

KWAZULU-NATAL
DEPARTMENT OF EDUCATION



TEACHER SUPPORT
DOCUMENT
PHYSICAL SCIENCES
GRADE 10
2020 JIT Term 2

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Electrostatics

Notes to the teacher:

- ✚ This document addresses all misconceptions which were picked up in the grade 12 diagnostic report.
- ✚ Provides all concepts according to examination guidelines
- ✚ This chapter must be introduced using investigative approach e.g. demonstrating the transfer of charges from one object to another by rubbing the following (*woollen cloth with plastic ruler, silk cloth with glass rod*) materials against each and bring them close to small pieces of paper and explain the observations

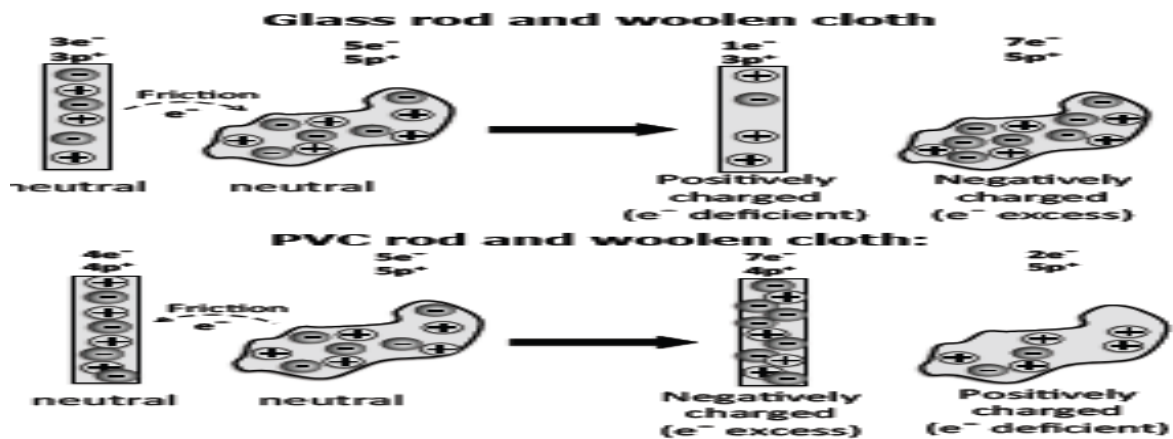
Electrostatics is a branch of physics that studies electric charges at rest. Since classical physics, it has been known that some materials such as amber attract light weight particles after rubbing

- All materials contain positive charges (**protons**) and negative charges (**electrons**)
- A neutral object has an equal number of protons and electrons and has no net charge (net charge equals zero).
- A positively charged object has lost electrons (**electron deficient**) a negatively charged object has gained electrons (**excess of electrons**)
- A charged object can also be attracted to a neutral conductor because of the movement of charges in the conductor
- A charged object can also be attracted to an insulator because of the movement of polarised molecules present in the insulator,
- Charged objects exert forces on each other when brought close together
- Like charges exert REPULSIVE forces on each other opposite charges exert ATTRACTIVE forces on each other
 - Objects 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 are the separated.
 - The polarity and strengths of the charges produced differ according to the materials.

Methods by which a neutral object can become charged

Friction

- Also known as tribo-electric charging
- Rub two objects together such as a glass rod and a woollen cloth. Electrons are transferred from one object to the other (this depends on which materials are used)
- The one object loses electrons and the other gains them

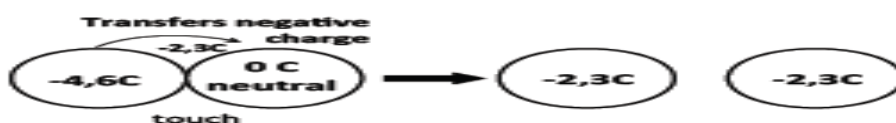


Contact

- When a charged conductor touches an identical neutral conductor, electrons are transferred to make the charge on the conductors equal.
- Positive conductor touches a neutral conductor \rightarrow negative charges are transferred from neutral to positive charge

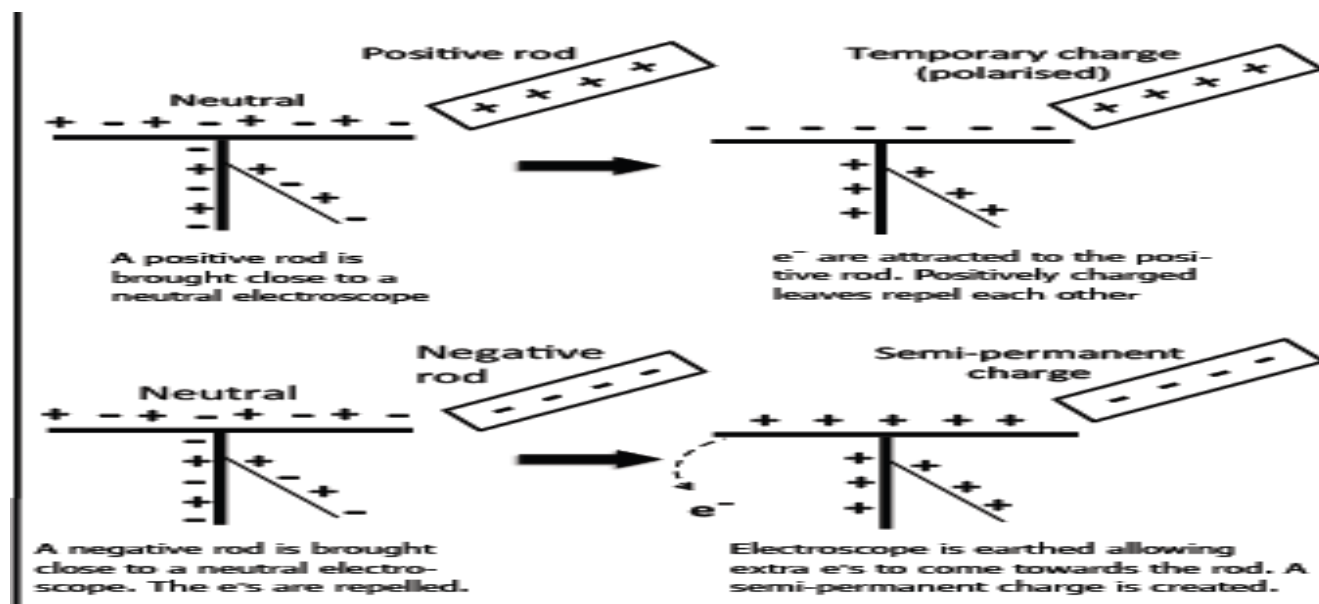


- Negative conductor touches a neutral conductor \rightarrow negative charges are transferred from negative to neutral charge



Induction

A method of charging whereby the objects do not touch one another. Neutral electroscope is charged by induction.



Principle of Conservation of charge

- **Principle of conservation of charge:** the net charge of an isolated system remains constant during any physical process.
- When identical objects with different charges touch, Q₁ and Q₂, charge will be transferred between conductors. The two conductors will then have the final equal charge given by:

$$Q_{\text{new}} = \frac{Q_1 + Q_2}{2}$$

Quantisation of charge

- The charge on a single electron is **q_e = - 1,6 × 10⁻¹⁹ C**
- **Principle of charge quantisation:** all charges in the universe consist of an integer multiple of the charge of an electron: **Q = nq_e**
 Where: Q = charge (C), n= number of electrons
 q_e = charge of an electron (C)
 (work through with learners when doing these examples)

EXAMPLE1: Two identical charges on insulated stands, +5 mC and -9 mC

$$Q_{\text{new}} = \frac{(+5 \times 10^{-3}) + (-9 \times 10^{-3})}{2}$$

$$Q_{\text{new}} = -2 \times 10^{-3} \text{ C each}$$

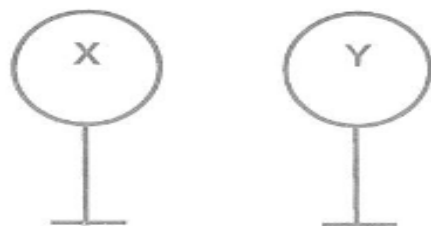
<p>respectively, touch and move apart again. Determine:</p> <p>(a) the new charge on each, (b) the amount of charge transferred and (c) the amount of electrons transferred.</p> <p style="text-align: center;">Solutions</p> <p>(a) $Q_{\text{new}} = \frac{Q_1 + Q_2}{2}$</p>	<p>(b)</p> $\Delta Q = Q_f - Q_i$ $\Delta Q = (-2 \times 10^{-3}) - (+5 \times 10^{-3})$ $\Delta Q = -7 \times 10^{-3} \text{ C}$ <hr/> $Q = nq_e$ $-7 \times 10^{-3} = n(-1,6 \times 10^{-19})$ <p>(c) $n = 4,38 \times 10^{16} \text{ e}^-$</p>
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Can use the following questions

