JENN

Training and Consultancy

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PHYSICAL SCIENCES

GRADE 10

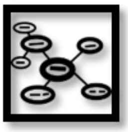
LEARNER STUDYGUIDE

TOPIC:1 Physical, Chemical change and balanced chemical equations

TOPIC:2 Magnetism and electrostatics

TOPIC:3 Electric circuit

ICON DESCRIPTION

			Mind Map		
	Table of Content		Steps		Key Concepts/Glossary
	Methodology		Activities		Bibliography

PROGRAMME		
DAY	**ACTIVITY**	**TIME**
1	Arrival + Pre-test	1hour
2	Physical and Chemical change	2hours
3	Physical and Chemical change	2hours
4	Magnetism and electrostatics	2hours
5	Magnetism and electrostatics	2hours
6	Electric circuit	2hours
7	Electric circuit	2hours
8	Electric circuit	2hours
9	Revision + Pre-test Feedback	2hours
10	Post -test + Closing the gaps	2hours
11	Post- test Feedback	2hours
12	Departure	

CONTENTS **PAGE**

Physical and Chemical Change
(This section must be read in conjunction with the CAPS, p. 35.)

Separation of particles in physical and chemical change

- Define a physical change as a change in which:
  - No new substances are formed
  - Energy changes are small in relation to chemical changes
  - Mass, numbers of atoms and molecules as being conserved
- Describe the rearrangement of molecules during physical changes, e.g.
  - Molecules separate when water evaporates to form water vapour
  - When ice melts molecules become disorderly arranged due to breaking of intermolecular forces
- Define a chemical change as a change in which:
  - New chemical substances are formed
  - Energy changes are much larger than those of the physical change
    Endothermic reaction: Energy is absorbed during the reaction
    Exothermic reaction: Energy is released during the reaction
  - Mass and atoms are conserved, but the number of molecules is not
- Describe examples of a chemical change that include the:
  - Decomposition of hydrogen peroxide to form water and oxygen
  - Synthesis reaction that occurs when hydrogen burns in oxygen to form water
  - Heating of iron and sulphur
  - Reaction of lead(II) nitrate and potassium iodide (in solid phase and/or as solutions)
  - Titration of hydrochloric acid with sodium hydroxide to measure the change in temperature

Conservation of atoms and mass

- Calculate relative molecular masses of reactants and products in balanced equations to illustrate that atoms are conserved during chemical reactions, but not molecules.

Representing Chemical Change
(This section must be read in conjunction with the CAPS, p. 37.)

Balanced chemical equations

- Write and balance chemical equations. Use formulae with subscripts to represent phases, viz. (s), (ℓ), (g) and (aq).
- Interpret balanced reaction equations in terms of:
  - Conservation of atoms
  - Conservation of mass (use relative atomic masses)

Reactions in aqueous solutions
(This section must be read in conjunction with the CAPS, p. 46–49.)

Ions in aqueous solution: their interaction and effects

- Explain, using diagrams, the polar nature of the water molecule and how water is able to dissolve ions.
- Define a polar molecule as having two oppositely charged poles and that it is also known as a dipole.
- Represent the dissolution process using balanced reaction equations with the abbreviation (s) for the solid phase and (aq) for substances dissolved in water, e.g. when salt is dissolved in water ions form according to the equation:
  $NaC\ell(s) \rightarrow Na^+(aq) + C\ell^-(aq)$
- Define an aqueous solution as a solution in which the solvent is water.
- Define dissociation as the process in which solid ionic crystals are broken up into ions when dissolved in water.

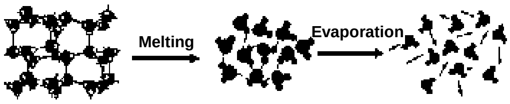
Physical and Chemical Change

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

A change during which a new substance is formed

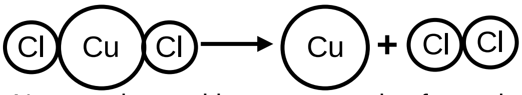
Separation of particles

Physical change



Ice water water vapour

Chemical change



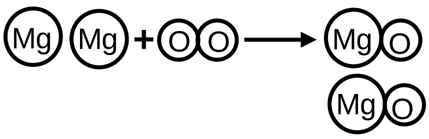
New products with new properties formed

Energy involved:

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

Conservation of atoms and mass

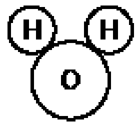
$2Mg + O_2 \rightarrow 2\ MgO$



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)

Law of constant composition



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.

LEARNER MANUAL	
TOPIC: Chemical change	Duration:4 Hours
Key Concepts: 1. Physical and chemical change 2. Conservation of atoms and mass 3. Law of constant composition 4. Balanced chemical equation	

Worked Example

QUESTION 1

1.1 Write down the chemical formula of:

1.1.1 Ammonium sulphate (2)

1.1.2 Potassium permanganate (2)

1.2 Sodium carbonate and hydrochloric acid reacts to form sodium chloride according to the following UNBALANCED equation.

$$Na_2CO_3(s) + HC\ell(aq) \rightarrow NaC\ell(aq) + H_2O(\ell) + CO_2(g)$$

1.2.1 Write down the common name of sodium chloride. (1)

1.2.2 Rewrite the above equation in your answer book and then balance the equation. (2)

1.2.3 Write down the Law of Conservation of Mass. (2)

1.2.4 Show that the mass is conserved in the reaction in QUESTION 1.2.2. (6)

1.3 Consider the UNBALANCED equation for the production of hydrogen chloride.

$$H_2(g) + C\ell_2(g) \rightarrow HC\ell(g)$$

1.3.1 Rewrite the above equation in your answer book and then balance the equation. (2)

1.3.2 Eight H_2 molecules react with excess $C\ell_2(g)$. How many $HC\ell$ molecules will be produced? (1)

1.4 Consider the following WORD EQUATION for a chemical reaction.

nitric acid + zinc oxide → zinc nitrate + water

Write down a balanced chemical equation for the above reaction. (4)

1.5 Rewrite the following INCOMPLETE EQUATION in your answer book. Fill in the missing formula and then balance the equation.

