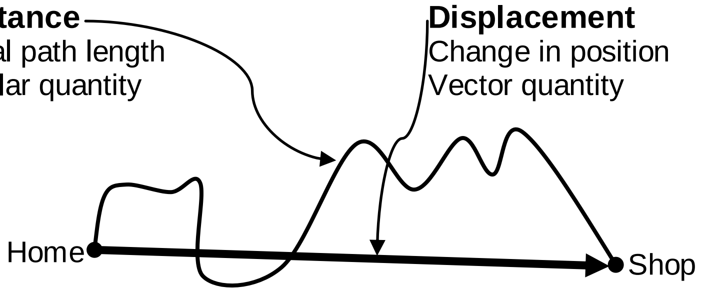
- Given relative to a point of reference
- Can be positive or negative
- Origin: zero of position



Position of square: - 4 m Position of cross: 0 Position of heart: 4 m

Distance
Total path length
Scalar quantity

Displacement
Change in position
Vector quantity



Average speed

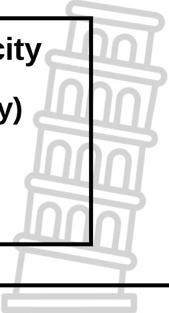
(Scalar quantity)

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Average velocity

(Vector quantity)

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$



Acceleration

Vector quantity: $a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$

Acceleration – increasing velocity: acceleration in same direction as motion
Deceleration – decreasing velocity: acceleration opposite to direction of motion
Positive acceleration: Increase in velocity in the direction chosen as positive
OR
Decrease in velocity in the direction chosen as negative
Negative acceleration: Increase in velocity in the direction chosen as negative
OR
Decrease in velocity in the direction chosen as positive

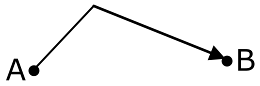
Daily Task 18.1: Homework/Classwork

1. Classify the following quantities as vectors or scalars:
displacement, distance, speed, velocity, acceleration, time

2. Classify the following statement as TRUE or FALSE.
An object can move for 10 seconds and still have a zero displacement.
If true, give an example. If false, give a reason.

3. Suppose you run along three different paths from position A to position B. Along which path(s) would the distance travelled differ from the displacement?

Path 1

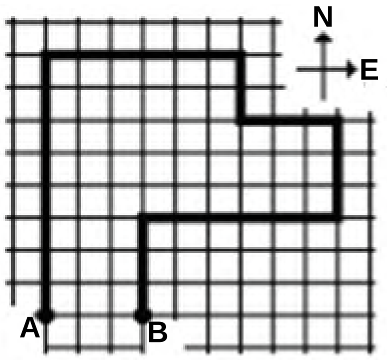


Path 2

Path 3

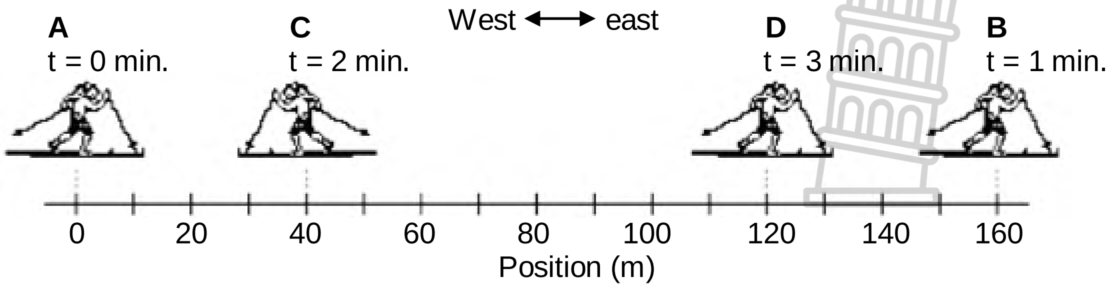
4. You run from your house to a friend's house that is 3 kilometres away. From there, you walk back home.
4.1 What distance did you travel?
4.2 What was the displacement for the entire trip?

5. Consider the diagram below. A person starts at A and walks along the path shown in bold to B. Each square represents 1 km x 1 km.



Determine the:
5.1 Distance walked by the person
5.2 Displacement of the person

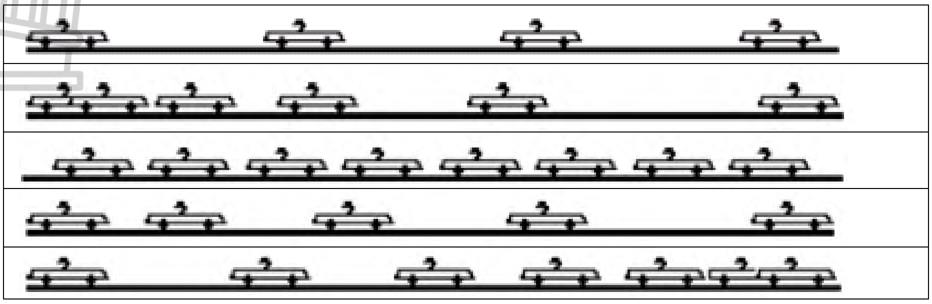
6. A cross-country skier moves from position **A** to position **B**, then from position **B** to position **C** and then from position **C** to position **D** as illustrated below. Each leg of the back and-forth motion takes 1 minute to complete. The total time taken in moving from position **A** to position **D** is 3 minutes.



Calculate the:
6.1 Total distance travelled by the skier during the three minutes
6.2 Displacement of the skier during the three minutes
6.3 Displacement during the second minute (from 1 min. to 2 min.)
6.4 Displacement during the third minute (from 2 min. to 3 min.)

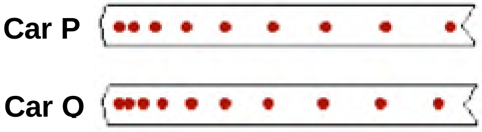
Daily Task 18.2: Homework/Classwork/Data-interpretation

1. The motion of a car in an amusement park is illustrated below. The position of the car is shown at regular time intervals. For each of the diagrams (7.1 to 7.5), write down whether the car is accelerating or moving with constant velocity. If accelerating, indicate the direction (right or left) of acceleration. Support your answer with reasoning.



1.1
1.2
1.3
1.4
1.5

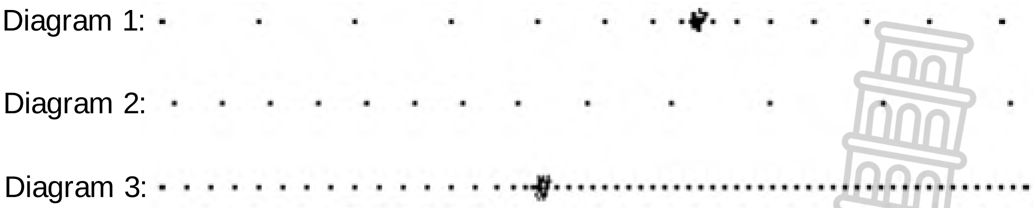
2. The diagram below shows the oil drop pattern left by two cars, **P** and **Q**, on a road.



Based on the oil drop pattern for the two cars, classify each of the following statements as TRUE or FALS.

A: Both cars have a constant velocity.
B: Both cars have an accelerated motion.
C: Car P is accelerating; car Q is not.
D: Car Q is accelerating; car P is not.
E: Car P has a greater acceleration than car Q.
F: Car Q has a greater acceleration than car P.

1. Puleng's car has an oil leak and leaves a trace of oil drops on the streets as she drives through Senekal. A study of Senekal's streets reveals the following traces.



Match the diagram (1, 2 or 3) with the verbal descriptions (3.1. to 3.3) given below. For each match, verify your reasoning.

1.1 Puleng was driving at a slow constant speed and then decreased speed and came to rest. The car remained at rest for 30 seconds after which she then drove again at a slow constant speed.
1.2 Puleng decreased speed from a very high speed until the car came to rest. The car then accelerated until it reached a moderate speed.
1.3 Puleng drove at a moderate speed and then accelerated.

4. The table below shows data obtained for the motion of an object.

time (s)	0	1	2	3	4	5
position (s)	0	20	50	130	150	200

4.1 Draw the position-time graph for the motion of the object.
4.2 From the graph, determine the:
4.2.1 Average speed during the first 2 seconds
4.2.2 Average speed between the 2nd and the 3rd second
4.2.3 Average speed for the whole trip
4.3 Determine the tangent of the graph between the 2nd and the 3rd second.
4.4 How does the answer to QUESTION 4.2.2 compare to the answer of QUESTION 4.3?

Daily Task §18.3: Homework/Classwork

1. The speed of sound in air is about 330 m·s^{-1}. A lightning bolt strikes a tree that is 1,5 km away from you.
1.1 Calculate the time from the moment that you see the lightning flash until you hear the thunder that accompanies it.
1.2 Give a reason why you see the lightning flash before you hear the thunder.