Question 1: multiple choice

1. Multiple choice question

- 1.1. A negatively charged plastic comb is brought close to, but does not touch a small piece of paper. If the comb and the paper are now attracted to each other, then the original charge on the paper was....
- Positive only
 - Negative only
 - Negative or neutral
 - Positive or neutral
- 1.2. A glass rod acquires a positive charge after it has been rubbed with a silk cloth. Which ONE of the following best explains why this happens?
- Negative charges are transferred from the silk cloth to the glass rod.
 - Positive charges are transferred glass rod to the silk cloth.
 - Negative charges are transferred from the glass rod to the silk cloth
 - Positive charges are transferred from the silk cloth to the glass rod.
- 1.3. A Perspex rod is charged negatively by rubbing it with woollen cloth. During the charging process...
- Electrons are transferred from the Perspex rod to the woollen cloth.
 - Electrons are transferred from the woollen cloth to the Perspex.
 - Protons are transferred from the Perspex rod to the woollen cloth.
 - Protons are transferred from the woollen cloth to the Perspex rod.
- 1.4. Two charged spheres, X and Y are made to touch each other and are then separated



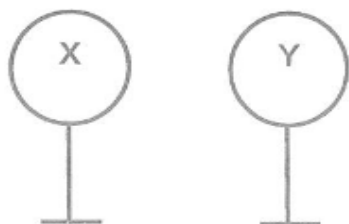
Which one of the following is most probable for these two charges?

	BEFORE TOUCHING		AFTER TOUCHING and SEPARATED
	X	Y	
A	+5,2 C	Neutral	X gained electrons
B	-3 C	-7 C	Y gained electrons
C	-3 C	-7 C	X lost electrons
D	+5.2 C	Neutral	X lost electrons

Long questions

Question 2

2. X and Y are two identical spheres mounted on insulated stands that are placed close to each other.



X carries a charge of $+64 \mu\text{C}$ and Y is neutral.

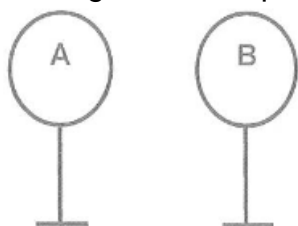
- 2.1. Is the electrostatic charge force that X exerts on Y attractive or repulsive? Explain fully. (3)

X is now brought into contact with Y for a moment and the spheres are placed back at their original positions.

- 2.2. State the principle of conservation of charge. (2)
- 2.3. Which sphere, X or Y, lost electrons when they touched? (1)
- 2.4. Calculate:
- 2.4.1. The new charge on each sphere after touching (2)
- 2.4.2. The number of electrons transferred when the spheres touched. (3)
- 2.5. Can a charge of $1,4 \times 10^{-19}\text{C}$ exist? (YES OR NO). Give a reason (2)

Question 3

3. Two identical metal spheres are placed on insulated stands. Sphere A carries a charge of $-3nC$ sphere B is UNCHARGED.



- 3.1. What is meant by sphere B is *uncharged*? (1)
3.2. Calculate the number of excess electrons on sphere A. (2)

Sphere A is brought CLOSE to sphere B without them touching.

- 3.3. Describe the changes that take place on sphere B (2)

The two spheres are NOW made to TOUCH each other and are then separated.

- 3.4. Will electrons be transferred from A to B from B to A? (1)
3.5. Calculate the final charge on each sphere after separation. (2)
3.6. State the principle of conservation of charge (2)
3.7. Calculate the amount of charge transferred when spheres were in contact. (2)
3.8. Will the spheres exert forces of attraction or repulsion on each other? Give a reason. (2)

Magnetism

Notes to the teacher:

- ✚ This document addresses all misconceptions which were picked up in grade 12 diagnostic report.
- ✚ Provide all concepts according to examination guidelines
- ✚ This chapter need to be introduced using an investigative approach e.g. performing an experiment using magnets and iron filling to demonstrate magnetic field pattern around the magnet and a compass to determine the direction of magnetic field around the bar magnet
- ✚ Can demonstrate attraction and repulsion using two magnets

Prior knowledge: grade 7 – 9

- ***The magnetic effect of electric current***
- ***Forces and force fields (gravitational, magnetic and electric fields)***

Magnetism is a force exerted by a magnet when they attract or repel each other. Magnetism is caused by the motion of electric charges. Every substance is made up of tiny units called atoms. Each atom has electrons, particles that carry electric charges.

Magnetic field: region in space where another magnet or ferromagnetic material will experience a non-contact force

Non-contact force: A force exerted on an object without touching the object.

Magnet: an object with a pair of opposite poles, called north and south

- Magnets can be made from *ferromagnetic materials; materials which are strongly attracted by magnets and are easily magnetised*. Common ferromagnetic materials include iron, cobalt, nickel and their alloys.

When two magnets are brought close to each other:

~ Like poles → **REPEL** each other

~ Unlike poles → **ATTRACT** each other

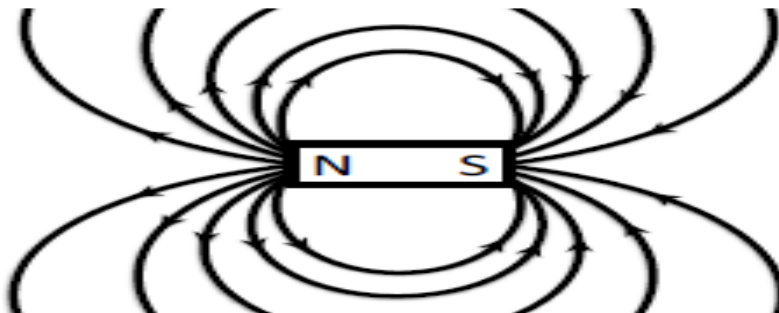
Even if a magnet is cut into little pieces it will form smaller magnets, each with their own north and south poles



• **Magnetic field lines** are imaginary lines around a magnet indicating the direction and the strength of the magnetic field surrounding the magnet (iron filings on paper can be used to indicate the field lines)

- The field lines occur inside the magnet and 3 dimensionally outside it.
- They come out of the magnet near the North Pole and enter near the South Pole again forming a loop.
- Compass is used to determine the directions of magnetic lines

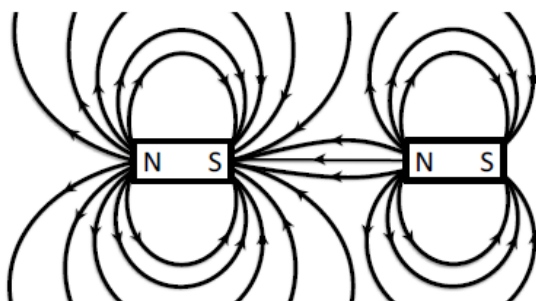
Bar magnet



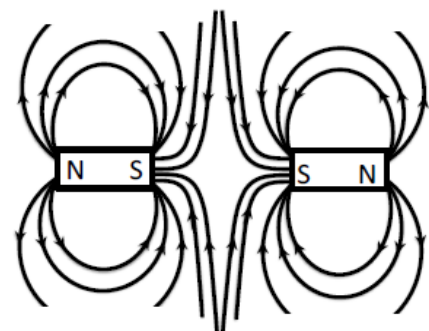
Properties of magnetic field lines

- The more closely spaced the field lines are at a point the greater the field at that point
- Arrows drawn on the field lines indicates the direction of field
- The direction of the magnetic field points from the North to the South Pole.
- Magnetic field lines never cross each other

Attraction between unlike poles

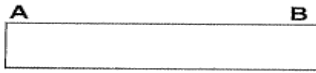


Repulsion between like poles



Example1

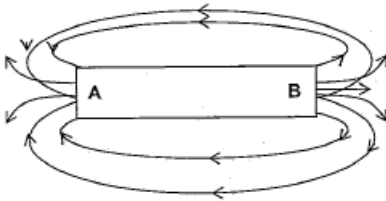
Question: In the bar magnet AB, B represents the North pole.



- 1.1. What is the magnetic field?
- 1.2. List three properties of magnetic field line
- 1.3. Draw the magnetic pattern for this magnet

Solutions

- 1.1. Region in space in which a magnet or ferromagnetic material will experience a force (magnetic)
- 1.2. – direction from north to south pole
 - they do not cross each other
 - density indicates the strength of the field
- 1.3.