$HC\ell + Na_2CO_3 \rightarrow$ ____ $+ CO_2 + H_2O$ (2)

[24]

QUESTION 2

Magnesium burns in oxygen to form a white powder. Fatima and Minty want to investigate whether mass is conserved during this reaction. They allow a known mass of magnesium to react with oxygen in a closed crucible. Heat is given off during the reaction.

2.1 Write down the NAME and FORMULA of the product formed in this reaction. (2)

2.2 Write a balanced chemical equation to represent this reaction. (3)

2.3 What type of bonds exist between the atoms of the product? (1)

2.4 Is this reaction a SYNTHESIS or a DECOMPOSITION? Give a reason for the answer. (3)

2.5 Is this reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (3)

Fatima weighs the crucible at the end of the experiment and calculates that the mass of magnesium oxide is greater than the mass of magnesium originally used.

2.6 Minty states that this experiment does NOT agree with the Law of Conservation of Mass, since the crucible has a greater mass after the experiment. Explain this increase in mass. (2)

[14]

QUESTION 1

SOLUTION

1.1

1.1.1 $(NH_4)_2$✓SO_4 ✓ (2)

1.1.2 K✓MnO_4 ✓ (2)

1.2

1.2.1 Table salt / *Tafelsout* ✓ (1)

1.2.2 <u>$Na_2CO_3 + 2HC\ell$</u> ✓ → <u>$2NaC\ell + CO_2 + H_2O$</u> ✓ (2)

1.2.3 Mass cannot be created or destroyed. / The total mass of reactants equals the total of products. ✓✓
Massa kan nie geskep of vernietig word nie. / Die totale massa van reaktanse is gelyk aan die totale massa van produkte. (2)

1.2.4 Mass (reactants)/*Massa (reaktanse)* =106 ✓ + 2(36,5) ✓ = 179 g
Mass (products)/*Massa (produkte)* = 58,5 ✓ + 44 ✓ + 18 ✓ = 179 g
} ✓Both answers/*Beide antwoorde* (6)

1.3

1.3.1 $H_2 + C\ell_2$ ✓ → $2HC\ell$ ✓ (2)

1.3.2 16 ✓ (1)

1.4 <u>$2HNO_3$</u>✓ + ZnO✓ → $Zn(NO_3)_2$✓ + H_2O ✓ (4)

1.5 $2HC\ell + Na_2CO_3 \rightarrow 2$<u>$NaC\ell$</u> ✓ + $CO_2 + H_2O$ Bal. ✓ (2)

[24]

QUESTION 2

2.1 Magnesium oxide / *Magnesiumoksied* ✓
MgO ✓ (2)

2.2 $2Mg + O_2$ ✓ → $2MgO$ ✓ Bal. ✓ (3)

2.3 Ionic / *Ionies* ✓ (1)

2.4 Synthesis / *Sintese* ✓
Elements react ✓ to form a new compound. ✓
Elemente reageer) om 'n nuwe verbinding te vorm. (3)

2.5 Exothermic/*Eksotermies* ✓
Heat is given off. / Energy is released. ✓✓
Hitte word afgegee. / Energie word vrygestel. (3)

2.6 Oxygen from the atmosphere ✓
combined with magnesium to form magnesium oxide. ✓
Suurstof uit die atmosfeer
verbind met magnesium om magnesiumoksied te vorm. (2)
[14]

ACTIVITY 1

The unbalanced equation **(i)** and the word equation **(ii)** for two chemical reactions are shown below.

(i) $SO_2(g) + O_2(g) \rightarrow SO_3(g)$

(ii) Calcium carbonate → calcium oxide + carbon dioxide

1.1 Which ONE of the above equations (**i** or **ii**) represents a:

1.1.1 Decomposition reaction (1)

1.1.2 Synthesis reaction (1)

1.2 What does (g) represent in equation **(i)** above? (1)

1.3 Write down a balanced chemical equation for the word equation **(ii)**. Show the phases of ALL reactants and products. (4)

1.4 Rewrite equation **(i)** in your ANSWER BOOK and balance the equation. (1)

1.5 Name the chemical law that a balanced equation illustrates. (1)

1.6 Using equation **(i)** above, show that mass is conserved during the reaction. (3)
[12]

ACTIVITY 2

The unbalanced chemical equation (i) and the word equation (ii) for two chemical reactions are shown below.

(i) $C\ell_2(g) + H_2(g) \rightarrow HC\ell(g)$

(ii) aluminium carbonate

2.1 Which ONE of the reactions, (i) or (ii), is:

2.1.1 A decomposition reaction (1)

2.1.2 A synthesis reaction (1)

2.2 What does the (g) in reaction (i) represent? (1)

2.3 Write down the chemical formulae for the following:

2.3.1 Aluminium carbonate (2)

2.3.2 Aluminium oxide (2)

2.4 Write a balanced chemical equation for equation (i). (2)

2.5 Use the balanced equation in QUESTION 2.4 to show that mass is conserved in a chemical reaction. (3)

2.6 Calculate the percentage composition of hydrogen chloride. (3)

[15]

ACTIVITY 3

Magnesium ribbon burns in oxygen with a bright white flame to produce a white solid, magnesium oxide.

3.1 Name the type of chemical bonding in:

3.1.1 Magnesium ribbon (1)

3.1.2 Magnesium oxide (1)

3.2 Is the reaction between magnesium ribbon and oxygen a PHYSICAL or CHEMICAL change? Give a reason for the answer. (2)

3.3 Write down a balanced equation for the reaction between magnesium and oxygen. (3)

3.4 Use the law of conservation of mass to show that mass is conserved during the reaction in QUESTION 3.3. (4)

3.5 Write down a balanced chemical equation for the following word equation:

Nitric acid + copper → copper(II) nitrate + water + nitrogen dioxide (3)

[14]

LEARNER MANUAL	
TOPIC: Magnetism and Electrostatics	Duration: 4Hours
Key Concepts: 1. Attraction and repulsion, magnetic field lines 2. Two kinds of charge 3. Charge conservation	

Magnetism
(This section must be read in conjunction with the CAPS, p. 38–39.)

