education

Department:
Education
PROVINCE OF KWAZULU-NATAL

CURRICULUM GRADE 10 -12 DIRECTORATE

NCS (CAPS)

LEARNER SUPPORT

DOCUMENT GRADE 10

PHYSICAL SCIENCES

STEP AHEAD PROGRAMME

2021

PREFACE

This support document serves to assist Physical Sciences learners on how to deal with curriculum gaps and learning losses as a result of the impact of COVID-19 in 2020. It also captures the challenging topics in the Grade 10 -12 work. Activities should serve as a guide on how various topics are assessed at different cognitive levels and also preparing learners for informal and formal tasks in Physical Sciences. It will cover the following topics:

SUMMARY NOTES

GRADE 10 MAGNETISM

Recap from GRADE 9.

Background

Both **electricity** and **magnetism** play a very important role in modern society. We cannot imagine a life without cars, household appliances and other electrical devices, televisions, cell phones or credit cards. We obtain the electrical energy we use daily from electric generators that make use of both electricity and magnetism. There the relationship between electricity and magnetism is very important.

MAGNETIC FIELDS

Magnetic field - 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 magnetized. E.g. iron, cobalt, nickel and their alloys
- **Non-contact force**: a force exerted on an object without touching the object.
- All magnetic fields originate as a result of moving charges

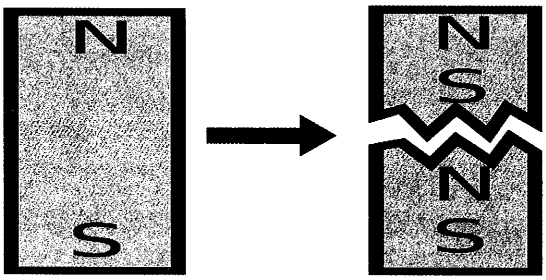
Electric field – is a region in space where a CHARGE experiences an electric force.

Gravitational field – is a region is space where a MASS will experiences a gravitational force.

Note: Magnetic fields differ from gravitational and electrical fields, as they do not have a SINGLE CENTRAL point as the other two.

POLES OF PERMANENT MAGNETS

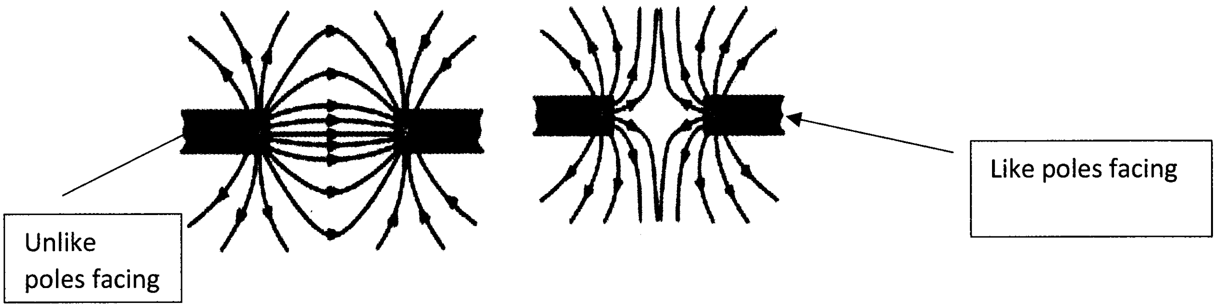
Magnet- is an object that has both a pair of opposite POLES, called NORTH and SOUTH (north-seeking and south-seeking)



Note: Even if the object is cut into tiny pieces, each piece will still have both a north and a south poles

ATTRACTION AND REPULSION

- If magnets are moved closer together, they will attract or repel each other.
- N-pole and S- pole attract (UNLIKE poles attract)
- N-pole and N-pole or S-pole and S-pole repel (LIKE poles repel)

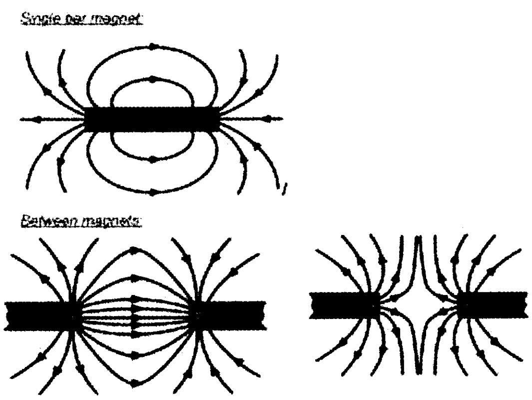


Note

- **Permanent** magnets (bar magnets) keep their magnetism once they have been magnetized. However they may lose their magnetism if they are hit with a hammer, dropped repeatedly or heated to high temperatures.
- **Temporary** magnets (a nail held near a magnet) are only magnetic if they are placed within another magnetic field.

MAGNETIC FIELD LINES

Magnetic field lines – are imaginary lines that are used to represent the 3-dimesnional force field existing around a magnet.