Example2

Question: The bar magnet is cut in half , and placed side by side as shown below



- 2.1. What is the polarity of poles represented by A and B?
- 2.2. What will be the nature of the force that the two magnets now exert on each other? (attractive or repulsive)

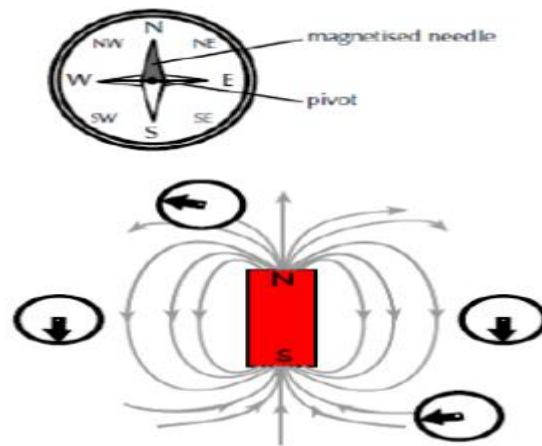
Solutions

- 2.1. A south pole
B North pole
- 2.2. Attractive

Earth's Magnetic field, compass

The Earth behaves as if it has a giant bar magnet running through it, with its magnetic field looping around the earth

- The arrow of the compass is the North Pole of the **compass**, and points towards magnetic North Pole of the Earth.

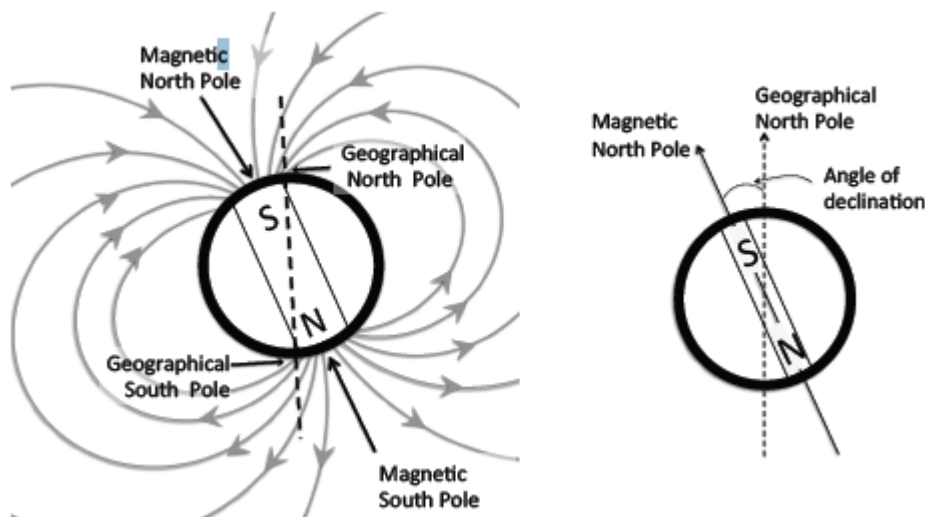


- In reality, the North Pole of the Earth is actually the South pole of the imaginary magnet through the Earth.
- The point in the Northern Hemisphere where the Earth's axis meets the surface of the Earth is the geographical or true North Pole. A compass will not point to this, but rather to the magnetic North Pole – which is actually the South Pole of the imaginary magnet through Earth.

The angle between the true North Pole and the magnetic North Pole is called the **angle of declination**.

Geographical 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



➤ Magnetic Phenomena

- The sun releases particles (mainly electrons and protons) which travel outwards in all directions at speeds of up to 900 m.s^{-1} .

- More particles are released during a solar storm called a coronal mass ejection.
- When these particles come close to the Earth, the **Magnetosphere** protects the Earth by deflecting most of the particles; however some penetrate the Magnetosphere and are pulled towards our North and South Poles.
 - They enter the upper atmosphere at high speed and collide with nitrogen and oxygen molecules causing them to glow with different colours.

Magnetosphere – A region surrounding the earth in which charged particles are trapped and their behaviour is dominated by the earth’s magnetic field

These are known as the **Aurora Borealis (Northern lights)** and **Aurora Australis (Southern lights)**.

- The earth’s magnetic field protect us from the worse effects of these **solar winds**. (*Solar wind is a stream of radioactive and charged particles sent into space at high speed*)
- This interaction with the solar wind causes the shape of the earth’s magnetic field to be changed for a short while and result in **magnetic storms**.
 - **Magnetic storm** – A disturbance in the earth’s outer magnetosphere, usually caused by streams of charged particles given off by solar flames
- A magnetic storm cause problems in television and cell phone signals, can also damage satellites and electrical equipment.

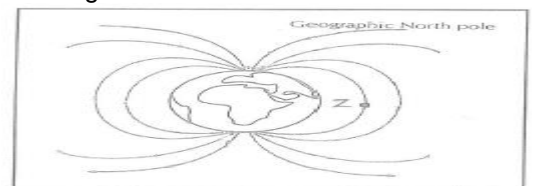
Example 3: The magnetic field lines of the earth look very similar to the magnetic field lines of a bar magnet. A compass is used to indicate direction. Like all magnetic fields, the magnetic field of the earth is caused by moving charges, in this case, charges moving inside the liquid core of the earth. The magnetosphere is very important to the life on the earth because it affects most of the solar winds. South Africa has a permanent base in Antarctica where scientists study the magnetosphere and aurorae.

- 3.1. Explain how a compass is used to indicate the direction of the earth
- 3.2. What is a solar wind?
- 3.3. How does the earth’s magnetic field protect us from the solar winds?

Solutions

- 3.1. A compass is an instrument containing a freely suspended needle comprising a small north pole. If placed anywhere in the Earth’s magnetic field, the needle will indicate the direction called the magnetic north.
- 3.2. Solar wind is a stream of radioactive and charged particles sent into space at high speed
- 3.3. the magnetosphere deflects the greater part of the charged particles away from the sun.

Example 4: The diagram show the magnetic field lines around the earth which is very much similar to the magnetic field pattern of a giant bar magnet



- 4.1. To which pole of the bar magnet does the magnetic north pole of the earth correspond to? Use the diagram to give a reason for the answer.
- 4.2. A compass is used to indicate direction. In which direction will the compass needle point when placed at point Z?
- 4.3. Which metal, aluminium or iron, would be most suitable to use in making a compass needle? Give a reason

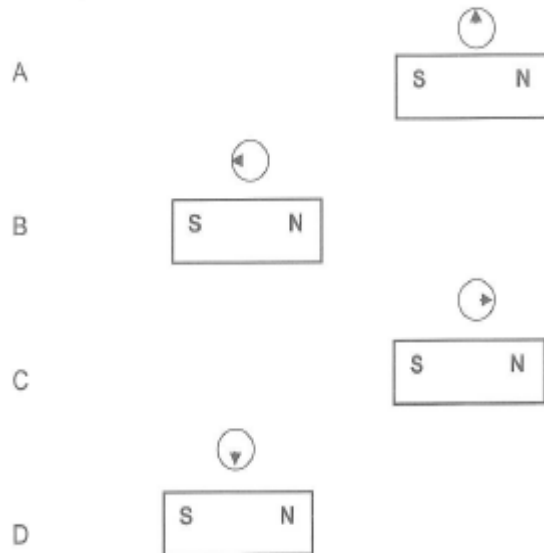
Solutions

- 4.1. South pole the direction of magnetic field lines is from north to south
- 4.2. north
- 4.3. Iron, iron is a ferromagnetic material

Questions 1

1. Multiple choice questions

- 1.1. The pointer on a compass is the North Pole of a small magnet. If a compass was placed next to a bar magnet, as shown below, what will be the correct direction of the pointer?



2

- 1.2. Which ONE of the following statements regarding the earth's magnetic field is FALSE?
- A. It varies from place to place
 - B. The magnetic south pole is the geographic north pole
 - C. It is due to moving charges inside the hot interior of the earth
 - D. The magnetic north and geographic north are at the same location

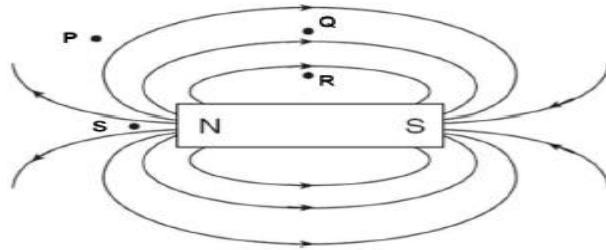
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- 1.3. Consider the following statements concerning magnetic fields:
- i. Magnetic field lines never touch each other
 - ii. The strength of the magnetic field is indicated by the closeness of the field lines.
 - iii. The magnetic field of a bar magnet is weaker at the poles

Which of the above statements are CORRECT?

- A. i, ii and iii
- B. i and ii
- C. i and iii
- D. ii and iii

1.4. The diagram below represents the magnetic field around a bar magnet.



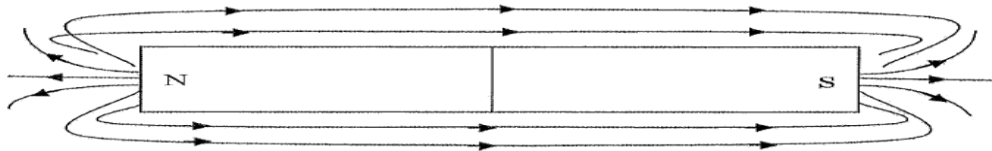
At which point is the magnetic field the strongest?