2. A car accelerates from rest to 90 km·h^{-1} in 8,8 s. Calculate the average acceleration of the car in m·s^{-2}.

3. A jet aircraft landing on an aircraft carrier is brought to a complete stop in 2,7 seconds from a velocity of 215 km·h^{-1}. Calculate the average acceleration in m·s^{-2}.

4. A certain car accelerates constantly at 2,4 m·s^{-2}. If it starts from rest, how long (in seconds) will the car require to obtain a velocity of 90 km·h^{-1}?

5. A car starts from rest and accelerates at 2 m·s^{-2} for 3 seconds. Calculate the car's velocity at t = 3 s.

6. A bicyclist travels at an average velocity of 15 km·h^{-1} north for 20 minutes. Calculate his displacement during this time.

7. A car moves 20 km east and then 60 km west in 2 hours. Calculate its average velocity.

8. A car moves at 20 m·s^{-1} for 15 minutes. Calculate the distance travelled.

Experiment 14: Measurement of average velocity

Aim: To determine the average velocity of a moving object

Apparatus
Ball
Measuring tape
Stopwatch

Method
1. Allow a ball to roll in a straight line across the floor from one marked point to another.
2. Use the stop watch to measure the time it takes the ball to roll from the one point to the other.
3. Measure the distance between the two points.
4. Record the results.

Results
Redraw the table below in your practical books, record the measured data and calculate the average velocity.

Distance between two points (m)	
Time (s)	
Average speed (m·s^{-1})	

Questions
1. Explain the difference between:
1.1 Distance and displacement
1.2 Speed and velocity

2. Which ONE of the following represents the car that moves at a higher average speed?
A: A car that travels 150 km in 3 hours
B: A car that travels 40 km in 0,5 hours
C: A car that travels 250 km in 8 hours

3. In the 2008 Olympics, Jamaican Usain Bolt became the fastest man in history by winning a Gold Medal for running the 100 m dash in a World Record time of 9,69 s (*while seemingly not even trying for the last 15 meters!).*
3.1 What was his average speed (in m·s^{-1}) during this race?
3.2 Several days later Bolt also won Gold and broke another World Record in the 200 m dash with a time of 19,30 s In which race did he have a higher average speed?

Experiment 15: Uniform velocity

Aim: To investigate the uniform velocity of a moving trolley.

Apparatus
Ticker timer
Ticker tape
Power source
Trolley
Trolley track

Method

1. Attach a long strip of paper tape to the trolley and pass the tape through the ticker timer.
2. Connect the ticker timer to the power source.
3. Raise the one end of the runway sufficiently so that the trolley moves down the runway at constant speed. (This adjustment which compensates for friction is most important for the success of this investigation.)
4. Cut off the beginning and end portions of the tape where the motion was not uniform, and keep only the portion of the tape where the dots are evenly spaced.
5. Measure the length of the tape and count the number of spaces. Record the results in Table 1.
6. Now mark the tape in lengths of 10 spaces (0,20 s if the frequency of the timer is 50 Hz) each. Measure the displacement (from the first chosen dot) for successive time intervals, i.e. for t = 5 time intervals, displacement = the total length of tape for 50 spaces. For each 10 space interval, calculate the *average velocity* during that interval by dividing the length of the interval (10 spaces), in meters, by 0,20 s (the time for 10 spaces). Record all results in Table 2.

Results

1. Copy Table 1 into your practical book. Record the length of the tape as well as the number of spaces as determined in step 5 of the method. The frequency of the ticker timer depends on the power source used. If connected to 220 V AC, the frequency is 50 Hz.

TABLE 1	
Length of tape (s) m	
No. of spaces (*n*)	
Frequency of timer (f)	50 Hz
Period of timer (T)	
Total time (*n* x T)	
Average velocity ($\frac{s}{t}$)	

2. Copy Table 2 into your practical book and then complete the open cells.

TABLE 2

1 Time t (s)	2 Δt (s)	3 Displacement (m)	4 Δs (m)	5 $\Delta v = \frac{\Delta s}{\Delta t}$ (m·s^{-1})
0	0,20			
0,20	0,20			
0,40	0,20			
0,60	0,20			
0,80	0,20			
1,00	0,20			
1,20	0,20			
1,40	0,20			

Conclusion and questions

1. What is the main reason for failure when performing this experiment? How can you try to compensate for that?
2. What is the meaning of the phrase *frequency of the timer*?
3. What is the meaning of the *period* of the timer?
4. Is it necessary to use the whole length of the tape for your calculations? Explain.
5. Show by a calculation that the time for one interval is 0,2 s.
6. Plot a graph of displacement vs. time on a graph paper. What is the shape of the graph?
7. What do you conclude from this regarding the relationship between s and t?
8. Calculate the gradient of the graph $\left(\frac{\Delta y}{\Delta x}\right)$ in m·s^{-1}.
9. How do these results compare with the answers obtained in column 5 of Table 2?
10. What does the gradient of a displacement versus time graph represent?
11. Plot a graph of velocity vs. time. What is the shape of the graph?
12. Draw a perpendicular from the end of the graph to the time axes. Calculate the area enclosed by the graph, the perpendicular and the two axes.
    How does this compare with the total displacement during the same time?
13. What does the area under a velocity vs. time graph represent?
14. What is the magnitude of the gradient of this graph?
15. How does this compare with the acceleration or the object?
16. What does the gradient of a velocity vs. time graph represent?

Topic 19: Instantaneous speed & velocity and the equations of motion

Instantaneous speed
Magnitude of instantaneous velocity

Instantaneous velocity
Displacement (change in position) divided by an infinitesimal (very small) time interval

Speed, velocity, graphs & equations of motion

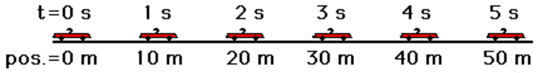
Diagrams & graphs

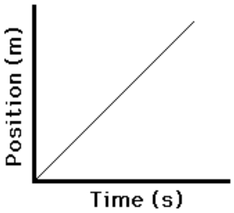
Equations of motion

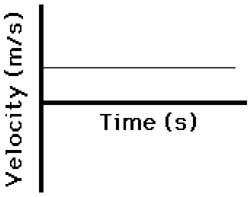
$$v_f = v_i + a\Delta t \qquad \Delta x = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$

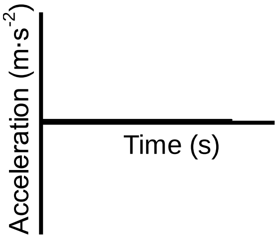
$$v_f^{\,2} = v_i^{\,2} + 2a\Delta x \qquad \Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$$

Uniform (constant) motion

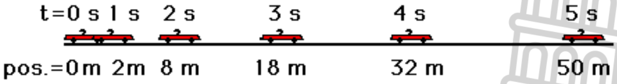


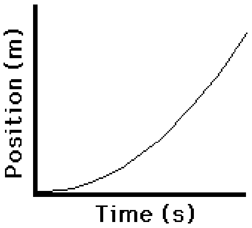


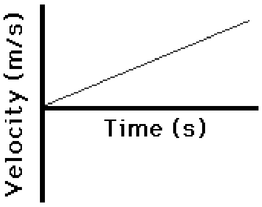


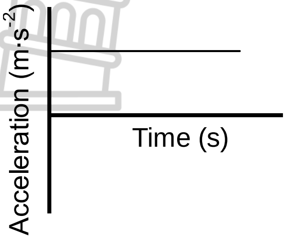


Uniform (constant) accelerated motion









Important terms/definitions	
Acceleration	The rate of change of velocity.
Average speed	The total distance travelled per time.
Average velocity	The total displacement per time.
Displacement	The change in position of an object from a point of reference. (Length and direction of the straight line drawn from the beginning to the endpoint.)
Distance	The total path length travelled by an object.
Frame of reference	A set of axes from which position or motion can be measured.
Gradient of a graph	
Instantaneous speed	The speed at a specific moment.
Instantaneous velocity	The velocity at a specific moment.
Motion in one dimension	Motion of an object in one plane only and in a straight line.
Position	The place occupied by an object - a measurement of a location with reference to an origin.
Speed	The rate of change of distance.
Velocity	The rate of change of position.

Daily Task 19.1: Homework/Classwork

1. Which one of the following is not a vector quantity?
   A Velocity
   B Acceleration
   C Time
   D Displacement

2. Which ONE of the following can be used to calculate the velocity from a displacement versus time graph?
   A Area under the graph.
   B Gradient of the graph
   C Addition of all values given on graph

3. Moving from rest implies:
   A A final velocity of zero
   B An initial velocity of zero
   C No acceleration

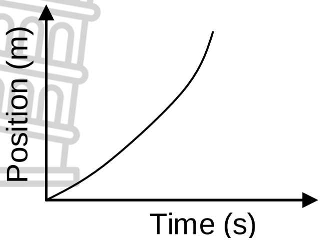
4. A car moves at an initial velocity of 40 $m \cdot s^{-1}$. It then accelerates until it reaches a velocity of 55 $m \cdot s^{-1}$. It takes the car 15 s to reach this new velocity. Calculate the acceleration of the car.