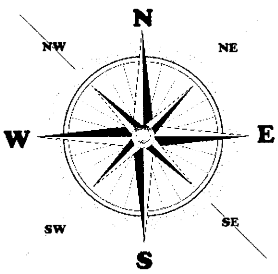


Properties of field lines

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

EARTH'S MAGNETIC FIELD, COMPASS

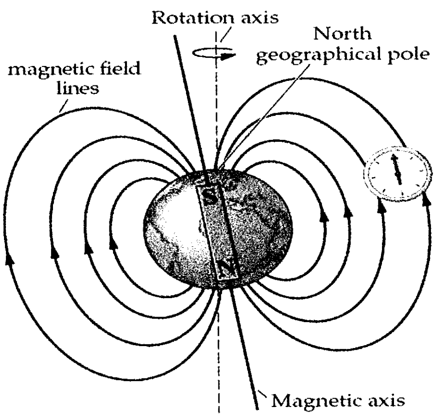
Compass – an instrument that is used to indicate where North is at any point on earth.



How a compass indicates direction of a magnetic field

- A compass needle moves freely on its axis.
- When placed anywhere in the earth's magnetic field, it will come to rest with the N-pole of the compass pointing in the direction called magnetic north.

The Earth's Magnetic Field



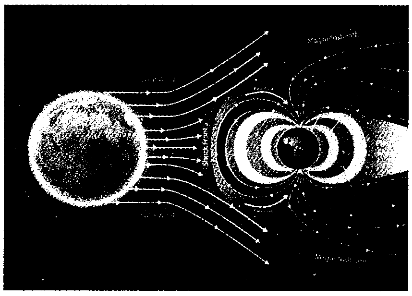
- In the earth's core, there are molten magnetic metals such as nickel and iron that results in the earth as if it has a gigantic magnet inside.
- The magnetic field of the earth is similar to that of a bar magnet, including a magnetic N-pole and South Pole.

Geographic North versus Magnetic North

- 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

PHENOMENA AS A RESULT OF THE MAGNETIC FIELD OF THE EARTH

1. **Solar winds**



2. **Northern lights**

3. **Magnetic storms**

Solar wind: A stream of radioactive and charged particles sent into space at high speeds due to reactions on the sun.

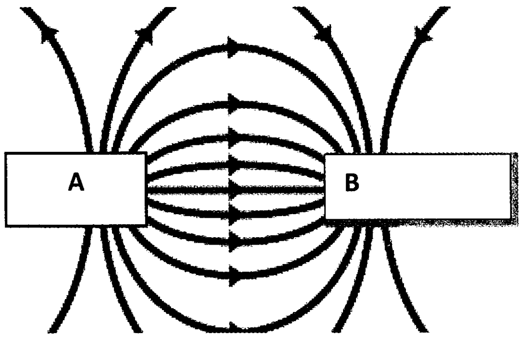
Aurora Borealis (Northern Lights): An atmospheric phenomenon consisting of bands of light at the North Pole caused by charged solar particles following the Earth's magnetic lines of force

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 kilometers above the surface) in which charged particles are trapped and their behaviour is dominated by the Earth's magnetic field.

Activity 1: Magnetic field

1. Define the term magnetic field. (2)
2. What general term is used to describe materials that are easily magnetized? (1)
3. Give an example of a non-contact force. (1)
4.



4.1 What is the nature of the FORCE between the two poles? (1)

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

Total [6 marks]

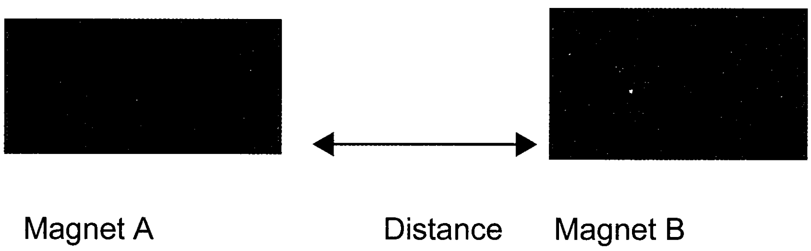
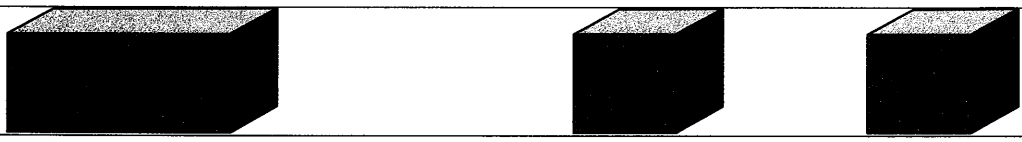
Activity 2: Compass

1. Explain how a compass works?
2. Why is the earth's magnetic field important in human and animals?
3. Explain what is meant by the geographical poles and the magnetic poles of the earth. Also indicate the difference between these poles.

Activity 3: Phenomena that are affected by earth's magnetic field

1. What is meant by magnetosphere?
2. What is a solar wind and how does the earth's magnetic field protect us from solar winds?
3. What is the name of the phenomenon visible as a bright glow of light near the North Pole?
4. What causes this phenomenon?