- A. P
- B. Q
- C. R
- D. S

2. Long Questions

Question 2

2.1. A grade 10 learner performed an experiment to determine the direction and pattern of the magnetic field around the bar magnet. Based on her results, she draws the following diagram in which the north and south poles of the magnets are correctly labelled.



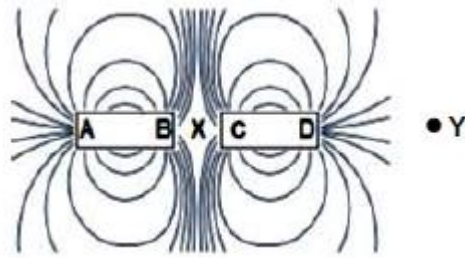
- 2.1.1. What is the magnetic field? 2
- 2.1.2. Identify THREE mistakes that the learner made in the drawing 3
- 2.1.3. Name the device that the learner used to determine the direction of the magnetic field. 1
- 2.1.4. Suppose the magnet used by the learner is broken into two pieces without losing its magnetic properties.
Draw a sketch of the two pieces and label the resulting magnetic poles 2

2.2. People that are living near the North Pole of earth can see the Northern light (Aurora Borealis). It is a particular display of coloured light in the sky. Briefly describe why it is visible near the geographical north pole of earth and how it is formed 4

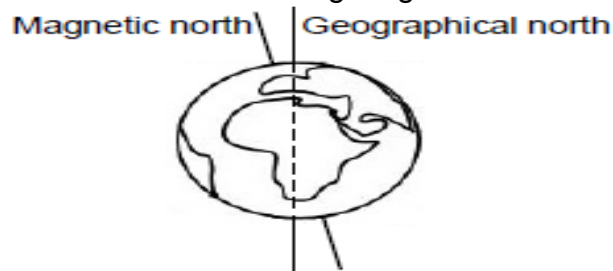
3. Question

3.1. What general term is used to described materials that are easily magnetised? 1

- 3.2. The diagram below shows the magnetic field pattern of two identical bar magnets with poles AB and CD.



- 3.2.1. What important information about polarities of B and C is obtained from the diagram? 1
- 3.2.2. A small piece of magnetic material is placed at point X, exactly in the middle between B and C. Will the material move? Write down only YES, NO or CANNOT TELL. 1
- 3.3. Earth has a geographical North Pole and magnetic north pole as indicated in the following diagram.



- 3.3.1. Explain what the geographic North Pole is. 2
- 3.3.2. Explain what the magnetic north pole is. 2

ELECTRIC CIRCUITS

- Electrical appliances, cell phones, cars, household lighting and industry all run on electricity. It is therefore important to know and understand the basic principles of electric circuits, and to work with circuits safely. This topic deals with DC (direct current) battery powered circuits. The voltages and currents cannot harm the learners when they experiment with circuits.

Introduction

When the battery is connected in the circuit it provides electrical energy to the components of the circuit. There are many misconceptions which stem from misunderstanding the function of the battery, and the way in which it carries out its function e.g.

- the battery is a source of constant current irrespective of the total resistance of the Circuit
- the battery stores charge
- Batteries can be “recharged”.

Notes to the teacher: The learners should be able to distinguish between energy and voltage:

Definitions

Potential Difference: Is the energy transferred per unit electric charge

Symbol: $v = \frac{w}{Q}$

Electro Motive Force: Work done per unit charge by the source (Battery) it is equal to the potential difference across the terminals of the battery when no charges are flowing in the circuit.

NB. Electro Motive Force is not the FORCE but it is the energy and is measured in Joules

Example 1

1. A cell (battery) with an emf of 1,50 V is connected to a light bulb. The terminal potential difference measured across the light bulb is 1,45 V.
 - 1.1 Describe the term “potential difference”.
 - 1.2 Name the apparatus used to measure the potential difference across the bulb.
 - 1.3 Explain what is meant by “the battery has an emf of 1,5 V”.

- 1.4 The terminal potential difference is slightly less than the emf of the battery. What happened in the battery to cause this difference?

Solution:

- 1.1 The potential difference is the amount of energy transferred per unit charge across two points.
- 1.1 Voltmeter.
- 1.2 The emf of a battery is the potential difference measured across the battery when no current passes through it.
OR The emf of a battery is the maximum energy transferred per unit charge passing through the battery.
- 1.3 Energy is transferred per unit charge passing through the battery because the battery has internal resistance.
OR Work was done on the charge as it passed through the battery because there is resistance inside the battery.

Current: the rate of flow of charge. It measured in Ampere (A) which is the same as coulomb per second.

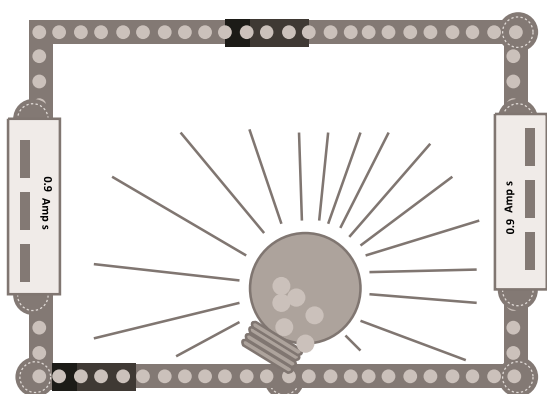
In symbols: $I = \frac{Q}{\Delta t}$

So 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.

- Potential difference is measured across two points in a circuit. The voltmeter is connected across two points to measure pd. Negligible current passes through the voltmeter, because the voltmeter has an extremely high resistance compared to any of the components of the circuit. For our purposes we can assume that no current passes through the voltmeter.
- When we measure potential difference, we are measuring the amount of energy transferred per unit charge. If the voltage across a light bulb is 3 V while it is glowing, then 3 J of energy is being transferred per coulomb of charge passing through the globe. NB. The charge passes through the bulb. The voltage is measured across the

bulb. Voltage does not flow – it's a measurement of the energy transferred per coulomb of charge. Charge flows – and that is measured by the current (rate of flow of charge).

It is a good idea to introduce each of these terms while demonstrating the electric circuits (or perhaps if you have access to a video projector and laptop to construct the circuits using the pHet simulation mentioned under Additional Viewing). The syllabus tends to define the terms first and then to discuss how to measure each using ammeters and voltmeters. During the stage of defining the terms, it can help the learners to see a circuit in operation as a demonstration. Later on, they will get to take measurements for themselves, and to hopefully consolidate their understanding. The idea of current being used up in a circuit is a common error. One way of combatting this is to set up a circuit with two ammeters reading the current before and after it passes through a light bulb. The reading on the ammeter before the bulb is the same as the reading on the ammeter after the bulb. In order for one electron to pass from the battery into the wires every electron in the circuit must move forward immediately. So, if the current is 0,9 A before the bulb, it will be 0,9 A after the bulb.



So, what gets “used up” in an electric circuit?

Actually, nothing is used up. Energy is transferred, from chemical energy in the battery to electrical energy in the components. In the bulb electrical energy is transferred to light and heat. By the law of conservation of energy, energy cannot be created or destroyed. It can only be transferred from one form to another.

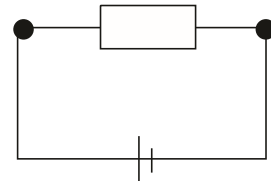
Some people believe that voltage is “used up”. In a series circuit, the terminal potential difference is equal to the sum of the potential differences across each of the components. It does not mean that the voltage is used up in a component. It simply means that amount of the energy was transferred per unit charge to that component. The energy was not used up – it was transferred to other forms e.g. heat in a resistor, or heat and light in a bulb, or motion in an electric motor.

Example 2:

Study the circuit diagram shown alongside.

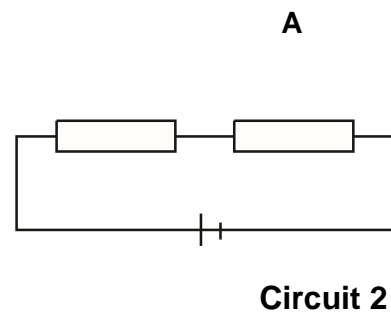
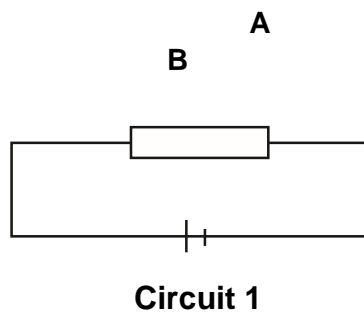
The current is measured at Point 1 and at Point 2.

- 2.1 Compare the readings of current at Points 1 and 2.
- 2.2 Briefly explain your reasoning.



Solution:

- 2.1 The current at Point 1 is the same as the current at Point 2.
- 2.2 Current that travels through the battery is the same as current that travels through the resistor **OR** current in a series circuit remains the same at all point in the circuit.
- 2.3 Two circuit diagrams are shown alongside. Resistors **A** and **B** are identical, and the cells are identical. The cells have negligible internal resistance.