Magnetic field of permanent magnets

- Explain that a magnetic field is a region in space where a magnet or ferromagnetic material will experience a force (non-contact).
  Ferromagnetic materials: Materials that are strongly attracted by magnets and are easily magnetised. Examples are iron, cobalt, nickel and their alloys.
  Non-contact force: A force exerted on an object without touching the object.
- Compare magnetic fields with electric and gravitational fields. An electric field is a region in space where an electric charge will experience an electric force. A gravitational field is a region in space where a mass will experience a gravitational force.

Poles of permanent magnets, attraction and repulsion, magnetic field lines

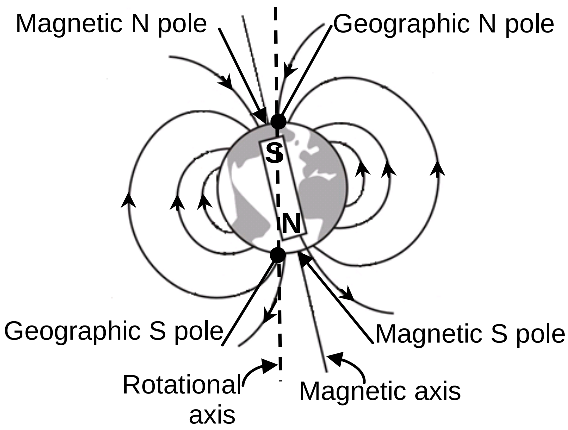
- Describe a magnet as an object that has a pair of opposite poles, called north and south (or north-seeking and south-seeking). Even if the object is cut into tiny pieces, each piece will still have both a north and a south pole.
- Apply the fact that like magnetic poles repel and opposite poles attract to predict the behaviour of magnets when they are brought close together.
- Sketch magnetic field lines to show the shape, size and direction of the magnetic field of different arrangements of bar magnets.
- Describe properties of magnetic field lines:
  - The more closely spaced the field lines are at a point the greater the field at that point.
  - Arrows drawn on the field lines indicate the direction of the field.
  - The direction of a magnetic field points from the North to the South Pole.
  - Magnetic field lines never cross.

Earth's magnetic field, compass

- Explain how a compass indicates the direction of a magnetic field.
- Compare the magnetic field of the Earth to the magnetic field of a bar magnet.
- Explain the difference between the geographical North Pole and the magnetic north pole of the Earth.
  Geographic north pole: Point in the northern hemisphere where the rotation axis of the Earth meets the surface.
  Magnetic north pole: The point where the magnetic field lines of the Earth enters the Earth. It is the direction in which the north pole of a compass points.
  Magnetic south pole: The point where the magnetic field lines of the Earth leaves the Earth.
- Give examples of phenomena that are affected by Earth's magnetic field, e.g. Aurora Borealis (Northern Lights) and magnetic storms.
  Aurora Borealis (Northern Lights): An atmospheric phenomenon consisting of bands of light at the north pole caused by charged solar particles following the Earth's magnetic lines of force.
  Magnetic storm: 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.
- Discuss qualitatively how the Earth's magnetic field provides protection from solar winds.
  Solar wind: A stream of radioactive and charged particles sent into space at high speeds due to reactions on the sun.

Magnetism

Earth's magnetic field



Magnetic materials

Materials that are attracted by magnets.

Ferromagnetic materials

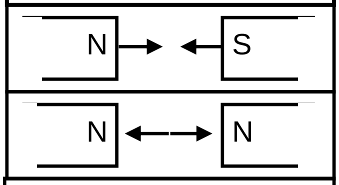
Iron, nickel, cobalt & their alloys

Strongly attracted by magnets & are magnetised easily

Permanent magnets: Hard iron
Temporary magnets: Soft iron

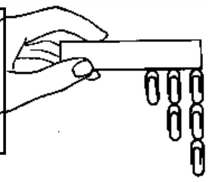
Magnets

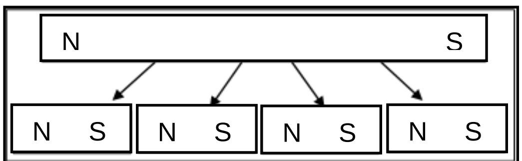
N pole and a S pole



Like poles repel
Unlike poles attract

Force strongest at poles
Non-contact force





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

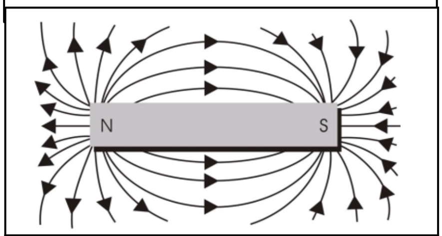
Magnetic field

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

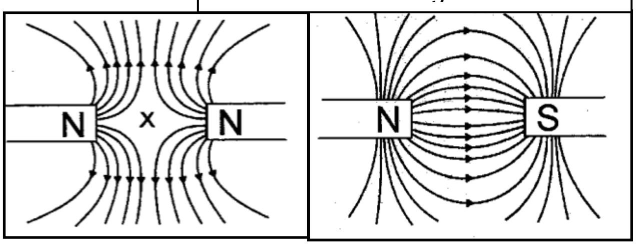
Points in direction of the force on a free N pole at a point in field.

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.

Electrostatics
(This section must be read in conjunction with the CAPS, p. 40–42.)