WORKSHEET 1: MAGNETISM

		Magnetism	
		Question 1	
1.1			
	1.1.1	Would magnet A attract or repel magnet B?	**(1)**
	1.1.2	What would happen to the force of magnet A on magnet B if the distance between them is increased?	(1)
	1.1.3	Draw the magnetic field between the two magnets.	**(3)**
		Question 2	
2.		What would happen to the poles of a magnet if the magnet were to be cut into two halves (as shown in the diagram below?	
	2.1		
3.1		Explain what is meant by "a magnetic field".	(2)

3.2		Explain how the magnetic field lines indicate the strength of the magnetic field.	
3.3		Study the following information about these three magnets: [redacted] [redacted] [redacted] Pole Q repels Pole X. Pole B attracts Pole P.	(2)
	A	Pole b and pole x	(1)
	B	Pole a and pole q	(1)
	C	Pole b and pole y	(1)
4.		Which of the following statements is true concerning magnetic fields?	
	A	They always begin on a north pole and travel to the south pole.	
	B	They show both the direction and the strength of the magnetic field.	
	C	They show the direction in which a positive charge will experience force.	
	D	They only cross when multiple magnets are present.	
5		The earth's magnetic field is shaped like that of a bar magnet around it. The magnetic poles of the earth are not aligned with its geographic poles.	
	5.1	Explain what is meant by "the geographic north pole".	
	5.2	Sketch the magnetic field of the earth.	
	5.3	To which pole does the north pole of a compass needle point?	

	5.4	Comment on this statement: "The north pole is actually a south pole". Is this statement true or false? Justify your answer.	
6		Migratory birds and sea turtles sense variations in the strength and inclination of the earth's magnetic field as they travel large distances across the world to mating grounds or beaches each year.	
	6.1	At which two places on the earth is its magnetic field the strongest?	
	6.2	One theory which explain how birds manage to sense the magnetic field is that they contain small particles of iron oxide (magnetite) in their beaks. Describe how the presence of iron oxide in its beak helps a bird to navigate.	

WORKSHEET 2: EARTH'S MAGNETISM

QUESTION 1			
		Question 1	
1.1		Choose the most correct answer (A, B, C or D) for each of the following questions.	(2)
	A	Iron	
	B	nickel	
	C	copper	
	D	chromium	
1.2		Which of the following statements about magnetic fields is false?	(2)
	A	The direction of a magnetic field is the direction towards which the north pole of a compass points due to the magnetic force on it.	
	B	Magnetic fields exist inside and outside magnets.	
	C	Magnetic field lines cross one another when there are more than two magnets present.	
	D	The magnetic field strength at the north pole of a magnet has the same size as that at its south pole.	
1.3		The magnetic north pole is	(2)
	A	Located at the south pole.	

	B	Is a south pole.	
	C	Located at the top of the earth's spin axis.	
	D	Located at the bottom of the earth's spin axis.	
		QUESTION 2	
2.		The science class were asked to investigate the relative strength of the magnetic field at the north pole of a bar magnet before it was cut in half, and after it was cut in half. They measured the relative strength by counting the number of paper clips that could be suspended from the north pole of the magnet, and its "half magnet".	
	2.1	Draw a neat sketch of the magnetic field of a bar magnet.	(3)
	2.2	Explain how the paper clips are attracted to the bar magnet.	(2)
	2.3	Give one reason why this method of using paper clips is a fairly good indicator of the field strength.	(3)
	2.4	Give one reason why this method could produce faulty results	(2)
	2.5	Predict the outcome of this experiment. Justify your answer. (4) One group of learners found it very difficult to cut their bar magnet in half. They decided to place it on a stone (outside) and to saw through the magnet with an electrically powered saw. The bar magnet vibrated significantly during this process. When they tested their "half magnets" they found that no paper clips could be suspended from either of the pieces, whereas before cutting the magnet it had suspended 6 paper clips.	(4)
	2.6	Explain what could have happened to cause these results.	(4)

ELECTROSTATICS NOTE SUMMARY

Electrostatics is the study of electric charge which is at rest/stationary or static (not moving).

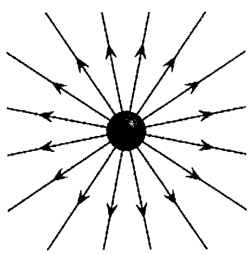
In this chapter we will look at electrostatics, the principle of conservation of charge and the principle of quantization of charge.

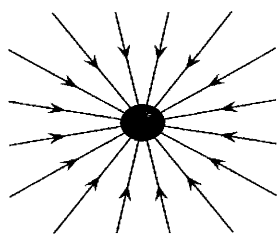
All objects surrounding us (including people!) contain large amounts of electric charge. There are two types of electric charge: **positive** charge and **negative** charge. If the same amounts of negative and positive charge are found in an object, there is *no net charge* and the object is electrically **neutral**. If there is more of one type of charge than the other on the object then the object is said to be **electrically charged**. The picture below shows what the distribution of charges might look like for a neutral, positively charged and negatively charged.

Two types of charges.

+	-
positive charge	**negative charge**

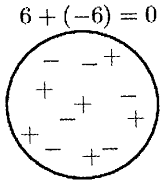
The electric field direction is always directed away from positive source charges and towards a negative source charge. See figures below:





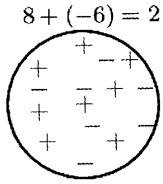
BELOW are the illustrations of neutral, negatively charged and positively charged objects.