5. Thabo is cycling at 20 $m \cdot s^{-1}$ when he sees a hole in the road. He applies brakes and stops after 4 s. Calculate his acceleration.

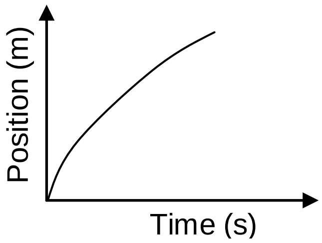
6. Draw the velocity time graph for the motion described below:
   A lift accelerates from rest for 2 s and then moves at a constant velocity for 5 s before it slows down and comes to a standstill in 2 s.

7. Describe the motion of the objects depicted by the graphs given below. In your description, include such information as the direction of the velocity vector (i.e., positive or negative), whether there is a constant velocity or an acceleration, and whether the object is moving slow, fast, from slow to fast or from fast to slow. Be complete in your description.

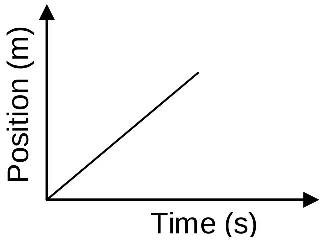
7.1



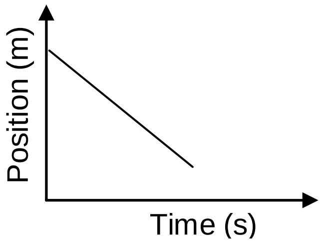
7.2



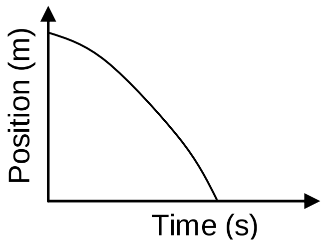
7.3



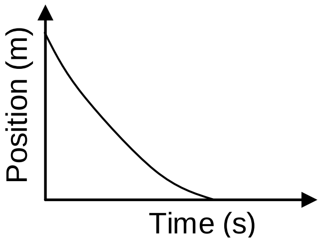
7.4



7.5

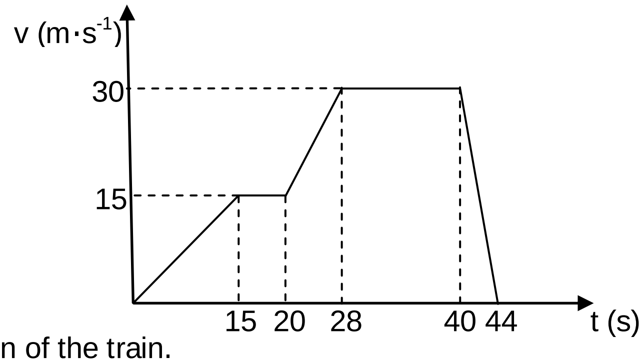


7.6



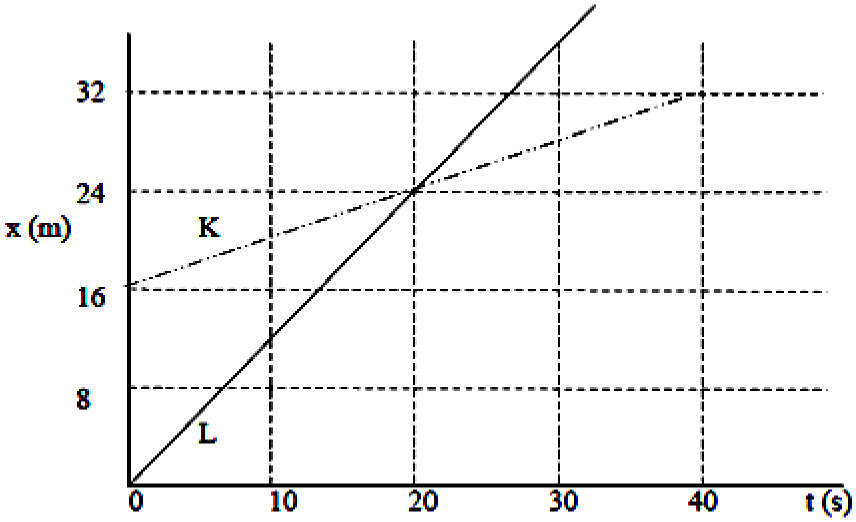
Daily Task 19.2: Homework/Classwork

1. The following graph represents the motion of a train.



1.1 Describe the motion of the train.
1.2 Calculate the acceleration of the train between 20 and 28 s.
1.3 Calculate the distance travelled in the 44 s.
1.4 Draw an acceleration time graph from this velocity time graph.

2. The position – time graph below represents the motion of two cars, **K** and **L**. The position of each car was marked at the instant t = 0 s.



2.1 Identify the car with the greatest velocity.
2.2 How far apart are the two cars at t = 0 s?

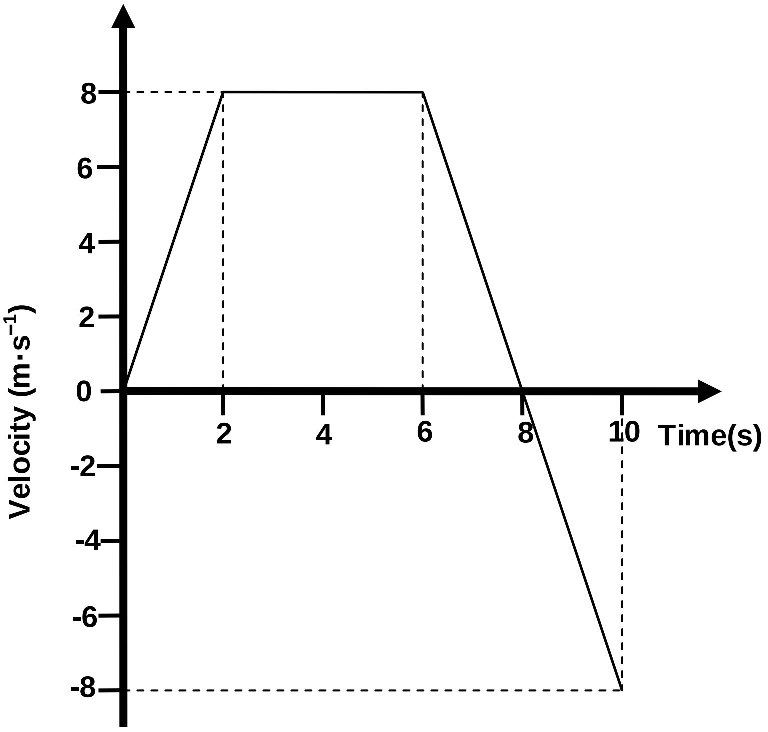
3. The following table provides the displacement of a car during a period of 10 seconds. Initially, the car moves in a northerly direction.

Time (s)	Displacement (m)
0	0
2	14
4	28
6	28
8	20
10	12

3.1 Draw an accurate displacement-time graph to represent the motion of the car.
3.2 Use the graph to determine the velocity of the car after 3 seconds.
3.3 What was the car's velocity after 5 seconds? Justify your answer.
3.4 Use the graph to determine the car's velocity after 9 seconds.
3.5 In words, describe the motion of the car during the 10 seconds.

Daily Task 19.3: Homework/Classwork

1. Study the velocity-time graph for the motion of an object in a straight line. Initially the object moves in an easterly direction.



1.1 Describe the motion of the object in words. Refer to the magnitude and the direction of the velocity, in your description.
1.2 Use the graph to determine the acceleration of the object over the following periods:
1.2.1 Between 0 and 2 s 1.2.2 Between the 2nd and 6th second
1.2.3 In the 8th second
1.3 Determine the total displacement of the object.
1.4 Determine the total distance covered by the object. A car accelerates uniformly in 12 s from 10 $m·s^{-1}$ to a speed of 18 $m·s^{-1}$. Calculate the distance travelled by the car while it is accelerating.

2. An aeroplane with a velocity of 45 $m·s^{-1}$ comes in to land at the start of the runway and brakes at - 5 $m·s^{-1}$. Will it be able to stop in time if the runway is 275 m long? Use the necessary calculations to explain our answer.

3. A motorcycle moving at 30 $m·s^{-1}$ due west on a straight road, brakes and comes to a standstill after 6 s. Calculate the acceleration of the motorcycle.

4. Sipho is cycling at 5 $m·s^{-1}$ on a gravel road when he spots a bull 20 m ahead of him. It takes him 30 seconds before he starts to apply the brakes. If he stops after 3 minutes, will he stops before he collides with the bull?