Two kinds of charge

- State that:
  - All materials contain positive charges (protons) and negative charges (electrons)
  - An object that has an equal number of electrons and protons is neutral (no net charge)
  - Positively charged objects are electron deficient and negatively charged objects have an excess of electrons
- Describe how objects (insulators) can be charged by contact (or rubbing) - tribo-electric charging.
  Tribo-electric charging: A type of contact electrification in which certain materials become electrically charged after they come into contact with different materials and are then separated (such as through rubbing). The polarity and strength of the charges produced differ according to the materials.

Charge conservation

- State that the SI unit for electric charge is the coulomb (C).
- State the principle of conservation of charge: The net charge of an isolated system remains constant during any physical process e.g. two charges making contact and then separating.
- Apply the principle of conservation of charge.
  When two identical conducting objects having charges Q_1 and Q_2 on insulating stands touch, each object has the same final charge on separation.
  Final charge after separation: $Q = \frac{Q_1 + Q_2}{2}$
  NOTE: This equation is only true for identically sized conductors on insulated stands.

Charge quantization

- State the principle of charge quantization: All charges in the universe consist of an integer multiple of the charge on one electron, i.e. $1{,}6 \times 10^{-19}$ C.
- Apply the principle of charge quantization: $Q = nq_e$, where $q_e = 1{,}6 \times 10^{-19}$ C and n is an integer.

Force exerted by charges on each other (descriptive)

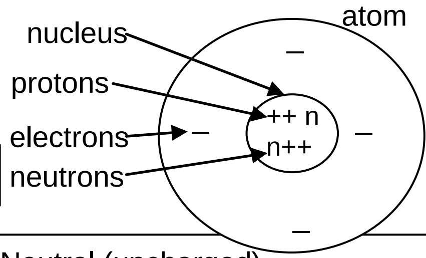
- State that like charges repel and opposite charges attract.
- Explain how charged objects can attract uncharged insulators because of the polarisation of molecules inside insulators.
  Polarisation: The partial or complete polar separation of positive and negative electric charge in a system.

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	G	$9{,}8\ m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	C	$3{,}0 \times 10^{8}\ m \cdot s^{-1}$
Planck's constant *Planck se konstante*	H	$6{,}63 \times 10^{-34}$ J·s
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}$ kg

ELECTROSTATICS

Study of charges at rest

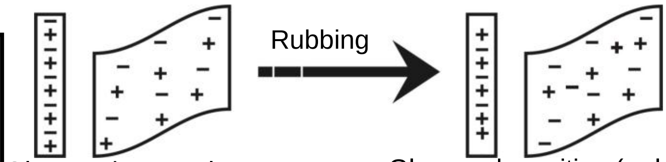


All matter consist of atoms

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

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

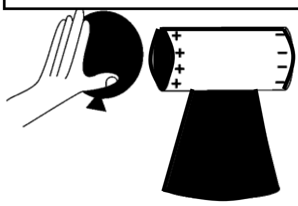
Glass rod: positive (e- lost)
Woollen cloth: negative (e^- gained)

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

Tribo-electric series Materials	
Dry skin of humans	Stronger positive ↑
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 negative ↓

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



Electrostatic forces
Charged object on neutral object by polarisation

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.

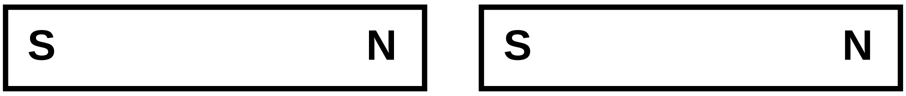
ELECTROSTATICS/*ELEKTROSTATIKA*

$n = \frac{Q}{e}$	$Q = \frac{Q_1 + Q_2}{2}$

Worked Example

QUESTION 1

Two bar magnets are brought closer to each other as show below.



1.1 Define the term *magnetic field*. (2)

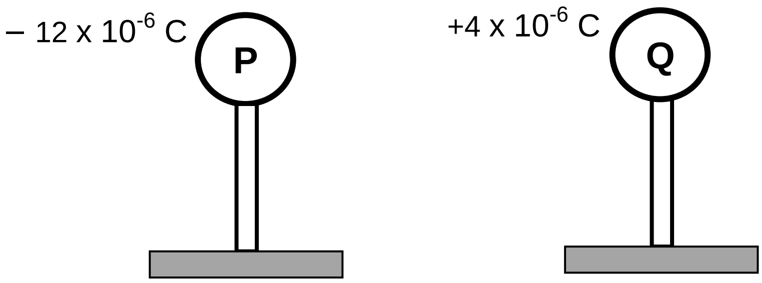
1.2 Will the two magnets REPEL or ATTRACT each other? (1)

1.3 Draw the magnetic field pattern in the region between the two magnets. (2)

1.4 The first magnet is now rotated so that the S pole faces the S pole of the second magnet. Draw the magnetic field pattern in the region between the two magnets. (2)
[7]

QUESTION 2

Two spheres, **P** and **Q**, on insulated stands, carry charges of - 12 x 10^{-6} C and + 4 x 10^{-6} C respectively as shown below.



THE SPHERES ARE NOW ALLOWED TO TOUCH EACH OTHER AND THEN SEPARATED AGAIN.