6 positive charges and
6 negative charges
$6 + (-6) = 0$



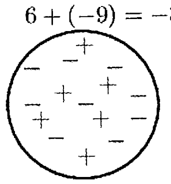
There is zero net charge:
The object is neutral

8 positive charges and
6 negative charges
$8 + (-6) = 2$



The net charge is $+2$
The object is positively charged

6 positive charges and
9 negative charges
$6 + (-9) = -3$



The net charge is -3
The object is negatively charged

Positive charge is carried by the protons in material and **negative charge by electrons**. The overall charge of an object is usually due to changes in the number of electrons. To make an object.

- If two negatively charged objects are brought close together, then they will repel each other.
- If two positively charged objects are brought close together, then they will repel each other.
- If a positively charged object is brought near to a negatively charged object, they will attract each other.
- In conclusion unlike charges attract each other while like charges repels each other.

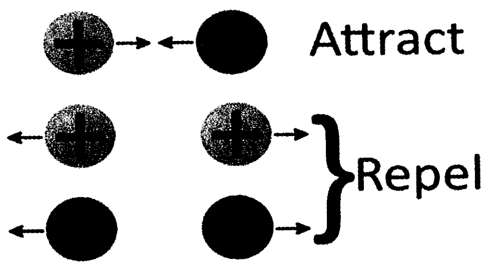


Figure showing unlike charges attracting and like charges repelling.

- An object is **positively charged**, as a result of having a shortage of electrons.
- An object is **negatively charged**, as a result of having excess electrons.
- An object is **neutral**, as it has equal numbers of protons and electrons.

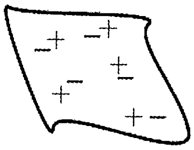
The process of materials becoming charged when they come into contact with other materials is known as **tribo-electric charging**.

Objects may become charged in many ways, including by contact with or being rubbed by other objects.

During tribe electric charging the charge like energy is neither created nor destroyed but is conserved. See figure below:

BEFORE rubbing:

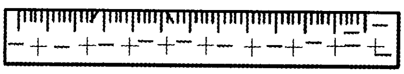
The ruler has 9 positive charges and 9 negative charges



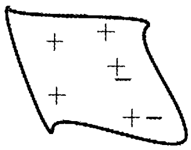
The neutral cotton cloth has 5 positive charges and 5 negative charges

The total number of charges is:
$(9 + 5) = 14$ positive charges
$(9 + 5) = 14$ negative charges

AFTER rubbing:



The ruler has 9 positive charges and 12 negative charges
It is now negatively charged.

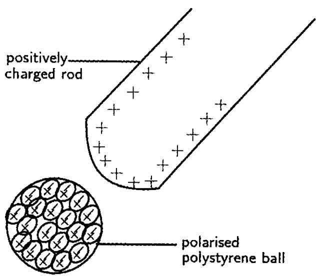


The cotton cloth has 5 positive charges and 2 negative charges.
It is now positively charged.

The total number of charges is:
$(9 + 5) = 14$ positive charges
$(12 + 2) = 14$ negative charges

Charges have been transferred from the cloth to the ruler BUT total charge has been conserved!

Polarisation is the partial or complete polar separation or positive and negative electric charge in a system.



Polarization illustration

- Other materials do not allow the charge carriers, the electrons, to move through them (e.g. plastic, glass). The electrons are bound to the atoms in the material.

These materials are called **non-conductors or insulators eg, glass and plastic. Conductors** conduct electrical current very easily because of their free electrons, eg, silver and copper. **Insulators** oppose electrical current and make poor **conductors**.

- The effect of the shape on the charge distribution is the reason that we only consider identical conductors for the sharing of charge.

The principle of conservation of charge states that the net charge of an isolated system remains constant during any physical process, e.g. two charge objects making contacting and separating.

- Equation, $Q \frac{Q1 + Q2}{2}$

The principle of quantisation of charge states that every charge in the universe consists of integer multiples of the electron charge, i.e. $Q=nqe$.

Equation, Q = n q_{e-}.

Where:

- Q= Charge
- n= integer
- qe= charge on electron.

Activities

WORKED EXAMPLE 1

Choose the correct answer A, B, C or D

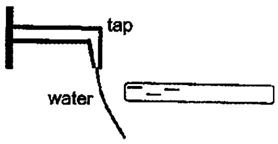
A plastic rod and a dry cloth are uncharged. The plastic rod is rubbed with the dry cloth and they both become charged. The rod becomes negatively charged because some particles move from the cloth to the rod.

	CHARGE ON ROD	PARTICLES THAT MOVED
a	**positive**	**protons**
b	**positive**	**electrons**
c	**negative**	**protons**
d	**negative**	**electrons**

Answer: B

Worked example 2

A Learner in Physical Sciences class rubs his hair with a plastic rod. The rod becomes negatively charged. The learner now opens a tap so that thin stream water runs from it. When the rod is brought close to the water without touching it, it is observed that the water bends towards the rod as shown in the diagram below.



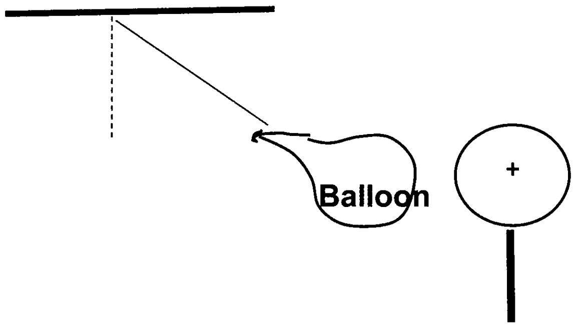
Question: Give a reason why the steam of water bends towards the rod.