5. A car accelerates from rest at 2,5 $m·s^{-2}$. Calculate the:
5.1 Distance covered after 10 s 5.2 Velocity after 10 s
5.3 Average velocity during the first 10 s
5.4 Distance covered when the car reaches a velocity of 33 $m·s^{-1}$

6. A train moves at 22 $m·s^{-1}$. The velocity of the train decreases to 12 $m·s^{-1}$ over a distance of 500 m. Calculate the acceleration of the train.

7. A car moves at 33 $m·s^{-1}$ on a straight road. The motorist sees an obstruction in the road and brings the car to a stop over a distance of 150 m. Calculate the:
7.1 Acceleration of the car 7.2 Time it takes the car to stop

Experiment 16: Uniform accelerated motion

Aim: To investigate the motion of a trolley running down an inclined plane.

Apparatus
Ticker timer
Ticker tape
Power source
Trolley
Trolley track

Method

1. Attach a long strip of paper tape to the trolley and pass the tape through the ticker timer.
2. Connect the ticker timer to the power source.
3. Raise the one end of the runway sufficiently so that the trolley moves down the runway at increasing speed.
4. Cut off the beginning and end portions of the tape where the dots cannot be clearly distinguished.
5. Mark the tape in lengths of 10 spaces (0,20 s if the frequency of the timer is 50 Hz) each. Measure the displacement (from the first chosen dot) for successive time intervals, i.e. for t = 5 time intervals, displacement = the total length of tape for 50 spaces. For each 10 space interval, calculate the *average velocity* during that interval by dividing the length of the interval (10 spaces), in meters, by 0,20 s (the time for 10 spaces). Record all results in the table.

Results

Copy the table below into your practical book.

Time ***t*** **(s)**	**Displacement** ***s*** **(m)**	**Change in displacement** Δs **(m)**	**Change in time** Δt **(s)**	$\bar{v} = \frac{\Delta s}{\Delta t}$ **($m \cdot s^{-1}$)**	Δv **($m \cdot s^{-1}$)**	$a = \frac{\Delta v}{\Delta t}$ **($m \cdot s^{-2}$)**
0						
0,1						
0,2						
0,3						
0,4						
0,5						
0,6						
0,7						
0,8						
0,9						
1,0						

Conclusion and questions

1. **Displacement-time graph**

1.1 Draw an accurate displacement-time graph for the motion of the trolley.

1.1 What shape is the graph? What can you deduce from the shape concerning the velocity of the car?

2. **Velocity-time graph**

2.1 Draw an accurate velocity-time graph for the motion of the trolley.

2.2 What shape is the graph? What can you deduce from this?

2.3 Use the velocity-time graph to determine the acceleration of the trolley. How does this value compare with the calculated value for acceleration in the table?

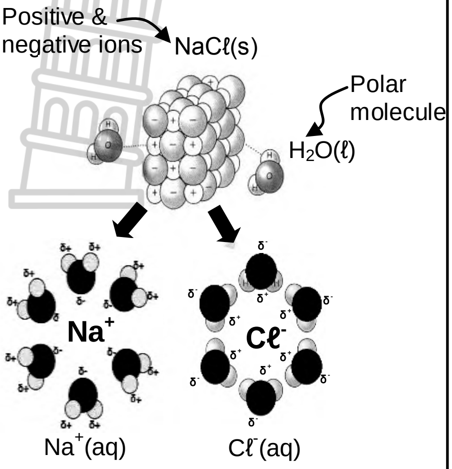
2.4 Use the velocity-time graph to determine the displacement of the trolley after 3 s. How does this answer compare with the value of displacement after 3 s, as indicated in the table?

3. **Acceleration-time graph**

3.1 Draw an accurate acceleration-time graph for the motion of the trolley.

Topic 20: Reactions in aqueous solution

Ions in solution



Hydration: ions surrounded by water molecules

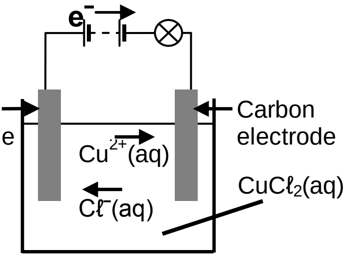
$NaCℓ(s) \rightarrow Na^+(aq) + Cℓ^-(aq)$

Electrolytes & conductivity

Solution or melt that conducts electricity through movement of ions.

Ability of a substance to conduct electricity.

Circuit to measure conductivity of solutions



Strong electrolyte: High ion concentration - bulb glows brightly.
Weak electrolyte: Low ion concentration - bulb glows dimly.
Non-electrolyte: Solution that does not conduct electricity – no free ions, only molecules e.g. sugar dissolved in water.

Types of chemical reactions

Ion exchange reactions

Acid-base reactions

Transfer of protons (H^+ ions)
(H_2O is formed as one of the products)

Acid + metal oxide → salt + H_2O
$2HCℓ + CuO \rightarrow CuCℓ_2 + H_2O$
Acid + metal carbonate → salt + H_2O + CO_2
$2HCℓ + CaCO_3 \rightarrow CaCℓ_2 + H_2O + CO_2$
Acid + base → salt + H_2O (neutralisation)
$HCℓ + NaOH \rightarrow NaCℓ + H_2O$

Gas-forming reactions

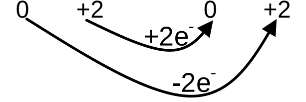
Reactions in which a gas is formed as one of the products

E.g. Acid + metal → salt + H_2
$Zn + 2HCℓ \rightarrow ZnCℓ_2 + H_2$

Redox reactions

Transfer of electrons

$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$



$Zn \rightarrow Zn^{2+} + 2e^-$
Oxidation: Loss of electrons

$Cu^{2+} + 2e^- \rightarrow Cu$
Reduction: Gain of electrons

Precipitation reactions

Formation of an insoluble salt, called a precipitate
$AgNO_3(aq) + HCℓ(aq) \rightarrow AgCℓ(s) + HNO_3(aq)$

Solubility rules – predict whether a precipitate will form in water

Soluble salts	Exceptions that are insoluble
All salts of NH_4^+ & Na^+, K^+ (group 1)	-
Nitrates (NO_3^-)	-
Chlorides ($Cℓ^-$)	$AgCℓ$, $PbCℓ_2$, $Hg_2Cℓ_2$, $BaCℓ_2$
Bromides (Br^-)	$AgBr$, $PbBr_2$, Hg_2Br_2
Iodides (I^-)	AgI, PbI_2, Hg_2I_2
Sulphates (SO_4^{2-})	$BaSO_4$, $PbSO_4$, $SrSO_4$ ($CaSO_4$, Ag_2SO_4 – slightly soluble)

Insoluble salts	Exceptions that are soluble
Carbonates (CO_3^{2-})	Salts of NH_4^+ & Na^+, K^+ (group 1)
Sulphides (S^{2-})	Salts of group 1 & 2 metals & NH_4^+
Hydroxides (OH^-)	Salts of Na^+, K^+, NH_4^+, Ca^{2+}, Ba^{2+}, Sr^{2+}
Oxides (O^{2-})	Oxides of Na^+, K^+ (group 1)
Sulphites (SO_3^{2-})	Salts of NH_4^+ & Na^+, K^+ (group 1)

Test for chlorides
Add $AgNO_3(aq)$ – white precipitate that is insoluble in dilute HNO_3

Test for bromides
Add $AgNO_3(aq)$ – cream precipitate that is insoluble in dilute HNO_3

Test for iodides
Add $AgNO_3(aq)$ – yellow precipitate that is insoluble in dilute HNO_3

Test for sulphates
Add $Ba(NO_3)_2(aq)$ – white precipitate forms that is insoluble in dilute HNO_3

Test for carbonates
Add $Ba(NO_3)_2(aq)$ – white precipitate forms that reacts with dilute HNO_3 to form $CO_2(g)$

Important terms/definitions	
Acid-base reaction	A chemical reaction during which protons (H^+ ions) are transferred.
Aqueous solution	A solution in which the solvent is water.
Concentration	The amount of substance present per volume of a solution.
Conductivity	The ability of a material to conduct electricity.
Dissolution process	The process by which a solid, liquid or gas forms a solution in a solvent.
Dissociation	The process by which solid ionic crystals are broken up into ions.
Electrolyte	A solution/melt that conducts electricity through the movement of ions.
Gas-forming reaction	A reaction during which a gas is formed as one of the products. The formation of the gas is the driving force for these reactions.
Hydration	The process in which ions are surrounded by water molecules in a solution.
Intermolecular forces	Forces between molecules.
Ion	An atom or molecule in which the total number of electrons is not equal to the total number of protons, giving it a net positive or negative charge.
Neutralisation	The reaction of an acid and a base to form a salt and water.
Oxidation	A loss of electrons during a chemical reaction.
Polar molecule	A molecule that as two oppositely charged poles. Also called a dipole.
Precipitate	The insoluble product formed when certain solutions are mixed.
Precipitation reaction	A reaction during which an insoluble product forms when solutions are mixed.
Redox reaction	A chemical reaction during which electrons are transferred.
Reduction	A gain of electrons during a chemical reaction.
Solubility	The maximum amount of a substance (the solute) that may be dissolved in another (the solvent).
Solute	The dissolved substance in a solution. (usually the substance present in lesser amount)
Solution	A homogenous mixture of two or more substances.
Solvent	The substance in a solution in which the solute is dissolved. (usually the substance present in greater amount)

Daily task 20.1: Homework/Classwork

1. Represent the dissolution of each of the following salts in water with a balanced equation. Indicate the phases of all compounds and ions.