2.1 Write down the *principle of conservation of charge.*

2.2 In which direction will electrons flow while spheres **P** and **Q** are in contact? Write down only from **P** to **Q** or from **Q** to **P**. (1)

2.3 Calculate the new charge on each sphere after separation. (3)

2.4 Calculate the net charge gained or lost by sphere **P**. (3)

2.5 Calculate the number of electrons transferred from one sphere to the other during contact. (2)
[11]

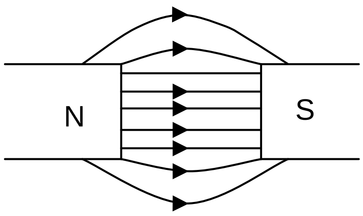
SOLUTION

QUESTION 1

1.1 A region in the space in which a magnet / ferromagnetic substance experiences a (non-contact force). ✓✓
'n Gebied in die ruimte waarin 'n magneet/ferromagnetiese stof 'n (nie-kontak)krag ondervind. (2)

1.2 Attract / *Aantrek* ✓ (1)

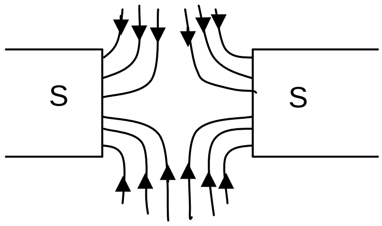
1.3



Field lines drawn as shown./*Veldlyne getreken soos anagetoon.* ✓
Direction of field lines from N to S pole between magnets./*Rigting van veldlyne vanaf N na S-pool tussen magnete.* ✓

(2)

1.4



Field lines drawn as shown./*Veldlyne getreken soos aangetoon.* ✓
Direction of field lines towards S poles between magnets./*Rigting van veldlyne na S-pole tussen magnete.* ✓

(2)
[7]

QUESTION 2

2.1 Charge cannot be created or destroyed, ✓
but only transferred from one object to another. ✓
Ladings kan nie geskep of vernietig word nie,
maar slegs oorgedra word van een voorwerp na 'n ander. (2)

2.2 P to/*na* Q ✓ (1)

2.3 New charge $= \frac{P + Q}{2}$

$= \frac{-12 \times 10^{-6} + 4 \times 10^{-6}}{2}$ ✓ ✓

$= -4 \times 10^{-6}$ C (3)

2.4

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2/ *OPSIE 2*</u>**
$\Delta Q_P = Q_f - Q_i$ $= -4 \times 10^{-6}$ ✓ $- (-12 \times 10^{-6})$ ✓ $= 8 \times 10^{-6}$ C ✓	$\Delta Q_Q = Q_f - Q_i$ $= -4 \times 10^{-6}$ ✓ $- (4 \times 10^{-6})$ ✓ $= -8 \times 10^{-6}$ C ✓

(3)

2.5 **POSITIVE MARKING FROM QUESTION 2.4.**

<u>OPTION 2/ *OPSIE 2*</u>	**<u>OPTION 2/ *OPSIE 2*</u>**
$Q_Q = nq$ $8 \times 10^{-6} = n(-1{,}6 \times 10^{-19})$ ✓ $n = 5 \times 10^{13}$ electrons ✓	$Q_P = nq$ $-8 \times 10^{-6} = n(1{,}6 \times 10^{-19})$ ✓ $n = 5 \times 10^{13}$ electrons ✓

(2)
[11]

ACTIVITY 1

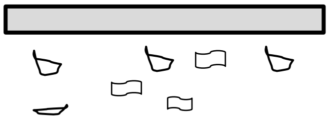
A neutral plastic ruler becomes charged when it is rubbed with a woollen cloth. After rubbing, the ruler has a charge of $-3,5 \times 10^{-15}$ C.

1.1 Distinguish between a *neutral object* and a *charged object*. (2)

1.2 Does the ruler GAIN or LOSE electrons? (1)

1.3 Calculate the number of electrons transferred during the process of rubbing. (3)

1.4 The charged ruler is now brought closer to pieces of paper. The pieces of paper are attracted to the ruler, as shown below.



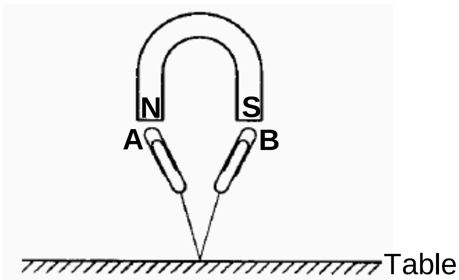
1.4.1 Explain why the pieces of paper are attracted to the ruler. (3)

1.4.2 Name ONE application of electrostatics in our daily lives. (1)

[10]

ACTIVITY 2

2.1 In the diagram shown below steel paper clips **A** and **B** are attached to a string which is attached to a table. The paper clips remain suspended beneath a magnet.



2 .1.1 Define the term *magnetic field*. (2)

2 .1.2 Will the top end of paper clip **A** be an N pole or an S pole? (1)

2 .2 Two bar magnets are placed close to one another as shown in the diagram below.

2.2.1 Draw the magnetic field pattern between the two magnets. (3)

2.2.2 The magnets are now moved further apart. What effect will this change have on the magnetic field pattern drawn in QUESTION 2.2.1? (1)

[7]

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ACTIVITY 3

Two magnets are placed so that their north poles face each other.

3.1 Explain the term *magnetic field.* (2)

3.2 Draw the magnetic field pattern between the two north poles of the magnets. (3)

3.3 The graph below shows how the magnetic force varies with distance between the magnets.

3.3.1 What is the mathematical relationship between magnetic force and distance between the two magnets? (1)

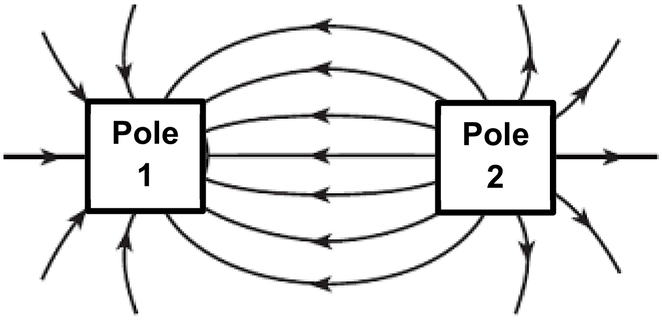
3.3.2 What is the magnitude of the magnetic force between the two magnets when they are 4 cm apart? (1)

3.3.3 How far apart must the magnets be to experience a force of 0,05 N? (1)

[8]

ACTIVITY 4

The magnetic field lines between two magnetic poles of a magnet are shown in the diagram below.