Answer: Water molecules are polarised by the rod, the positive pole of the water is attracted to the negative pole, causing stream of water to bend towards the rod.

Activities

1. A balloon is brought closer to a positively charged sphere as shown in the diagram below.

The balloon is attracted to the sphere.



1. Which ONE of the following is the type of charge on the balloon?

a) Positive

b) Positive or neutral

c) Negative or neutral

d) Negative or positive

Answer:

2. A rubber balloon obtains a negative charge after it has been rubbed against

Human hair.
Which ONE of the statements below best explains why this happens?

a) Negative charges are transferred from the rubber balloon to the human hair.
b) Positive charges are transferred from the rubber balloon to the human hair.
c) Positive charges are transferred from the human hair to the rubber balloon.
d) Negative charges are transferred from the human hair to the rubber balloon.

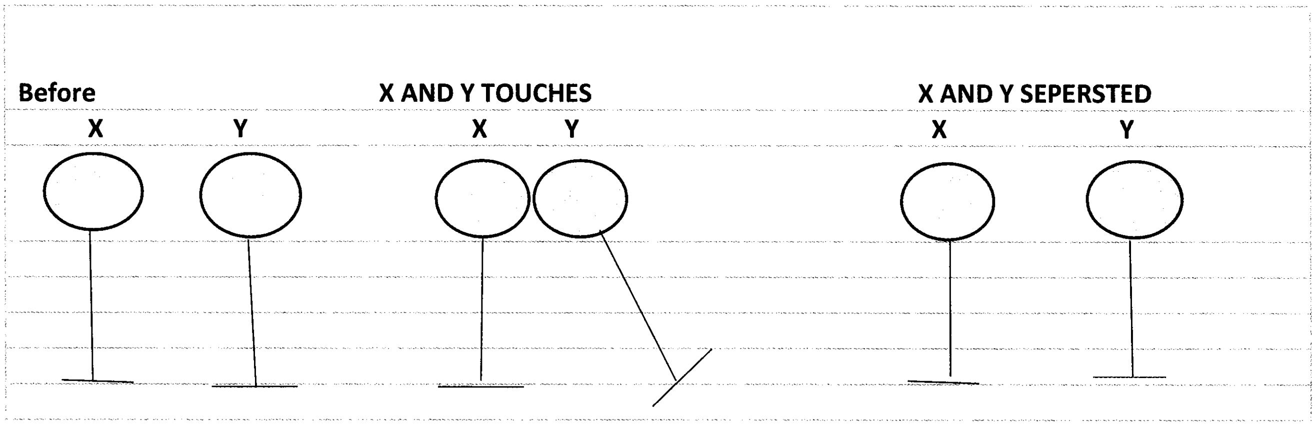
Answer:

THE PRINCIPLE OF CONSERVATION OF CHARGE ACTIVITIES

WORKED EXAMPLE

QUESTION 1

1. **X and Y are two identical spheres. Sphere X is on an insulated stand while Y has an insulated handle attached. The charge in sphere X is +6.4 x10^{-19}C and Y is NEUTRAL. Y is now brought nearer and touches X, after which they are separated again.**



1. State the Law of Conservation of charge in words (2)
2. Does sphere X has excess or deficiency of electrons before touching? (2)
3. Y was neutral before. Explain what this means: (2)
4. Are electrons transferred from X to Y or from Y to X when they touch? (1)
5. Calculate the new charge on Y after touching and separation. (4)

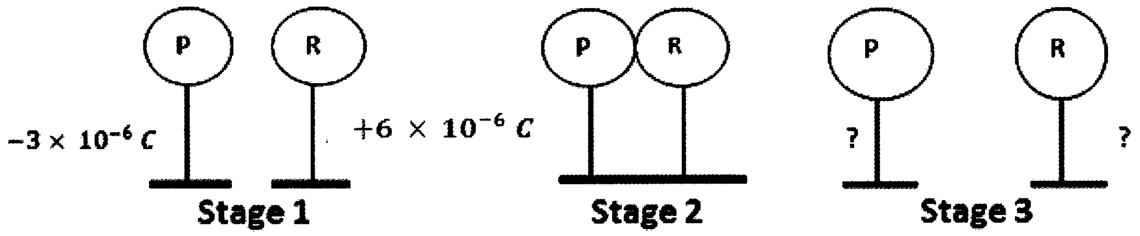
Worked example QUESTION 1 ANSWERS

1. Charge can neither be created nor destroyed but merely transferred from one body to another. (2)OR
- The total charge in a closed system remains constant.
  OR
- The total charge in an isolated system is conserved. (2)
2. X has a deficiency of electrons. (2)
3. Neutral means having equal number of electrons and protons. (2)
4. $Y\ to\ X$ (1)
5.