- 2.3.1 In Circuit 2 how does the current through resistor A compare the current through resistor B in Circuit1?
- 2.3.2 Briefly explain your reasoning to 2.3.1.
- 2.3.3 In Circuit 2 how does the current through resistor A compare with the current through resistor B?
- 2.3.4 Briefly explain your reasoning to 2.3.3
- 2.3.5 In Circuit 2 how does the potential difference across A compare with that of B?
- 2.3.6. Explain your reasoning to 2.3.5
- 2.3.7 In Circuit 2 how does the potential difference across A compare with that across A in Circuit 1?

2.3.8 Explain your reasoning to 2.3.7

Solution:

2.3.1 Current in Circuit 2 is less than the current in Circuit 1. (Current in Circuit 2 is half that of Circuit 1).

2.3.2 Circuit 2 has greater resistance than Circuit 1 therefore charge experiences greater opposition to flow in Circuit 2 (**OR** vice versa).

2.3.3 The same current passes through resistor **A** and **B**.

2.3.4 Circuit 2 is a series circuit. The current is the same at all points in a series circuit.

2.3.5 The pd across **A** is equal to the pd across **B**.

2.3.6 The resistors are identical. Each receives half of the terminal pd from the battery.

2.3.7 The pd across A in Circuit 1 is twice the pd across A in Circuit 2.

2.3.8 A is connected to the battery in Circuit 1 therefore it has the whole emf connected across it. In Circuit 2 there are two resistors in series, so A receives only half the pd from the battery.

Resistance: The ratio of potential difference across the resistor to the current in the resistor.

- Resistance is the opposition to the flow of charge. The unit for resistance is ohms (Ω). One ohm is equal to one volt per ampere.

In symbols: $R = \frac{V}{I}$

Factors that affect the resistance of a resistor.

- Temperature
- Length
- Thickness

Resistor in series

- The current is the same through each resistor in a series circuit.
- Resistors in series are potential difference dividers because the total potential difference is equal to sum of the potential difference across all individual components.
- Calculate the total resistance of resistors connected in series using $R_s = R_1 + R_2$

Resistors in parallel

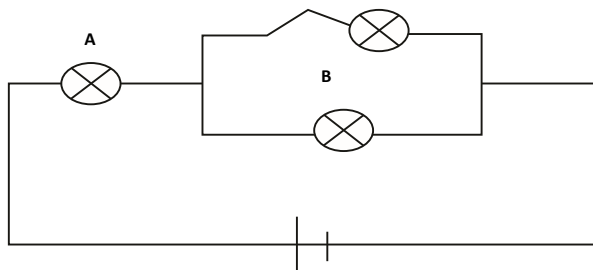
- The potential difference is the same across all resistors connected in parallel.
- Parallel circuits are current dividers because the total current in the circuit is equal to the sum of the current in the branches.
- Calculate the total resistance of the resistors connected in parallel using the following equations:

For more than 2 parallel resistors use: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

For two resistors only use: $R_p = \frac{R_1 \times R_2}{R_1 + R_2}$

Example 3

3. Study the circuit diagram shown alongside. The battery has negligible internal resistance. The three bulbs A, B and C are identical.



3.1 Describe the brightness of bulbs A, B and C when the switch is open.

3.2 Briefly explain your answer to a.

3.3 Describe the brightness of bulbs A, B and C when the switch is closed.

3.4 Briefly explain your answer to c.

Solution:

3.1 Bulbs A and B are equally bright. Bulb C does not light up.

3.2 Bulbs A and B are connected in series therefore they receive the same current and the

same voltage. Bulb C is not connected into the circuit.

3.3 Bulb A is the brightest. Bulbs B and C are equally bright as each other, but dimmer than

bulb A. Bulb A is brighter than it was when the switch was open.

3.4 Bulbs B and C are connected in parallel so they each glow equally bright. They have the same pd across them, and the same current passing through them. Bulb A has twice the amount of current passing through it, and it has twice the pd across it (compared with bulbs B and C). It therefore shines twice as brightly as B and C.

The parallel connection of bulbs B and C decreases the total resistance of the circuit, so a greater current can pass through it. Bulb A has a greater current and a greater pd across it when the switch is closed; therefore, it shines brighter when the switch is closed than it did when the switch was open.

Activities

(integration of all the concepts)

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A, – D) next to the question number (1.1 – 1.10) in your ANSWER BOOK, for example 1.11. D.

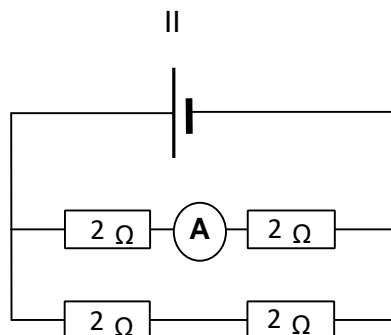
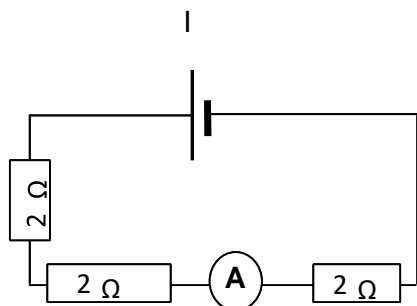
1.1 Electric current strength is defined as the ...

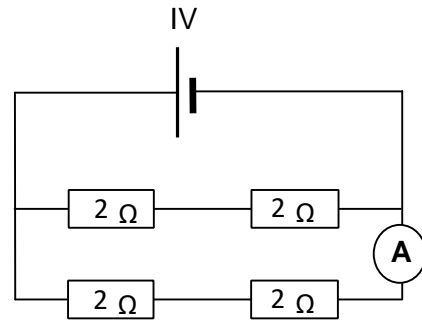
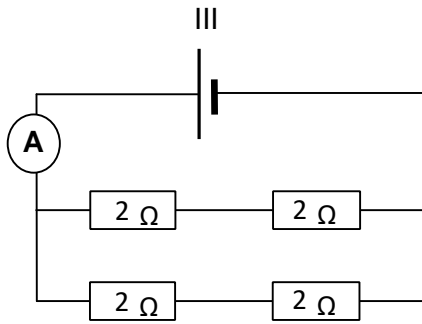
- A flow of charge.
 - B rate of flow of charge.
 - C work done per charge.
 - D potential difference per charge.
- (2)

1.2 The electric current in a wire ...

- A only depends on the resistance of the wire.
 - B only depends on the potential difference across the wire.
 - C does not depend on the potential difference across the wire.
 - D depends on the potential difference across and the resistance of the wire.
- (2)

1.3 Consider the circuits represented below.

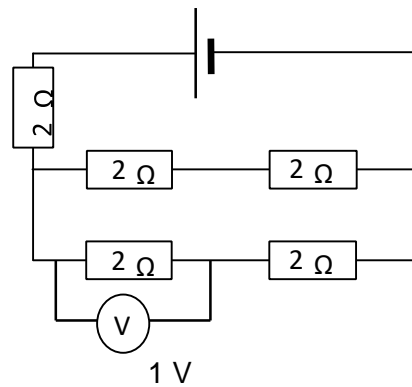




In which circuit(s) does the ammeter measure the main current?

- A I, III and IV
 - B Only I
 - C III and IV
 - D I and III
- (2)

1.4 In the circuit below the resistances of the battery and the connecting wires are negligible.



The emf of the battery is:

- A 1 V
 - B 2 V
 - C 4 V
 - D 6 V
- (2)

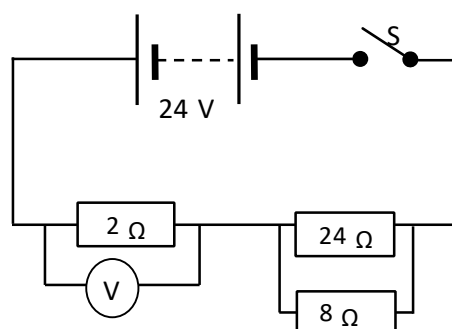
1.5 For which ONE of the quantities below is the CORRECT unit of measurement given?

	QUANTITY	UNIT
A	Current	A·s ⁻¹
B	Energy	kW
C	Potential difference	V
D	Resistance	V·s

(2)

LONG QUESTIONS

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



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

2.2 Define the term *resistance*. (2)

2.3 Calculate the:

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

2.3.2 Total resistance of the circuit (2)

2.4 When the switch is closed, the voltmeter connected across the $2\ \Omega$ resistor measures $6\ \text{V}$. Determine the potential difference across the parallel combination. (1)

2.5 A charge of $18\ \text{C}$ flows through the battery in $6\ \text{s}$.

2.5.1 Use the data supplied in QUESTION 4.5 and calculate the current in the $2\ \Omega$ resistor. (3)

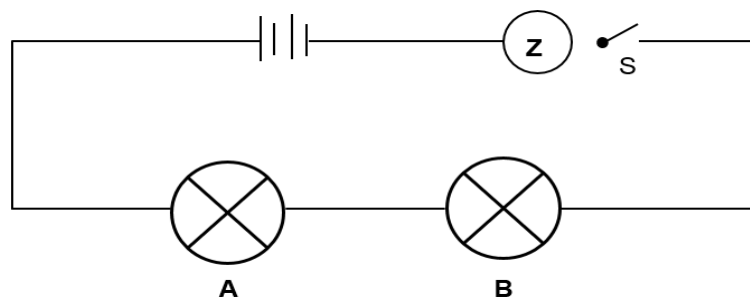
2.5.2 Use ratios to determine the current in the $24\ \Omega$ resistor. (3)

[16]

QUESTION 3

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.