4.1 The magnetic force is a non-contact force.

4.1.1 Define the term *non-contact force*. (2)

4.1.2 Give another example of a non-contact force. (1)

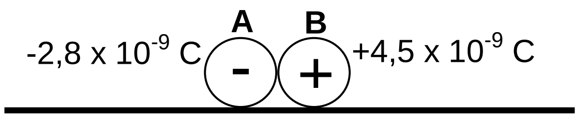
4.2 What is the nature of the force between the two poles? (1)

4.3 What is the polarity of pole 2? Give a reason for the answer. (2)

[6]

ACTIVITY 5

Two identical metal spheres, **A** and **B**, on an insulated surface carry charges of $-2,8 \times 10^{-6}$ C and $+4,5 \times 10^{-6}$ C respectively. The spheres are brought in contact with each other.



5.1 It is observed that the spheres move apart after contact. Briefly explain this observation. (3)

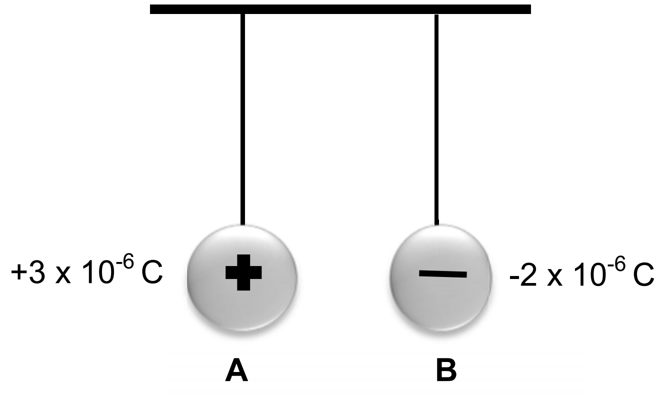
5.2 Calculate the new charge on each sphere after they moved apart. (3)

5.3 Calculate the number of electrons transferred from one sphere to the other during contact. (4)

[10]

ACTIVITY 6

Two small identical spheres, **A** and **B**, are suspended on long silk threads, as shown in the sketch below. The spheres carry charges of $+3 \times 10^{-6}$ C and -2×10^{-6} C respectively.



6.1 Which sphere has an excess of electrons? (1)

6.2 The two spheres are allowed to touch. Will the electrons be transferred from **A to B** or **B to A**? (1)

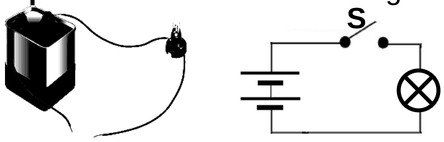
6.3 The spheres are now separated.

Calculate the new charge on sphere **B**. (3)

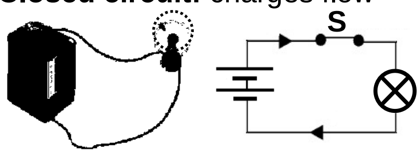
6.4 Calculate the number of electrons transferred during contact. (3)

[8]

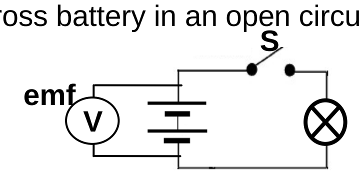
Open circuit: no flow of charge



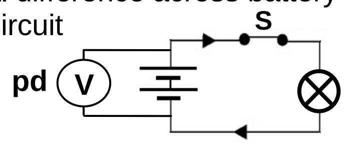
Closed circuit: charges flow



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



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



<u>Potential difference</u>
Unit: volt (V)
Measuring instrument:
voltmeter - connected in parallel

<u>Current:</u>

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

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

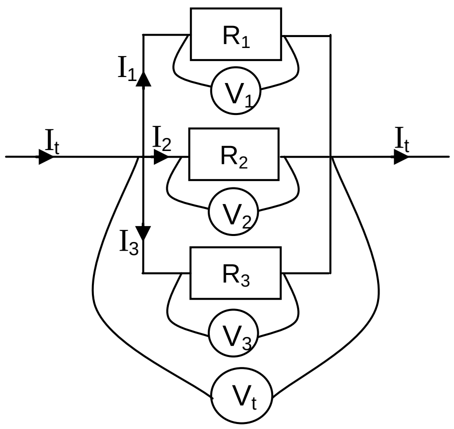
Electric circuits

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: $V_t = V_1 = V_2 = V_3$

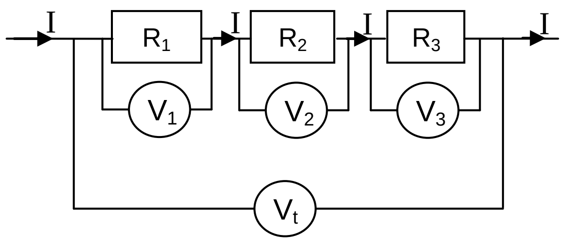


Series circuit

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.

Electric Circuits
(This section must be read in conjunction with the CAPS, p. 42–45.)

Terminal potential difference and emf

- Define potential difference across the ends of a conductor as the energy transferred per unit electric charge flowing through it. In symbols: $V = \frac{W}{Q}$
  Potential difference is measured in volts (V).
- Define emf as the work done per unit charge by the source (battery). It is equal to the potential difference measured across the terminals of a battery when no charges are flowing in the circuit.
- Define terminal potential difference as the voltage measured across the terminals of a battery when charges are flowing in the circuit.
- Do calculations using $V = \frac{W}{Q}$.

Current

- Define current strength, I, as the rate of flow of charge. It is measured in ampere (A), which is the same as coulomb per second.
- Calculate current strength in a conductor using the equation $I = \frac{Q}{\Delta t}$.
  Q is the symbol for electric charge measured in coulomb (C). One coulomb is defined as the charge transferred in a conductor in one second if the current is one ampere.
- Indicate the direction of conventional current (from positive to negative) in circuit diagrams using arrows.