$Q = \frac{Q1 + Q2}{2}$
$= \frac{+6,4 \times 10 - 19}{2}$ (1 for Nr and 1 for Dr)
$=3,2 \times 10-19C$ (4)

ACTIVITY

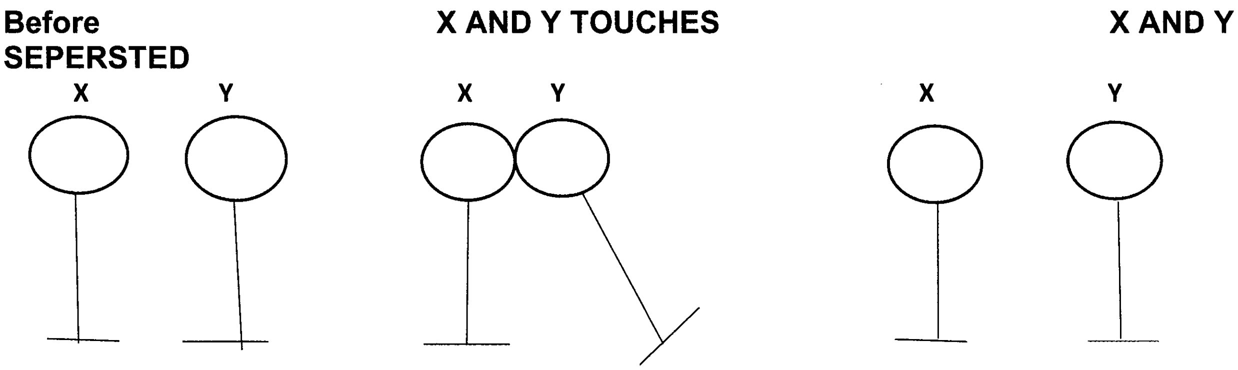
1. Two small metal spheres, on insulated stands, carry charges of $-3\times 10^{-6}\ C$ and $+6\times 10^{-6}\ C$ respectively. The spheres were moved to touch one another, got separated and then returned to their original positions



1. Which ONE of the two spheres, **P** or **R**, at Stage 1, has electron deficiency? (1)
2. Will the spheres at Stage 3 **Attract** or **Repel**? (1)
3. Write down the reason for your answer in 2. Above.
4. State the principle of Conservation of Charge. (2)
5. Calculate the charge on **Sphere P** at **Stage 3 (3)**

THE PRINCIPLE OF QUANTISATION OF CHARGE ACTIVITIES

1. **X and Y are two identical spheres. Sphere X is on an insulated stand while Y has an insulated handle attached. The charge in sphere X is +6.4 x10^{-19}C and Y is NEUTRAL. Y is now brought nearer and touches X, after which they are separated again.**



1. State the principle of charge quantization. (2)
2. Calculate the number of electrons transferred from one sphere to the other when X and Y touch. (3)

QUESTION 1 Answers

1. Every charge in this universe is an integral multiples of the electron charge. 2)

2.

$n = \frac{\Delta Q}{Qe}$

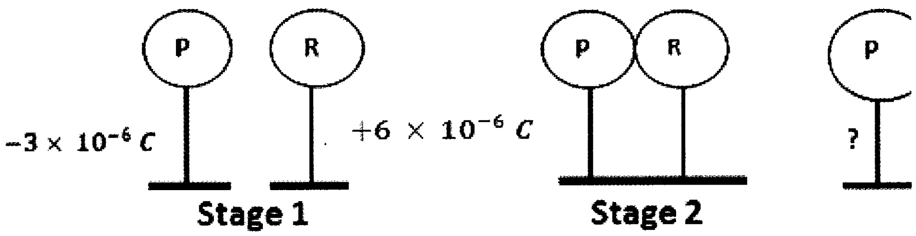
$= \frac{-3{,}2 \times 10-19}{-1{,}6 \times 10-19}$ OR $\frac{3{,}2 \times 10-19}{1{,}6 \times 10-19}$ (1 for Nr and 1 for Dr) ✓

$= 2$✓ (3)

ACTIVITIES

1. Two small metal spheres, on insulated stands, carry charges of −3× 10−6 C and +6× 10−6 C respectively. The spheres were moved to touch one another, got separated and then returned to their original positions

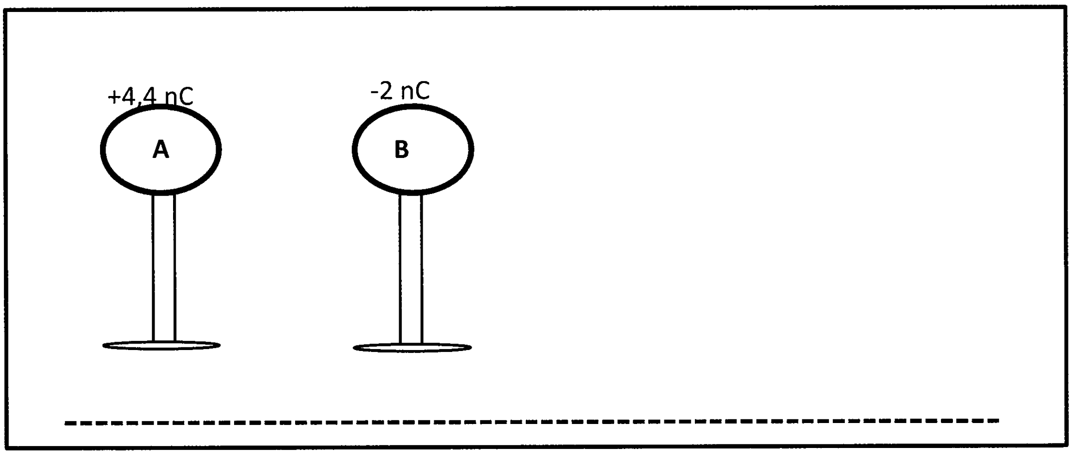
1. Comparing stage 1 and stage 3, determine the number of



electrons transferred. (3)

Activity 2

Two identical metal spheres **A** and **B** are placed on insulated stands. Spheres **A** and **B** carry charges of +4,4 nC and -2 nC respectively.