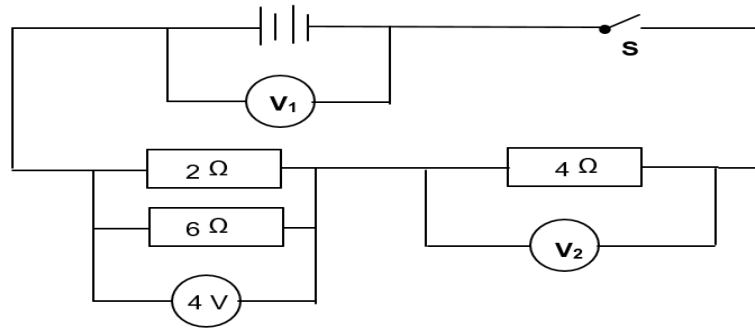
3.1 Which physical quantity will device **Z** measure when the switch is closed? (1)

3.2 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.

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

3.4 the circuit below, potential difference V_1 across the battery and potential difference V_2 across the $4\ \Omega$ resistor are unknown.



Switch **S** is closed briefly, the potential difference across the parallel combination is $4\ \text{V}$.

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

Calculate the:

3.4.2 Effective resistance of the $2\ \Omega$ and $6\ \Omega$ resistors. (3)

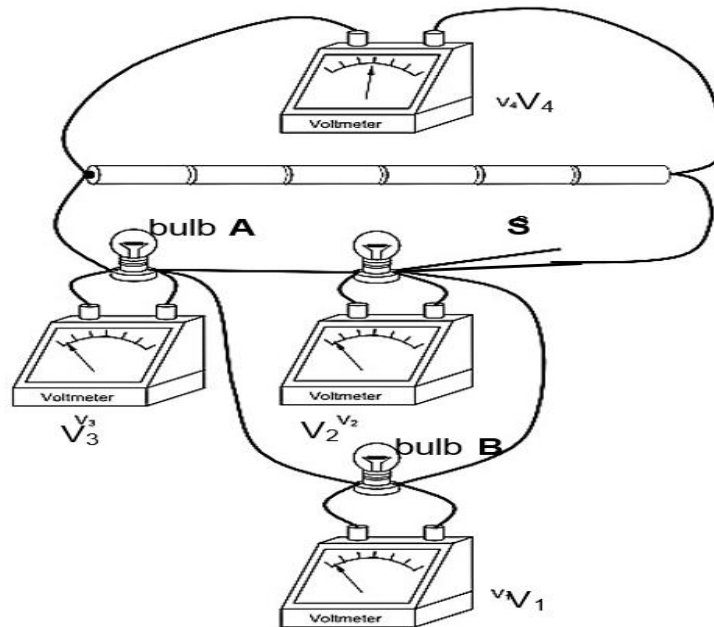
3.4.3 Reading on voltmeter V_1 (4)

3.4.4 Reading on voltmeter V_2 (2)

[14]

QUESTION 4

- 4.1 In the circuit represented below, the bulbs are identical. The resistance of the connecting wires and battery can be ignored.



- 4.1.1 Draw a circuit diagram for the circuit by using the correct symbols. (4)
- 4.2 Define the term *potential difference*. (2)
- 4.3 The reading on voltmeter V_1 is 2 V. Determine the following:
- 4.3.1 Reading on voltmeter V_2 in volt. (2)
- 4.3.2 Reading on voltmeter V_3 in volt. (2)
- 4.3.3 Reading on voltmeter V_4 in volt. (2)
- 4.3.4 4 EMF, in volt, of each cell. (1)
- 4.4 What is the current in bulb **B** if the current in bulb **A** is 2 A? (1)
- 4.5 Calculate the total resistance of the circuit if each bulb has a resistance of $2\ \Omega$. (5)

[21]

SOLUTIONS: ELECTROSTATICS

1. Multiple choice

- 1.1. D ✓ ✓
- 1.2. C ✓ ✓
- 1.3. B ✓ ✓
- 1.4. A ✓ ✓

Long Questions

2. Question 2

2.1. Attractive

X induces a negative polarity on Y in the region close to X

2.2. The net charge of an isolated system remains constant during any physical process.

2.3. Y

2.4.1. $Q_{\text{new}} = \frac{Q_x + Q_y}{2}$

$$= \frac{6 \times 10^{-6} + 0}{2}$$

$$= +3.2 \times 10^{-6} \text{C}$$

2.4.2. $n = \frac{\Delta Q}{Q_e}$

$$n = \frac{+3.2 \times 10^{-6}}{-1.6 \times 10^{-19}}$$

$$= 2 \times 10^{13} \text{electrons}$$

2.5. NO

The smallest charge that can exist is $1.6 \times 10^{-19} \text{C}$ equal to charge on the electron.

3. Question 3

3.1. The number of electrons is equal to the number of protons OR. There is no excess charge.

3.2. *number of excess electrons* $= \frac{-3 \times 10^{-9}}{-1.6 \times 10^{-19}} = 1,875 \times 10^{10}$

3.3. The electrons in sphere B will be repelled by the excess electrons in sphere A, resulting in a separation of charge in sphere B.

3.4. A to B

3.5. $Q = \frac{Q_1 + Q_2}{2} = \frac{-3 \times 10^{-9} + 0}{2} = -1,5 \times 10^{-9} \text{C}$

3.6. The net charge of an isolated system remains constant during any physical process.

3.7. $\Delta Q = -1.5 \times 10^{-9} - (-3 \times 10^{-9}) = 1.5 \times 10^{-9} \text{C}$

3.8. Repulsion like charges repel

SOLUTIONS: MAGNETISM

Question 1

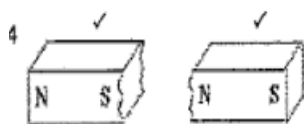
1. Multiple choice

- 1.1. C
- 1.2. D
- 1.3. B
- 1.4. D

Long questions

2. Question2

- 2.1.1. Region around the magnet where another magnet/ magnetic substance experiences a force.
- 2.1.2. Some magnetic field lines do not touch the magnet.
Incorrect direction at South Pole.
Some magnetic field lines cross.
- 2.1.3. (plotting) compass



- 2.1.4.
- 2.2. When, charged particles from the sun reach the magnetic field of earth (magnetosphere) the particles follow the magnetic field lines to the North Pole. When they collide with particles in the atmosphere of Earth, light is given out

3. Question 3

- 3.2.1. Ferromagnetic(material)
Same polarity or both south poles
- 3.2.2. No
- 3.3.1. Point in the northern hemisphere where the rotation axis of the earth meets the surface
- 3.3.2. The point where the magnetic field lines of the earth meets the surface

SOLUTIONS: ELECTRIC CIRCUITS

QUESTION 1

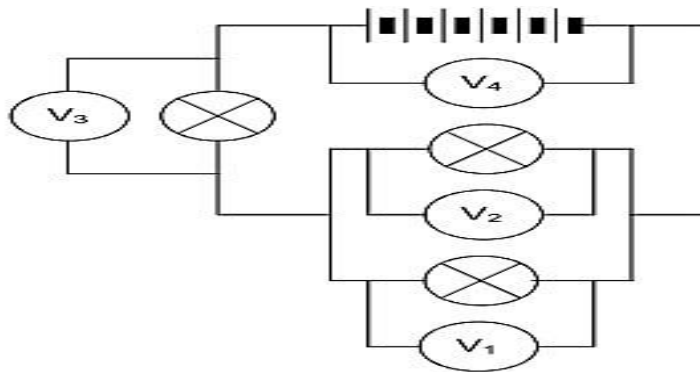
1.1	B ✓✓	
1.2	D ✓✓	
1.3	D ✓✓	
1.4	C ✓✓	
1.5	C ✓✓	
		2X5=10
QUESTION 2		
2.1	Potential difference ✓	(1)
2.2	The ratio of the potential difference across a resistor to the current in the resistor. ✓✓	(2)
2.3		
2.3.1	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$ $\frac{1}{R_p} = \frac{1}{24} + \frac{1}{8} \checkmark$ $R_p = 6 \Omega \checkmark$	(3)
2.3.2	$R_t = 2 + 6 \checkmark = 8 \Omega \checkmark$	(2)
2.4	18 V ✓	(1)
2.5		
2.5.1	$I = \frac{Q}{\Delta t} \checkmark$ $= \frac{18}{6} \checkmark$ $= 3 \text{ A} \checkmark$	(3)
2.5.2	Ratio of resistances: 24: 8 = 3 : 1 ✓ 24 Ω: 3 – 2,25 = 0,75 A ✓	