1.1 $NaC\ell(s)$
1.2 $CuC\ell_2(s)$
1.3 $Mg(NO_3)_2(s)$
1.4 $K_2SO_4(s)$
1.5 $CaC\ell_2(s)$
1.6 $KNO_3(aq)$
1.7 $CuSO_4(s)$
1.8 $MgSO_4(s)$
1.9 $Na_2SO_4(s)$
1.10 $Pb(NO_3)_2$

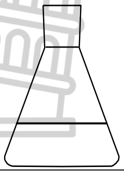
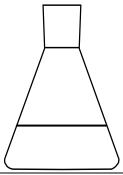
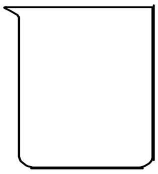
2. Briefly describe the dissolution process of table salt in water.

3. Define the following terms:

3.1 Electrolyte
3.2 Ionic compound
3.3 Conductivity
3.4 Dissociation
3.5 Ion
3.6 Hydration
3.7 Solution
3.8 Solvent
3.9 Solute
3.10 Strong electrolyte

Daily task 20.2: Homework/Classwork

A learner wants to determine the relationship between conductivity and concentration of ions in an aqueous solution. The following chemicals and apparatus are supplied.

0,5 mol·dm^{-3} sodium chloride solution 			Carbon rods 	0,5 mol·dm^{-3} calcium chloride solution 
Glass beaker 			Conducting wires 	

NOTE: The unit of electrical conductivity is not the ampere However, in this experiment the ammeter reading is taken as a MEASURE of the relative conductivity of the two solutions.

1. Identify the:
1.1 Dependent variable 1.2 Independent variable 1.3 Two controlled variables
2. Write down an investigative question for this investigation.
3. Write down a hypothesis for this investigation.
4. Draw a labelled diagram to show how the learner can use some of the above apparatus and chemicals to conduct the investigation.
5. The steps below describe the method that must be followed to conduct the investigation. The steps are not in the correct sequence. Arrange the steps in the correct sequence. Only write down the letters representing each step in the correct sequence in your practical book.

   a. Add a second drop of the 0,5 mol·dm^{-3} $NaC\ell$ solution, swirl the beaker and again measure the ammeter reading.
   b. Pour 50 cm^3 distilled water into a glass beaker.
   c. Repeat the procedure until 10 drops of $NaC\ell$ solution are added to the water.
   d. Use connecting wires to connect the two carbon electrodes in series with a battery and an ammeter.
   e. Use the medicine dropper and add one drop of the 0,5 mol·dm^{-3} $NaC\ell$ solution to the water in the beaker and stir the solution.
   f. Repeat the above steps with the $CaC\ell_2$ solution and the 1 mol·dm^{-3} $NaC\ell$ solution.
   g. Place the two carbon rods in the solution (without touching each other) and measure the ammeter reading.

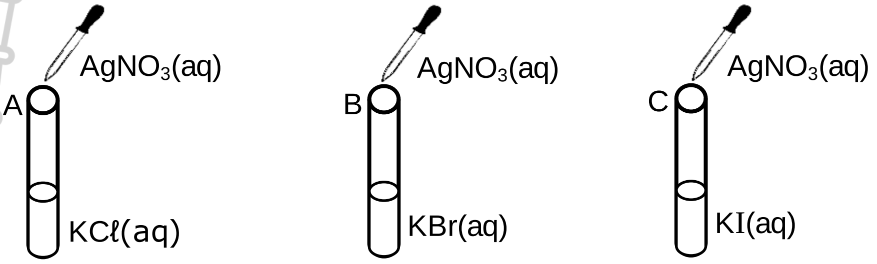
6. The results obtained are shown in the table below.

Number of drops	0	1	2	3	4	5	6	7	8	9	10
Conductivity of $NaC\ell(aq)$ (mA)	0,18	0,34	0,55	0,74	0,92	1,10	1,29	1,47	1,47	1,65	1,84
Conductivity of $CaC\ell_2(aq)$ (mA)	0,18	0,55	0,91	1,29	1,47	1,84	2,21	2,21	2,39	2,39	2,57

6.1 On the same set of axes, draw graphs of conductivity versus number of drops (i.e. concentration) for both solutions.
6.2 Describe the change in conductivity as the concentration was increased by the addition of $NaC\ell$ drops.
6.3 Write down the mathematical relationship between conductivity and concentration.
6.4 Write down equations to represent the dissociation of $NaC\ell(s)$ and $CaC\ell_2(s)$ in water.
6.5 What causes the difference in slope between the two graphs?
6.6 Draw a conclusion from the results obtained.

Daily task 20.3: Homework/Classwork

1. The three test tubes (**A**, **B** and **C**) contain solutions of potassium halides as shown. A few drops of silver nitrate solution are added into each of the three test tubes shown below.



After making observations, a few drops of nitric acid are added to each solution.

1.1 Write chemical equations to show how the following salts dissociate in water: (Include the phases of all compounds and ions.)

1.1.1 Potassium chloride 1.1.2 Potassium bromide
1.1.3 Potassium iodide 1.1.4 Silver nitrate

1.2 Complete the table below. Only write down the answer next to the question number.

Test tube	**A**	**B**	**C**
Colour of halide solution	1.2.1	1.2.2	1.2.3
Observation when $AgNO_3(aq)$ is added	1.2.4	1.2.5	1.2.6
Observation when $HNO_3(aq)$ is added	1.2.7	1.2.8	1.2.9

1.3 Write balanced chemical equations for the reaction of each of the following halide solutions with a silver nitrate solution. Include the phases of all reactants and products.

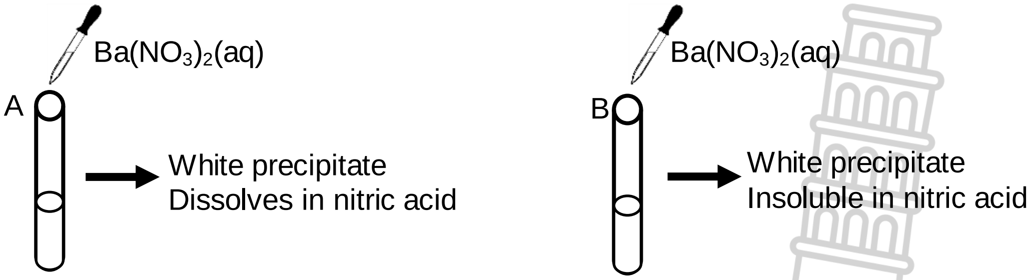
1.3.1 Potassium chloride 1.3.2 Potassium bromide 1.3.3 Potassium iodide

1.4 Classify the three reactions as REDOX, ACID-BASE, GAS FORMING or PRECIPITATION.

1.5 Formulate a test for each of the above three halides.

2. You are supplied with two unknown sodium salts. It is known that the one salt is a sulphate and the other one a carbonate.

In order to identify the two salts, a small amount of each salt is dissolved in distilled water in two test tubes marked **A** and **B**. A few drops of barium nitrate are added to each solution. A white precipitate forms in each test tube. After addition of nitric acid, the precipitate in test tube **A** dissolves to release a gas, whilst the precipitate in test tube **B** remains.



2.1 Write down the test for sulphates.

2.2 Write down the test for carbonates.

2.3 Identify the two sodium salts, **A** and **B**. Write down the name and formula of each sodium salt.

2.4 Write down balanced chemical equations for the two reactions that take place in test tube **A**. Indicate the phases of all reactants and products.

2.5 Write down the name of the precipitate that forms in test tube **A**.

2.6 Write down a balanced chemical equation for the reaction that explains the formation of the precipitate in test tube **B**. Indicate the phases of all reactants and products.