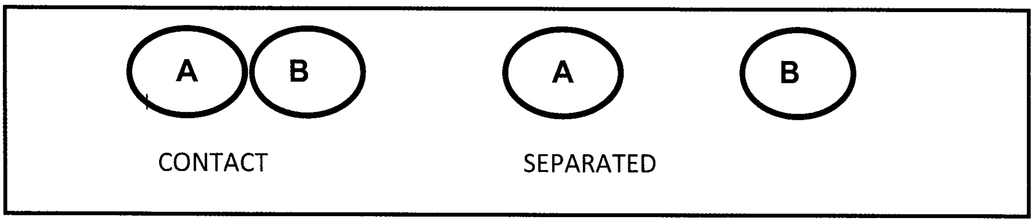


Which sphere (**A** or **B**) has FEWER electrons? (1)

Write down the NAME of the type of FIELD around the charged spheres. Choose from MAGNETIC, ELECTRIC or GRAVITATIONAL. (1)

Give a reason why the charged spheres are placed on insulated stands. (2)

The spheres are brought into contact and then separated as shown below.



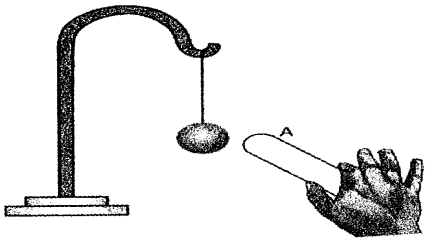
State the principle of conservation of charge. (2)

Which sphere loses electrons when the two spheres come into contact? (1)

Calculate how many electrons transferred from one sphere to the other when they come into contact. (5)

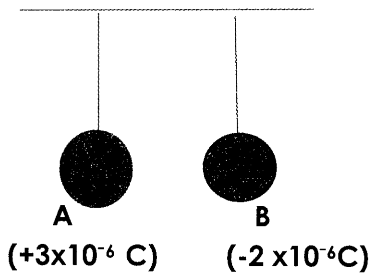
WORKSHEET: ELECTROSTATICS

<table>
<tr><td></td><td></td><td>CONSERVATION OF CHARGE</td><td></td></tr>
<tr><td></td><td></td><td>QUESTION 1</td><td>MARKS</td></tr>
<tr><td></td><td>1.1.1</td><td>Choose the correct answer A, B, C or D
A plastic rod and a dry cloth are uncharged. The plastic rod is rubbed with the dry cloth and they both become charged. The rod becomes negatively charged because some particles move from the cloth to the rod.
<table>
<tr><td></td><td>CHARGE ON ROD</td><td>PARTICLES THAT MOVED</td></tr>
<tr><td>A</td><td>POSITIVE</td><td>PROTONS</td></tr>
<tr><td>B</td><td>POSITIVE</td><td>ELECTRONS</td></tr>
<tr><td>C</td><td>NEGATIVE</td><td>PROTONS</td></tr>
<tr><td>D</td><td>NEGATIVE</td><td>ELECTRONS</td></tr>
</table></td><td>(2)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>1.1.2</td><td>A positively charged plastic rod attracts small pieces of paper because…
A. The paper pieces are negatively charged.
B. The paper pieces are neutral.
C. The paper pieces are very small.
D. The paper pieces become polarised.</td><td>(2)</td></tr>
<tr><td></td><td></td><td>QUESTION 2</td><td></td></tr>
<tr><td></td><td>2.1</td><td>A pith ball is a polystyrene sphere coated with metal paint.</td><td></td></tr>
</table>

		A **plastic rod (A) is charged by rubbing it with a cloth**. It is held next to an **uncharged pith ball** that is suspended on light cotton thread. 	
	2.1.1	Describe how the plastic rod becomes positively charged when it is rubbed with a cloth.	(2)
	2.1.2	Describe what happens in the metal paint on the pith ball when the positively charged plastic rod is brought near to it.	(2)
	2.1.3	The ball is attracted to the rod. Explain why this happens, given that the pith ball is uncharged.	(2)
	2.1.4	Predict what you would see if the pith ball touches the positively charged rod. (2)	(2)
	2.1.5	Explain your prediction in 2.2.4.	(2)

WORKSHEET: ELECTROSTATICS

		QUANTIZATION OF CHARGE	
		QUESTION 1	**19 MARKS**
1.1			
	1.1.1	State the principle of quantisation of charge.	(2)
	1.1.2	An object has an excess charge of $-1,92 \times 10^{-17}$C. How many excess electrons does it have?	(3)
	1.1.3	Two identical pith balls are suspended on light, inelastic cotton threads. Pith ball A has a positive charge of 5,4 nC. Pith ball B carries a negative charge of 8,2 nC. Calculate the extra number of electrons added to pith ball B.	(3)