QUESTION 3		
3.1	Current ✓	(1)
3.2	The bulbs are identical and in series ✓ / the same current flows through each of the bulbs OR The same amount of charge passes through each of them in any given time ✓	(1)
3.3	Decrease ✓	(1)

3.4.1	Potential difference across a conductor is the energy per unit charge flowing through it. ✓✓	(2)
3.4.2	$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$ $= \frac{1}{2} + \frac{1}{6} \checkmark$ $R_P = 1,5 \Omega \checkmark$	(3)
3.4.3	$V = IR \checkmark$ $4 = I(1,5)$ $I = 2,667A$ $V_2 = IR = 2,667(4) \checkmark$ $= 10,67 V$ $V_1 = V_{tot} = (4 + 10,67) \checkmark$ $= 14,67 V \checkmark$	(4)
3.4.4	$V_2 = V_{tot} - V_{//}$ $= (14,67 - 4) \checkmark$ $= 10,67 V \checkmark$	(2)

QUESTION 4

4.1.1



(4)

Marking criteria

- Six cells connected in series with one another and in series with rest of circuit. ✓
- Two bulbs in parallel with one in series. ✓
- V3 connected in parallel across the bulb that is connected in series with other bulbs. ✓
- V1 and V2 connected in parallel across the bulbs that are connected in parallel. ✓

4.2 Potential difference across the ends of a conductor is the energy transferred per unit electric charge flowing through it. (2)

4.3.1 2 V ✓✓ (2)

4.3.2 4 V ✓✓ (2)

4.3.3 6 V ✓✓ (2)

4.3.4 1 V ✓✓ (2)

4.4 1A ✓✓ (2)

4.5 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$ (5)

$$= \frac{1}{2} + \frac{1}{2} \checkmark$$

$$R_p = 1\Omega$$

$$R_T = R_p + R \checkmark$$

$$= 1 + 2 \checkmark$$

$$= 3 \Omega \checkmark$$

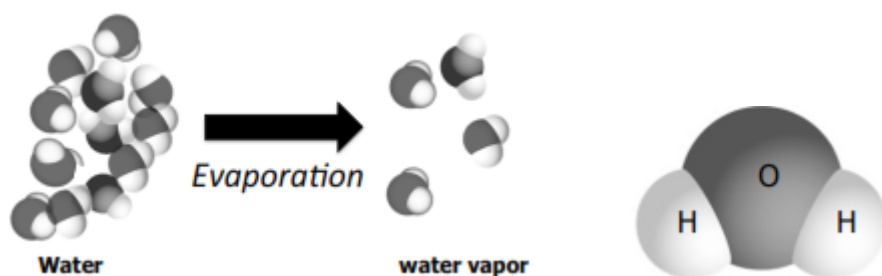
PHYSICAL CHANGE

NOTES TO THE TEACHER

1. This section integrate with the acids and bases(Grade9-12) ,stoichiometry ,redox reactions in Grade11 , rates of reactions, Chemical equilibrium and electrochemistry in Grade.
2. Usage of the Periodic table must be emphasized and firstly learners must be asked questions on the Periodic table to assess prior knowledge since it is taught in GET Band.
3. Experiment on aqueous solutions and electrolysis must be done to enhance the knowledge of learners and must understand the dependent ,independent and controlled variables.
4. The calculations on conservation of mass must be emphasized.
5. The educator must use models to demonstrate reactions.

Physical change is a change in which no new substances are formed.

- The definition implies that the change affect the form of the substances not its chemical composition.



- Energy changes are small in relation to chemical changes.
- Mass, numbers of atoms and molecules are conserved.

CHEMICAL CHANGE

Chemical change is a change in which new chemical substances are formed.



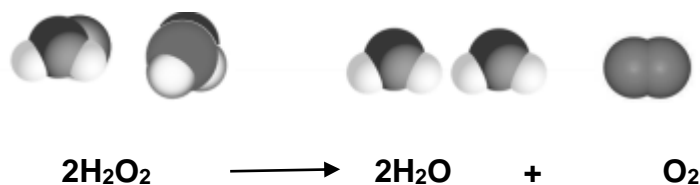
Energy changes are larger those of the physical changes .

- **Exothermic reaction** is the chemical reaction in which energy is released during the reaction.
- **Endothermic reaction** is the chemical reaction in which energy is absorbed during the reaction.

EXAMPLES OF CHEMICAL CHANGE

Decomposition reaction is the reaction in which the chemical substance breaks down to form two or more other substances.

DECOMPOSITION OF HYDROGEN PEROXIDE



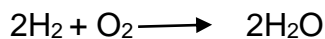
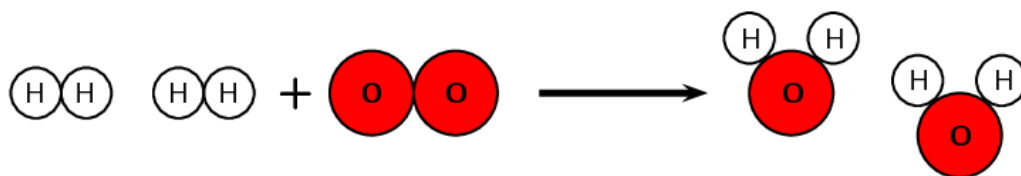
SYNTHESIS

Synthesis is the combining of two or more substances to form a single substance.

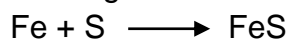
Example of a synthesis reaction.

Hydrogen burns in oxygen to form water.





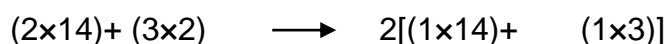
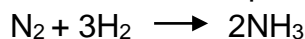
Heating of iron and sulphur



CONSERVATION OF ATOMS AND MASS

LAW OF CONSERVATION OF MASS states that the total mass of reactants and products in a chemical reaction is conserved.

Balance the chemical equation before calculating relative molecular masses of reactants and products.



Total mass of reactants is equal to total mass of product.

REACTIONS IN AQUEOUS SOLUTIONS

Ions in aqueous solution: their interaction and effects

- The polar nature of the water molecule can be explained using diagrams to show how water is able to dissolve ions.
- A polar molecule is a molecule having two oppositely charged poles and is also known as a dipole.

• The dissolution process can be represented using a 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 following equation:



An aqueous solution as a solution in which the solvent is water.

- Dissociation is the process in which solid ionic crystals are broken up into ions when dissolved in water.

Hydration: it is a process in which ions are surrounded with water molecules

Solubility: It is the maximum amount of a substance (the solute) that may be dissolved in another (the solvent).

Solute: It is the dissolved substance in a solution – usually the substance present in lesser amount

Solution: A solution is a homogenous mixture of two or more substances.

Solvent: It is a substance in which the solute is dissolved - usually the substance is present in greater amount in the solution

Electrolytes and extent of ionization as measured by conductivity

- Conductivity is the ability of a material to conduct electricity.
- An electrolyte is a solution that conducts electricity through the movement of ions.
- Conductivity depends on the:
 - Concentration (amount of substance present per volume) of ions in solution and this in turn to the solubility of ionic substances.
 - Type of substance, since some substances, like sugar, dissolve but this does not affect conductivity

4.3 Precipitation reactions

- By identifying an ion or ions in a solution of the reactants, and the observations of the products, we are able to test for the presence of the following anions in solution and write chemical equations:
 - Chlorides – using silver nitrate. Precipitate confirmed by its insolubility in nitric acid but solubility in ammonia.
 - Bromides – using silver nitrate. Precipitate confirmed by using chlorine water and carbon tetrachloride which results in displacement of bromine by chlorine and noting the colour change of the layer of carbon tetrachloride.
 - Iodides – using silver nitrate. Precipitate confirmed by using chlorine water and carbon tetrachloride which results in displacement of iodine by chlorine and noting the colour change of the layer of carbon tetrachloride.
 - Sulphates – using barium nitrate. Precipitate confirmed by its solubility in nitric acid.
 - Carbonates – using barium nitrate. Precipitate confirmed by its solubility in nitric acid and production of carbon dioxide confirmed by turning clear lime water milky.

ASSESSMENT ACTIVITIES

QUESTION 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A-D) NEXT TO THE QUESTION (1.1-1.5) IN THE ANSWER BOOK.

For example 1.2 D

1.1 During an experiment, a group of learners observe ice melting in a beaker. Which one of the following best explain learner observation?

- A the ice is releasing heat energy.
- B the ice is undergoing physical change.
- C the ice is undergoing chemical change.
- D the ice is decomposing into the elements hydrogen and oxygen.