Measurement of potential difference and current

- Draw a diagram to show how to correctly connect an ammeter to measure the current through a given circuit element. An ammeter is connected in series and has a very low resistance.
- Draw a diagram to show how to correctly connect a voltmeter to measure the potential difference across a given circuit element. A voltmeter is connected in parallel and has a very high resistance.

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

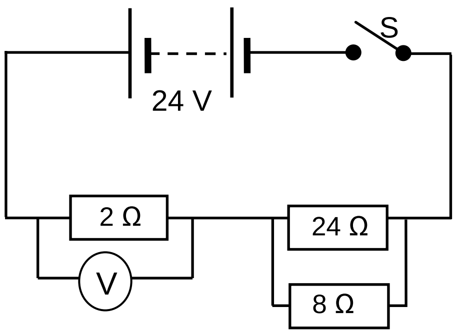
$Q = I\,\Delta t$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$R_s = R_1 + R_2 + ...$	$V = \frac{W}{q}$

LEARNER MANUAL	
TOPIC: Electric circuit	Duration:6Hours
Key Concepts: 1. Emf, potential difference 2. Current 3. Resistance	

Worked Example

QUESTION 1

In the circuit below, the connecting wires and the battery have negligible resistance.



1.1 Name the physical quantity measured by a voltmeter. (1)

1.2 Define the term *resistance*. (2)

1.3 Calculate the:

1.3.1 Equivalent resistance of the resistors connected in parallel (3)

1.3.2 Total resistance of the circuit (2)

1.4 When the switch is closed, the voltmeter connected across the 2 Ω resistor measures 6 V. Determine the potential difference across the parallel combination. (1)

1.5 A charge of 18 C flows through the battery in 6 s.

1.5.1 Define a *coulomb of charge*. (2)

1.5.2 Use the data supplied in QUESTION 1.5 and calculate the current in the 2 Ω resistor. (3)

1.5.3 Use ratios to determine the current in the 24 Ω resistor. (2)

[16]

QUESTION 1

SOLUTION

1.1 Potential difference / *Potensiaalverskil* ✓ (1)

1.2 The ratio of the potential difference across a resistor to the current in the resistor.
Die verhouding ✓ van die potensiaalverskil oor 'n weerstand tot die stroom in die weerstand. ✓ (2)

1.3

1.3.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{24} + \frac{1}{8}$ ✓

$\therefore R_p = 6\ \Omega$ ✓ (3)

1.3.2 **POSITIVE MARKING FROM QUESTION 1.3.1.**

$R_t = 2 + 6$ ✓ $= 8\ \Omega$ ✓ (2)

1.4 18 V ✓ (1)

1.5

1.5.1 A coulomb the charge transferred in a conductor in one second ✓
if the current is one ampere. ✓
'n Coulomb is die lading oorgedra in 'n geleier in een sekonde wanneer die stroom een ampere is. (2)

1.5.2 $I = \frac{Q}{\Delta t}$ ✓

$= \frac{18}{6}$ ✓

$= 3\ A$ ✓ (3)

1.5.3 Ratio of resistances: 24 : 8 = 3 : 1

24 Ω: $\frac{1}{4} \times 3$ ✓ $= 0,75\ A$ ✓

OR/*OF*

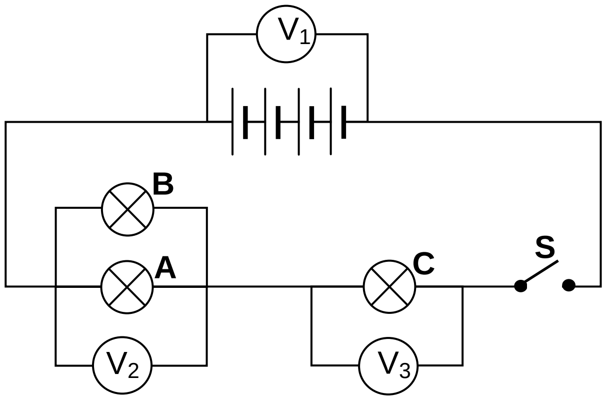
8 Ω: $\frac{3}{4} \times 3$ ✓ $= 2,25\ A$

24 Ω: 3 – 2,25 = 0,75 A ✓ (2)

[16]

ACTIVITY 1

Learners set up a circuit as shown in the diagram below. The emf of each cell is 1,5 V. Each of bulbs **A** and **B** has a resistance of 2 Ω and bulb **C** has a resistance of 3 Ω.



1.1 Calculate the effective resistance of bulbs **A** and **B**. (3)

Switch **S** is now closed for a short time.

1 .2 Determine the reading on:

1.2.1 Voltmeter V_1 (1)

1.2.2 Voltmeter V_3 (2)

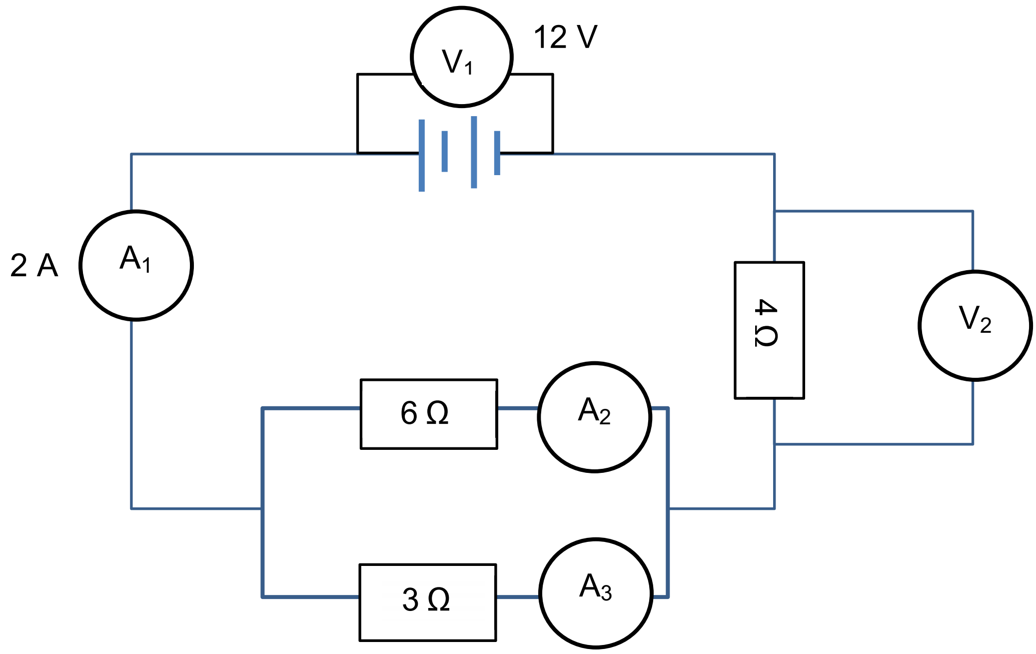
1 .3 Calculate the energy transferred in bulb **C** in 3 seconds if the current in the circuit is 2 A. (5)