2.7 Write down the name of the precipitate that forms in test tube **B**.

Daily task 20.4: Homework/Classwork

1. Define each of the following terms:
1.1 Redox reaction 1.2 Oxidation 1.3 Reduction
1.4 Acid-base reaction 1.5 Precipitate 1.6 Neutralisation

2. Complete and balance each of the following equations. Indicate the phases of all products. Then classify each reaction as a PRECIPITATION, GAS-FORMING, ACID-BASE or REDOX reaction.
1.1 $Zn(s) + H_2SO_4(aq) \rightarrow$ ______ + _______
1.2 $Zn(s) + CuSO_4(aq) \rightarrow$ ______ + _______
1.3 $KBr(aq) + AgNO_3(aq) \rightarrow$ ______ + _______
1.4 $Na_2SO_4(aq) + BaC\ell_2(aq) \rightarrow$ ______ + _______
1.5 $CaCO_3(s) + HC\ell(aq) \rightarrow$ ______ + ________ + _______
1.6 $H_2SO_4(aq) + NaOH(aq) \rightarrow$ ______ + _______
2.7 $CuO(s) + HC\ell(aq) \rightarrow$ ______ + ________

2. Silver nitrate is added to the five solutions shown in the table below.
2.1 Predict whether a precipitate will form. Redraw the table in your work book. Make a tick (✓) in the open space below each solution to indicate the formation of a precipitate or a cross (✗) if no precipitate is formed. Also write down the formula of all precipitates that are formed.

	$NaC\ell(aq)$	$NaBr(aq)$	$NaI(aq)$	$Na_2SO_4(aq)$	Na_2CO_3
Add $AgNO_3(aq)$					
Formula of precipitate					

3.2 Write down balanced equations in ionic form for all reactions that take place. Indicate the phases of all reactants and products.

3. Barium nitrate is added to the five solutions shown in the table below.
3.1 Predict whether a precipitate will form. Redraw the table in your work book. Make a tick (✓) in the open space below each solution to indicate the formation of a precipitate or a cross (✗) if no precipitate is formed. Also write down the formula of all precipitates that are formed.

	$NaC\ell(aq)$	$NaBr(aq)$	$NaI(aq)$	$Na_2SO_4(aq)$	Na_2CO_3
Add $BaC\ell_2(aq)$					
Formula of precipitate					

4.2 Write down balanced equations in ionic form for all reactions in which precipitates are formed. Indicate the phases of all reactants and products.

4. The reaction between an acid and a metal is an example of a gas-forming reaction as well as a redox reaction. An example of such a reaction is given below.

$$Zn + 2HC\ell \rightarrow ZnC\ell_2 + H_2$$

4.1 Rewrite the above equation in your work book and include the phases of all reactants and products.
4.2 Explain the difference between a gas-forming and a redox reaction.
4.3 Give a reason why the above reaction can be classified as a gas-forming reaction.
4.4 How does the charge on the zinc atom change during this this reaction?
4.5 How does the charge on the hydrogen ion in $HC\ell$ change during this reaction?
4.6 Use the answers to QUESTIONS 5.4 and 5.5 to explain why this reaction can also be classified as a redox reaction.

Experiment 17: Solubility tests

Aim: To investigate the solubility of different salts.

Apparatus & chemicals

- 10 test tubes
- 2 test tube racks
- Distilled water
- Group 1: NaCℓ, NaBr, NaI, Na_2CO_3, Na_2SO_4
- Group 2: NaCℓ, $NaNO_3$, Na_2SO_4, Na_2CO_3, $MgSO_4$

Method

1. Pour 20 cm^3 distilled water to each of the ten test tubes.
2. Use a spatula and add a pinch of each of the salts listed above into separate test tubes to obtain ten solutions.
3. Add a few drops of silver nitrate to each of the solutions in Group 1. Record your observations in the table shown below.
4. Add a few drops of barium nitrate to each of the solutions in Group 2. Record your observations in the table shown below.
5. Add a few drops of dilute nitric acid to each precipitate. Record your observations in the table.
6. Identify the precipitate formed in each test tube.

Results

Redraw the following table in your practical book. In the open cells:

- Make a ✓ if a precipitate is formed or a ✗ if no precipitate is formed when $AgNO_3(aq)$ is added to solutions in group 1 and when $Ba(NO_3)_2(aq)$ is added to solutions in group 2
- Use a ✓ to indicate if the precipitate is soluble in concentrated nitric acid or a ✗ if insoluble
- Write down the formula of each precipitate formed

Group 1					
	NaCℓ(aq)	NaBr(aq)	NaI(aq)	$Na_2CO_3(aq)$	$Na_2SO_4(aq)$
$AgNO_3(aq)$ added					
Colour of precipitate					
Conc. HNO_3 added					
Formula of precipitate					

Group 2					
	NaCℓ(aq)	$NaNO_3(aq)$	$Na_2SO_4(aq)$	$Na_2CO_3(aq)$	$MgSO_4(aq)$
$Ba(NO_3)_2(aq)$ added					
Colour of precipitate					
Conc. HNO_3 added					
Formula of precipitate					

Conclusion and questions

1. For group 1, write down balanced ionic equations to explain the formation of all precipitates when silver nitrate is added. Include phases of all reactants and products.
2. Write down the name of the precipitate in group 1 that is soluble in dilute nitric acid. Write down a balanced ionic equation to represents its formation. Include phases of all reactants and products.
3. Use the results obtained from salts in group 1 and formulate a tests for:

3.1 Chlorides 3.2 Bromides 3.3 Iodides

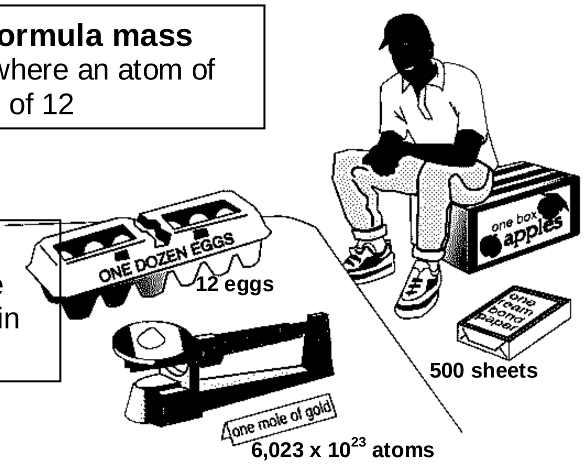
4. For group 2, write down balanced ionic equations to explain the formation of all precipitates. Include phases of all reactants and products.
5. Write down the name of the precipitate in group 2 that is soluble in dilute nitric acid. Write down a balanced ionic equation to represents its formation. Include phases of all reactants and products.
6. Use the results obtained from salts in group 2 and formulate a test for:

6.1 Sulphates 6.2 Carbonates.

Topic 21: Quantitative aspects of chemical change

Relative atomic/molecular/formula mass
Mass of ONE particle on a scale where an atom of carbon -12 has a mass of 12

Mole (n)
Amount of substance having the same number of particles as there are atoms in 12 g of carbon-12



Avogadro's number
Number of particles (atoms, molecules, formula-units) present in mole
N_A = 6,023 x 10^{23} particles·mol^{-1}

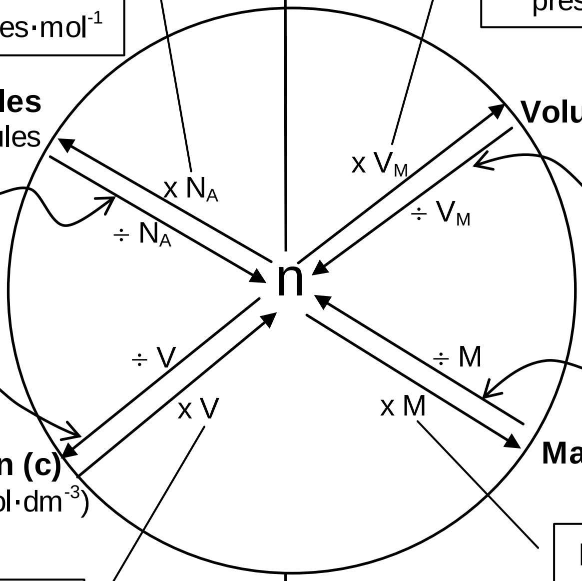
Molar gas volume (mol·dm^{-3})
Volume of 1 mole gas
At STP (standard temperature and pressure): V_M = 22,4 dm^3·mol^{-1}

Number of particles
(atoms, ions, molecules

$$n = \frac{\text{number of particles}}{N_A}$$

Volume of gas (dm^3)

$$n = \frac{V}{V_M}$$



$$c = \frac{n}{V}$$

Concentration (c)
of solutions (mol·dm^{-3})

$$n = \frac{m}{M}$$

Mass (g)

Volume of solution in dm^3

Molar mass (in g·mol^{-1})
Mass of one mole of a substance

Percentage composition
% of each element in a compound

Empirical formula
Gives the simplest whole-number ratio of atoms in a compound.

Stoichiometric calculations

Steps to be followed when doing stoichiometric calculations:
1. Write a balanced chemical equation for the reaction.
2. Convert the known (mass, volume or number of particles) to number of moles.
3. Use the balanced equation to find the mole of the unknown.
4. Calculate the unknown (mass, volume or number of particles).