1.2 Which of the following balanced equations represents a dissociation process?

- A $K^+(aq) + Cl^-(aq) \rightarrow KCl(s)$
- B $NaCl(s) \rightarrow Na^+(aq) + Cl^-(s)$
- C $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
- D $NaCl(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgCl(s)$

Question 2

2.1 Many chemical reactions take place in aqueous solutions. Define the term aqueous solution.

2.2 Ionic solids dissociates when dissolved in water.

2.2.1 Define the term dissociates.

2.2.2 Write down the balanced equation for the dissociation of ammonium carbonate, $(NH_4)_2CO_3$ in water.

2.3 The experimental setup below is used to compare the electrical conductivity of Solutions, $NaCl(aq)$ and $CaCl_2(aq)$. The concentration of each solution is $0.5 mol. dm^{-3}$.

The $CaCl_2(aq)$ is added drop by drop to water and ammeter reading is Recorded after addition of each drop .The procedure is then repeated With the $NaCl(aq)$.The results are shown in the table below:

Number of drops of solution	Ammeter reading(mA)	
	$CaCl_2(aq)$	$NaCl(aq)$
0	0.18	0.18
1	0.55	0.34
2	0.92	0.55
3	1.29	0.74
4	1.47	0.92
5	1.84	1.1
6	2.21	1.29
7	2.39	1.47

2.3.1 Identify the :

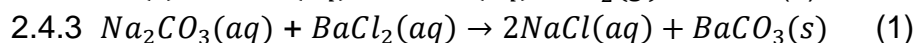
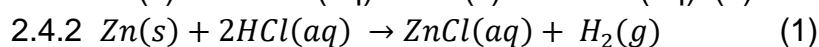
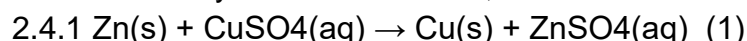
(a) Dependent variable (1)

(b) Independent variable (1)

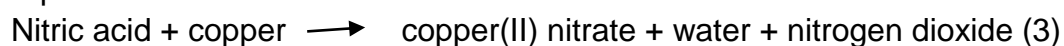
2.3.2 From the results ,deduce the relationship between the ion Concentration in solution and its conductivity. (1)

2.3.3 Use the balanced chemical equations to explain why $CaCl_2(aq)$ Is the stronger electrolyte than $NaCl(aq)$. (4)

2.4 Indicate the type of reaction represented by each of the equations. Write down only PRECIPITATION,REDOX OR GAS FORMING.



2.5 Write down the balanced chemical equation for the following word equation:



SOLUTIONS

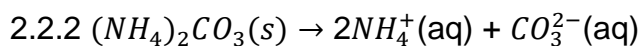
QUESTION 1

1.1 B

1.2 B

2.1 Solution in which water is the solvent.

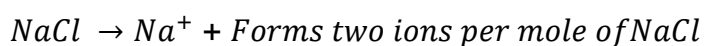
2.2.1 The process in which ionic crystals are broken up into ions when dissolved in water.



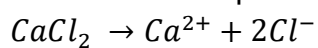
2.3.1 (a) Conductivity/Ammeter reading

(b) Type of compound /Concentration of ions

2.3.2 An increase in ion concentration increases the conductivity .



Forms two ions per mole of $NaCl$.

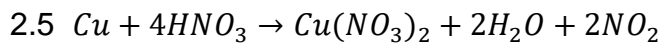


Forms three ions per mole of $CaCl_2$

2.4.1 Redox

2.4.2 Gas forming

2.4.2 Precipitation



ACTIVITIES 1

1. List four observations that could indicate that a chemical change is taking place.

(4)

2. Carbon dioxide undergoes sublimation.

2.1. Is this a physical or chemical change? Give a reason for your answer. (3)

2.2. Describe the changes that takes place in terms of the rearrangement of molecules during this change. (3)

2.3. Describe the energy change that occurs during this change. (2)

3. Write down which of the following are chemical changes and which are physical changes.

3.1 Baking a cake. (1)

3.2 Braking a glass bottle. (1)

3.3 Boiling water. (1)

3.4 Rusting iron (1)

3.5 burning wood. (1)

4. Which of the following are synthesis reaction and which are decomposition reaction.

4.1 Hydrogen gas and oxygen gas are combined to form water. (2)

4.2 ammonia breaks up into nitrogen and hydrogen. (2)

4.3 ammonium hydroxide is heated and it changes to ammonia water. (2)

5. state the law of conservation of mass. (2)

6. using relative atomic masses. Show that the mass is conserved in the following chemical reaction:



[30]

ACTIVITIES 2

1. Water vapour condenses to form water.
 - 1.1 is this a chemical change or a physical change (1)
 - 1.2 Describe how the molecules rearrange when this change occurs. (3)
 - 1.3 Describe the energy change that occurs during this process (2)
2. Which requires more energy
 - 2.1 Changing ice to water or (2)
 - 2.2 Breaking water down into Hydrogen and oxygen. (4)
 - 2.3 Give a reason why this is so. (2)
3. Verify the law of conservation of mass by using the relative atomic masses for the following chemical reactions.
$$\text{BaCl}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{HCl} \quad (7)$$
4. A reaction is carried out by using 10 g of carbon completely in oxygen gas. This produces 35.6 g of carbon dioxide. In another experiment 15.2 g of carbon is burned completely in oxygen gas and this produces 55.84 g of carbon dioxide.
Use this data to show that law of constant composition is verified. (9)

30]

SOLUTIONS TO ACTIVITIES

ACTIVITIES 1

1. List four observations that could indicate that a chemical change is taking place.

(4)

- A change in temperature
- Release of a gas
- A change in colour
- A precipitate is formed

2. Carbon dioxide undergoes sublimation.

2.1. Is this a physical or chemical change? Give a reason for your answer. (3)

- a physical change. There is no new substance formed, there is only rearrangement of the molecules.

2.2. Describe the changes that takes place in terms of the rearrangement of molecules during this change. (3)

- in solid carbon dioxide there is a structure in which molecules are held in fixed positions. When it becomes a gas there is no structure in the arrangement of molecules they are moving randomly.

2.3. Describe the energy change that occurs during this change. (2)

- the molecules of the solid absorb energy which enable them to vibrate more strongly
- the forces between the molecules are no longer strong enough to keep them together.
- The forces holding them in place are broken and they are completely free to move.

3. Write down which of the following are chemical changes and which are physical changes.

3.1 Baking a cake. (1)

- Physical change

3.2 Braking a glass bottle. (1)

- Physical change

3.3 Boiling water. (1)

- Physical change

3.4 Rusting iron .(1)

- chemical change

3.5 burning wood. (1)

- chemical change

4. Which of the following are synthesis reaction and which are decomposition reaction.

4.1 Hydrogen gas and oxygen gas are combined to form water. (2)

- synthesis

4.2 ammonia brakes up into nitrogen and hydrogen. (2)

- decomposition

4.3 ammonium hydroxide is heated and it changes to ammonia water. (2)

- decomposition

5. state the law of conservation of mass. (2)

- in a chemical reaction, the total mass of the reactants is equal to the total mass of the products.

6. using relative atomic masses. Show that the mass is conserved in the following chemical reaction:



Reactants: $56 + 2(1 + 35.5) = 129$

Products: $56 + 2(2 \times 35.5) + (2 \times 1) = 129$ **[30]**

ACTIVITIES 2

1. Water vapour condenses to form water.
 - 1.1 is this a chemical change or a physical change (1)
physical change
 - 1.2 Describe how the molecules rearrange when this change occurs. (3)
There are very weak forces between molecules in water vapour.
The molecules are totally free to move. When water vapour turn to liquid, the forces keep the molecules together but they can flow over to each other.
 - 1.3 Describe the energy change that occurs during this process (2)
The water molecules use energy and when the temperature is low enough they will have lost energy for the molecules to hold each other and form a liquid.
2. Which requires more energy
 - 2.1 Changing ice to water or (2)
 - 2.2 Breaking water down into Hydrogen and oxygen.
3. Chemical change
 - 3.1 Give a reason why this is so. (2)
The brown rust that forms on a metal is a new substance. There is a change in colour from grey to reddish brown.
4. Verify the law of conservation of mass by using the relative atomic masses for the following chemical reactions.
$$\text{BaCl}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{HCl} \quad (7)$$

Reactants : $\text{BaCl}_2: 137.33 + (2 \times 35.5)=208.33$

$$\text{H}_2\text{SO}_4 = (2 \times 1) + 32 + (4 \times 16)=98$$

total reactants = 306.33

products : $\text{BaSO}_4=137.33 + 32 + (4 \times 16)=233.33$

$$\text{HCl} = 2(1 + 35.5)=73$$

Total products = 306.33

5. A reaction is carried out by using 10 g of carbon completely in oxygen gas. This produces 35.6 g of carbon dioxide. In another experiment 15.2 g of carbon is burned completely in oxygen gas and this produces 55.84 g of carbon dioxide.

Use this data to show that law of constant composition is verified. (9)

Mass (c) = 10 g

Mass of oxygen = 35.6 - 10

25,6 g

C:O

[30]