1 .4 ALL the bulbs are now connected in parallel. How will the total current in the circuit be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[12]

ACTIVITY 2

In the circuit diagram below the reading on voltmeter V_1 is 12 V and the reading on ammeter A_1 is 2 A.



2.1 Calculate the:

2.1.1 Total resistance of the circuit (4)

2.1.2 Reading on V_2 (3)

2.1.3 Reading on A_2 (3)

2.1.4 Amount of charge that flows through ammeter A_1 in 120 s (3)

2.2 How will the reading on ammeter A_1 be affected if the 6 Ω resistor is removed from the circuit?

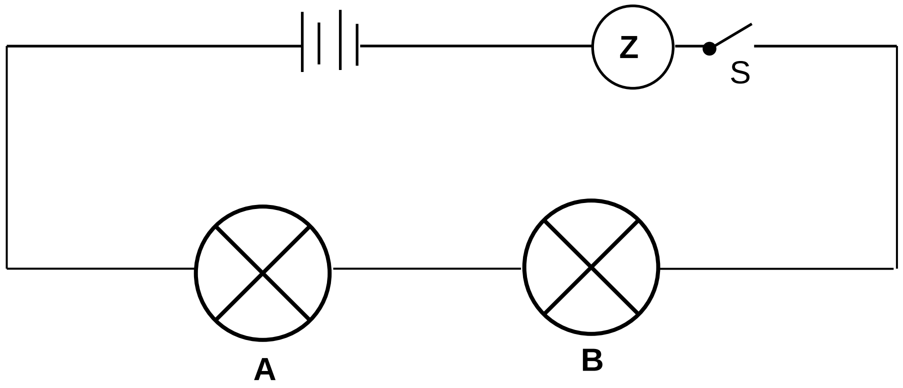
Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)

2.3 Explain the answer to QUESTION 2.2 WITHOUT any calculations. (3)
[17]

ACTIVITY 3

3.1 Two IDENTICAL bulbs, **A** and **B**, as well as a measuring device **Z**, are connected to a battery, as shown in the circuit below.

The switch is initially open.



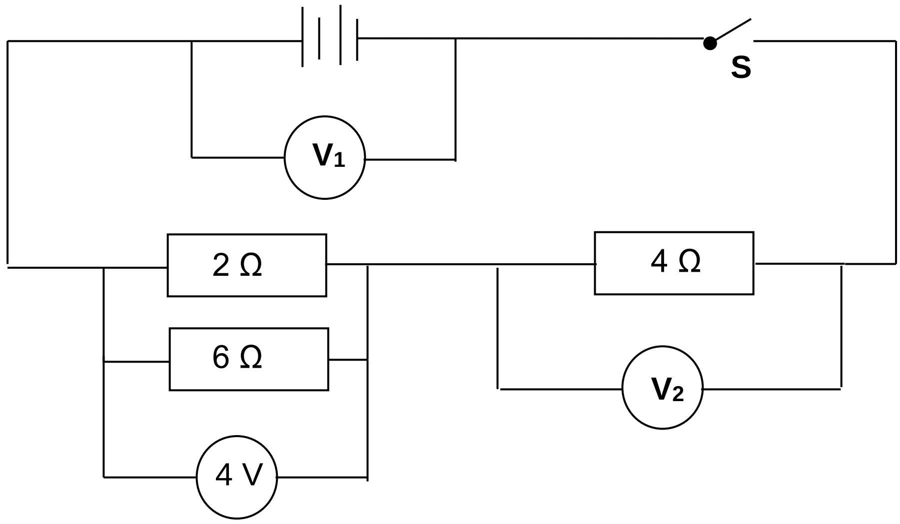
3.1.1 Which physical quantity will device **Z** measure when the switch is closed? (1)

3.1.2 Give a reason why the brightness of the bulbs will be the same when the switch is closed. (1)

A third identical bulb is now connected in series with bulbs **A** and **B** in the circuit.

3.1.3 Will the brightness of the bulb INCREASE, DECREASE or REMAIN THE SAME? (1)

3.2 In the circuit below, potential difference **V_1** across the battery and potential difference **V_2** across the 4 Ω resistor are unknown.



When switch **S** is closed briefly, the potential difference across the parallel combination is 4 V.

3.2.1 Define the term *potential difference*. (2)

Calculate the:

3.2.2 Effective resistance of the 2 Ω and 6 Ω resistors (3)

3.2.3 Reading on voltmeter **V_1** (4)

3.2.4 Reading on voltmeter **V_2** (2)
[14]

Sources of Information (SOI):

1. Physical sciences grade 10 Exemplar 2012 DBE
2. Physical sciences grade 10 Nov 2017 DBE
3. Physical sciences grade 10 Nov 2016 DBE
4. Physical sciences grade 10 Nov 2015 DBE
5. Physical sciences grade 10 June 2014 FSDOE
6. Physical sciences exam guideline DBE
7. Physical sciences FSDOE