Important terms/definitions	
Actual yield	The quantity physically obtained from a chemical reaction.
Anhydrous	Without water - A substance is anhydrous if it contains no water.
Avogadro's law	One mole of any gas occupies the same volume at the same temperature and pressure. At STP: $V_M = 22,4\ dm^3\cdot mol^{-1}$
Avogadro's number (N_A)	Number of particles (atoms, molecules or formula units) present in one mole of a substance. $(N_A) = 6,023 \times 10^{23}$ particles·mol^{-1}
Empirical formula	A formula that gives the simplest whole-number ratio of atoms in a compound.
Hydrate	Solid ionic compounds in which water molecules are captured.
Limiting reactant	The reactant that is completely consumed in a chemical reaction.
Molar concentration	The number of moles of solute per liter of solution.
Molar mass (M)	The mass of one mole of a substance. Unit: $g\cdot mol^{-1}$
Molar volume (V_M)	The volume of one mole of a gas.
Mole (n)	The amount of substance with the same number of particles as there are atoms in 12 g carbon-12.
Molecular formula	A formula that indicates the ratio of atoms in a compound as well as the actual number of atoms of each element in the compound.
Percentage composition	The mass of each atom present in a compound expressed as a percentage of the total mass of the compound. (A pure sample of a given compound always has exactly the same composition.)
Relative atomic mass	The relative atomic mass of an element is the weighted average of the masses of its isotopes on a scale on which a carbon-12 atom has a mass of exactly 12 units. (A "weighted" average allows for the fact that there won't be equal amounts of the various isotopes of an element.)
Relative formula mass	The relative formula mass of a substance is the weighted average of the masses of the formula units (e.g. NaCℓ) on a scale on which a carbon-12 atom has a mass of exactly 12 units.
Relative molecular mass	The relative molecular mass of a substance (e.g. H_2O) is the weighted average of the masses of the molecules on a scale on which a carbon-12 atom has a mass of exactly 12 units.
Solute	The dissolved substance (usually the substance present in lesser amount)
Solution	A homogeneous mixture of two or more substances.
Solvent	The substance in which the solute is dissolved (usually the substance present in greater amount)
Stoichiometric calculations	Calculations involving the mole ratios of reactants and products in a chemical reaction. (Molar masses and mole ratios, together with other factors, are used to determine information about one reactant or product in a chemical reaction from known information about another.)
Stoichiometry	The branch of chemistry that deals with the relative quantities of reactants and products in chemical reactions.
STP	Standard Temperature and Pressure T = 273 K (0 °C) and p = 101,3 kPa
Theoretical yield	Calculated yield of a product in a chemical reaction.
Water of crystallisation	Water that is stoichiometrically bound into a crystal e.g. the H_2O in $CuSO_4.5H_2O$.

Steps for determining percentage composition

2. Calculate the molar mass of the given compound.
3. Determine the contribution (to the total molar mass of the compound) of each element present in the compound and express it as a percentage of the molar mass of the compound.

EXAMPLE:

Determine the percentage composition of methane (CH_4).

Step 1:

$M(CH_4) = 16\ g\cdot mol^{-1}$

Step 2:

$\%C = \frac{12}{16} \times 100 = 75\%$ $\%H = \frac{4}{16} \times 100 = 25\%$

Steps for determining empirical formulae

1. Express percentages as masses.
2. Convert the mass of each element to number of moles.
3. Determine the ratio of the different elements in the compound by dividing the number of moles of each element by the smallest number of moles.
4. Express these ratios as the smallest whole number. These values are the subscripts of atoms in the empirical formula.
5. Determine the molar mass represented by the empirical formula. If they are the same, the empirical formula and the molecular formula is the same.
6. IF NOT THE SAME, divide the molar of the compound by the empirical formula. This value indicates the amount of empirical formula units in the molecular formula.

EXAMPLE:

Octane contains 84,2% carbon and 15,8% hydrogen by mass. Its relative molecular mass is 114. Determine the molecular formula of octane.

Step 1:

84,2 g C & 15,8 g H

Step 2:

$n(C) = \frac{m}{M} = \frac{84,2}{12} = 7,0167\ mol$ $n(H) = \frac{m}{M} = \frac{15,8}{1} = 15,8\ mol$

Step 3:

n (C)is the smallest, thus: $n(C) : n(H) = \frac{7,0167}{7,0167} : \frac{15,8}{7,0167} = 1 : 2,25$

Step 4:

1 : 2,25 = 4 : 9 Empirical formula is C_4H_9

Step 5:

$M_r(C_4H_9) = 57\ g\cdot mol^{-1}$

$\frac{M(octane)}{M(C_4H_9)} = \frac{114}{57} = 2$ Molecular formula: C_8H_{18}

Steps for determining the formula of a hydrate

1. Calculate the number of moles of water.
2. Calculate the number of moles of the anhydrous salt.
3. Calculate the mole ratio - water : anhydrous salt
4. Write down the formula for the hydrate.

EXAMPLE:

2,5 g hydrated copper(II) sulphate ($CuSO_4.xH_2O$) is heated. After heating the mass of white anhydrous copper(II) sulphate ($CuSO_4$) is determined as 1,59 g. Determine the formula of the hydrate.

Step 1:

$m(H_2O) = 2,5 – 1,59 = 0,91\ g$ $n(H_2O) = \frac{m}{M} = \frac{0,91}{18} = 0,05\ mol$

Step 2:

$n(CuSO_4) = \frac{m}{M} = \frac{1,59}{159,5} = 0,0097\ mol$

Step 3:

$n(H_2O) : n(CuSO_4) = \frac{0,05}{0,0097} = 5,15$

Step 4:

x = 5, thus the formula is: $CuSO_4.5H_2O$

Daily task 21.1: Homework/Classwork

1. Determine the relative atomic mass of:
1.1 silver
1.2 Cu
1.3 H
1.4 O
1.5 Fe
1.6 mercury
1.7 $C\ell$
1.8 Br

2. Calculate the relative molecular mass of:
2.1 water
2.2 chlorine
2.3 H_2
2.4 O_2
2.5 NH_3
2.6 SO_2
2.7 NO_2
2.8 bromine

3. Calculate the relative formula mass of:
3.1 iron(III) chloride
3.2 sodium chloride
3.3 KNO_3
3.4 $MgSO_4$
3.5 K_2SO_4
3.6 lead(II) nitrate
3.7 Na_2CO_3
3.8 $CuSO_4.5H_2O$

Daily task 21.2: Homework/Classwork

1. Define the following terms:
1.1 Mole
1.2 Molar mass
1.3 Relative formula mass
1.4 Avogadro's number

2. Calculate the molar mass of:
2.1 Water
2.2 Chlorine
2.3 $HOC\ell$
2.4 O_2
2.5 $NH_4C\ell$
2.6 SO_2
2.7 Nitrogen(II) oxide
2.8 Br_2
2.9 $FeC\ell_2$
2.10 Potassium chloride
2.11 Barium nitrate
2.12 Na_2SO_4
2.13 Silver sulphide
2.14 $Pb(NO_3)_2$
2.15 $CuSO_4.5H_2O$

Daily task 21.3: Homework/Classwork

1. Calculate the number of moles in:
1.1 320 g of magnesium oxide
1.2 21,6 g of silver
1.3 6,4 g SO_2
1.4 0,46 g sodium
1.5 10 g potassium sulphate
1.6 3 g iron sulphide
1.7 12 g sodium sulphite
1.8 5 g ammonia

2. Calculate the mass of:
2.1 2 moles of water
2.2 0,5 moles of iodine, I_2
2.3 1,2 moles of sodium chloride
2.4 0,125 moles of oxygen, O_2
2.5 10 moles of $HC\ell$
2.6 0,6 moles of sulphur dioxide
2.7 1 mole sodium hydroxide
2.8 0,25 moles of silver nitrate

3. Calculate the number of moles at STP in:
3.1 56 dm^3 xenon
3.2 10 dm^3 oxygen, O_2
3.3 2,24 dm^3 of chlorine, $C\ell_2$
3.4 2,24 dm^3 sulphur dioxide
3.5 2,24 m^3 nitrogen
3.6 12 m^3 neon

4. Calculate the volume at STP occupied by:
4.1 5 moles of carbon dioxide
4.2 3 moles of ammonia
4.3 2 moles of oxygen, O_2
4.4 64 moles of sulphur dioxide
4.5 2 moles of hydrogen, H_2
4.6 0,01 moles of nitrogen, N_2

5. Calculate the number of:
5.1 Molecules in 2 moles of carbon dioxide
5.2 Atoms in 4 moles of sodium
5.3 Molecules in 0,5 moles of water
5.4 Formula units in 10 moles of sodium chloride

Daily task 21.4: Homework/Classwork

1. 1 mole of sodium carbonate (Na_2CO_3) contains 2 moles of sodium atoms, 1 mole of carbon atoms and 3 moles of oxygen atoms. In the same way, write down the number of moles of each atom present in 1 mole of:

1.1 PbO 1.2 NH_4NO_3 1.3 $Ca(OH)_2$
1.4 CH_3COOH 1.5 $FeSO_4.7H_2O$ 1.6 Pb_3O_4

2. Calculate the:

2.1 Mass of 44,8 dm^4 carbon dioxide at STP
2.2 Mass of 3,0115 x 10^{24} silver atoms
2.3 Volume of 20 g H_2 at STP
2.4 Number of formula-units in 2 g $NaC\ell$
2.5 Number of atoms in 12 g Mg
2.6 Volume of 32 g oxygen at STP
2.7 Number of Mg atoms in 20 g $MgSO_4$
2.8 Number of K atoms in 20 g K_2SO_4
2.9 Number of oxygen atoms in 10 g $AgNO_3$
2.10 Mass of 30 dm^3 ammonia at STP

Daily task 21.5: Homework/Classwork

1. Calculate the volume of a:

1.1 0,4 $mol{\cdot}dm^{-3}$ salt solution that contains 0,1 mol of salt
1.2 0,4 $mol{\cdot}dm^{-3}$ solution of X that contains 2 moles of X

2. Calculate the number of moles of solute in:

2.1 500 cm^3 of a solution of concentration 2 $mol{\cdot}dm^{-3}$
2.2 2 liters of a solution of concentration 0,5 $mol{\cdot}dm^{-3}$

3. Calculate the concentration of a solution containing:

3.1 11,7 g of $NaC\ell$ in 500 cm^3 solution
3.2 2,54 g of I_2 in tetrachloromethane to give a 100 cm^3 solution
3.2 53 g sodium carbonate dissolved in 1 litre of water
3.4 62,5 g $CuSO_4.5H_2O$ dissolved in 1 litre of water

4. Calculate the mass of sodium hydroxide present in:

4.1 500 cm^3 of a 1 $mol{\cdot}dm^{-3}$ solution
4.2 25 cm^3 of a 0,5 $mol{\cdot}dm^{-3}$ solution

Daily task 21.6: Homework/Classwork

1. Define the following terms:

1.1 Percentage composition
1.2 Empirical formula

2. Fertilisers contain nitrogen needed by plants to grow. Ammonium nitrate is used as fertiliser. It has the formula NH_4NO_3. Calculate the:

2.1 Percentage of nitrogen in ammonium nitrate
2.2 Mass of nitrogen in a 20 kg bag of fertiliser

3. Calculate the percentage of copper in each of the following copper compounds: $CuC\ell_2$; $Cu(NO_3)_2$; $CuSO_4.5H_2O$

4. Calculate the empirical formula of each of the compounds having the following percentage compositions:

4.1 31,8% K; 29% Cℓ; 39,2% O
4.2 30,5% N; 69,6% O
4.3 53% Aℓ; 47% O
4.4 45,3% O; 43,4% Na; 11,3% C
4.5 40% S; 60% O

5. 56 g of iron combine with 32 g of sulphur to form iron(II) sulphide. Find its empirical formula.

Daily task 21.7: Homework/Classwork

1. A compound contains 92,2% C and 7,7% H. The molar mass of the substance is 104 g·mol^{-1}. Determine this compound's:
1.1 Empirical formula 1.2 Molecular formula

2. Vinegar is a dilute form of ethanoic acid with a molar mass of 60 g·mol^{-1}. The percentage composition of ethanoic acid is as follows: 39,9% C; 6,7% H and 53,4% O
For ethanoic acid, determine its:
2.1 Empirical formula 1.2 Molecular formula

3. 1,628 g of hydrated magnesium iodide is heated to remove the crystal water. Its mass is reduced to 1,072 g when all the crystal water is removed. Determine the formula of hydrated magnesium iodide.

4. Determine the formula of a hydrate that is 85,3% barium chloride and 14,7% water?

5. A 4,89 g sample of calcium sulfate was heated. After the water was driven off, 3,87 g of the anhydrous calcium sulfate remained. Determine the formula of this hydrate.

Daily task 21.8: Homework/Classwork

1. Consider the following balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$
How many moles of:
1.1 N_2 will react with 3 moles of H_2
1.2 H_2 will react with 3 moles of N_2
1.3 NH_3 will be formed from 11 moles of H_2
1.4 NH_3 will be formed from 11 moles of N_2

2. Consider the following balanced equation: $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

How many moles of:
3.1 Fe_3O_4 will be formed from 12 moles of Fe
3.2 Fe are needed to produce 16 moles of H_2
3.3 H_2 will be formed if 40 moles of Fe_3O_4 are formed
2.4 H_2O are needed to react with 14,5 moles of Fe

3. Calculate the mass of carbon that reacts with 7,95 g of copper(II) oxide. The balanced equation for the reaction is: $2CuO + C \rightarrow 2Cu + CO_2$

4. Calcium metal reacts with water to form an insoluble suspension of calcium hydroxide and hydrogen gas. Calculate the mass of hydrogen produced from 10 g of calcium.

5. Calculate the volume of hydrogen produced at STP from 1 dm^3 of ammonia in the following reaction: $2NH_3 \rightarrow N_2 + 3H_2$

6. Calculate the mass of sodium that will react with 230 g of oxygen to form sodium oxide.
7. Hydrogen burns in oxygen to from water. Calculate the mass of:
7.1 Oxygen needed to burn 1 g of hydrogen
7.2 Mass of water produced from 1 g of hydrogen

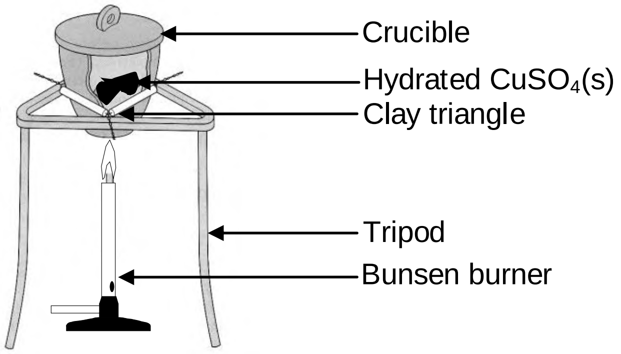
8. Calcium carbonate reacts completely with 30 cm^3 hydrochloric acid of concentration 0,5 mol·dm^{-3}.
8.1 Write down a balanced equation for this reaction.
8.2 Calculate the number of moles of acid that has reacted.
8.3 Calculate the mass of calcium carbonate that has reacted.
8.4 Calculate the volume of gas that will be formed at STP.
8.5 Calculate the number of calcium carbonate formula units that have reacted.

Experiment 18: Water of crystallisation

Aim: To determine the formula of hydrated copper(II) sulphate i.e. solve for x in the formula $CuSO_4.xH_2O$.

Apparatus & chemicals

- Tripod
- Clay triangle
- Crucible
- Spatula
- Hydrated copper(II) sulphate
- Bunsen burner
- Chemical balance



Method

1. Determine the mass of crucible and record it in the table.
2. Half fill the crucible with hydrated copper(II) sulphate.
3. Determine the mass of the crucible and its contents and record the mass in the table.
4. Place the crucible on the clay triangle and heat using a clean blue flame.
5. Heat strongly for about five minutes until no further change is observed.
6. Remove the crucible from the flame and allow it to cool down.
7. Determine the mass of the crucible and its contents again.
8. Repeat the heating until the mass of the crucible and its contents remain constant. Record this constant mass in the table.

Results

Redraw the following table in your practical book. Record all the masses in the table and calculate the mass of water of crystalisation.

1	Mass of crucible (g)	
2	Mass of crucible and hydrated $CuSO_4$ (g)	
3	Mass of hydrated $CuSO_4$ (g) [2 – 1]	
4	Mass of crucible and anhydrous $CuSO_4$ (g)	
5	Mass of anhydrous $CuSO_4$ (g) [4 – 1]	
6	Mass of crystal water [3 – 5]	

Conclusion and questions

1. Define the following terms:
1.1 Water of crystalisation 1.2 Hydrated salt 1.3 Anhydrous salt
2. What do you initially see happening when the crystals are heated?
3. How do you know when all the water of crystallisation has been lost?
4. What is the colour of:
   4.1 Hydrated copper(II) sulphate 4.2 Dehydrated copper(II) sulphate
5. What is the formula of a water molecule? Calculate the molar mass of water.
6. Use the results obtained to calculate the number of moles of water of crystalisation in hydrated copper(II) sulphate.
7. Write down the formula of anhydrous copper(II) sulphate. Calculate its molar mass.
8. Use the results obtained to calculate the number of moles of anhydrous copper(II) sulphate.
9. Calculate the ratio of the number of moles of water of crystalisation to the number of moles of anhydrous copper(II) sulphate.
10. Express your answer to Question 9 as a whole number and write down the formula of hydrated copper(II) sulphate.