	1.1.4	**Neutral plastic ruler becomes charged when it is rubbed with a woolen cloth. After Rubbing, the ruler has a charge of -3,5 x 10^{-15} C.** Distinguish between a neutral object and a charged object.	(2)
	1.1.5	Calculate the number of electrons transferred during the process of rubbing.	(3)
	1.2	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 x 10^{-6} C and -2 x 10^{-6} C  **The two spheres are allowed to touch and then separated.**	
	1.2.1	Calculate the new charge on sphere B.	(3)
	1.2.2	Calculate the number of electrons transferred during contact.	(3)

EMF, POTENTIAL DIFFERENCE (PD)

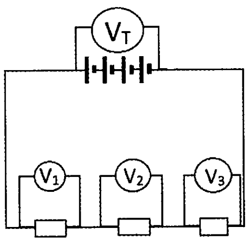
- EMF, electromotive force, is registered when the switch is open.
- Terminal potential difference is registered when the switch is closed.
  - Internal resistance of the cell is ignored, but it does exist, it will be discussed in grade 12.
- Potential difference is defined as work done per unit charge: $\boldsymbol{V = \frac{W}{Q}}$
- Units is the volt (V), or as a compound unit, joules per coulomb (J.C^{-1})
- Measured using a voltmeter which is always connected in parallel.
- Calculations must adhere to the **FOUR** steps
  - **<u>Step 1:</u>** Identify the variables
  - **<u>Step 2:</u>** Pick the correct formula

- **Step 3:** Substitute in SI units
- **Step 4:** Answer the question

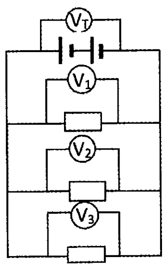
Example: Calculate the potential difference across the terminals of a battery if a charge of 3 C gains 27 J of energy passing through the battery.

Step 1: Identify the variables	V = ? Q = 3 C W = 27 J
Step 2: Pick the correct formula	$V = \frac{W}{Q}$
Step 3: Substitute in SI units	$V = \frac{27}{3}$
Step 4: Answer the question	$V = 9\ V$

- $V_T = V_1 + V_2 + V_3$



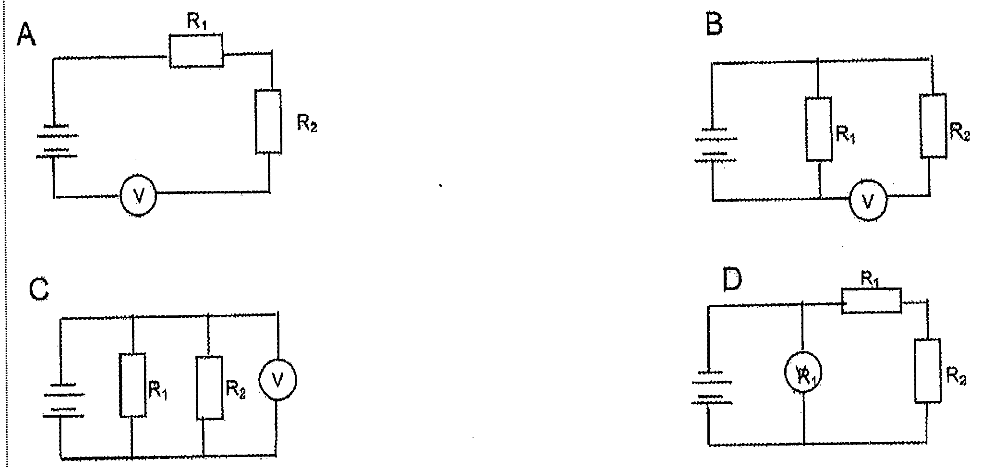
- $V_T = V_1 = V_2 = V_3$



WORKSHEET: POTENTIAL DIFFERENCE

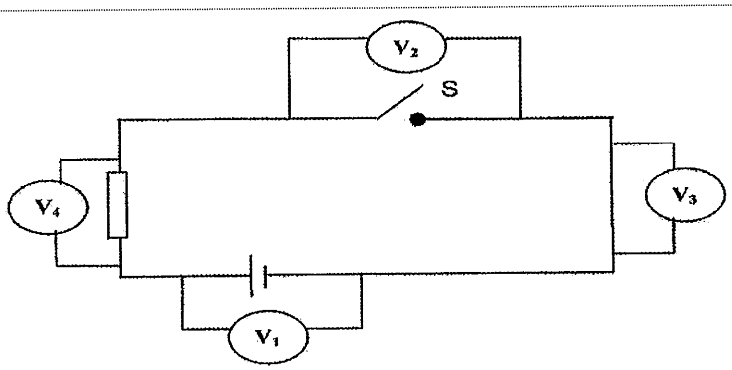
QUESTION 1			
1.1		What is the function of a voltmeter in a circuit?	(1)
1.2		How should a voltmeter be connected in circuit?	(1)
1.3		In which unit is the potential difference measured?	(1)
1.4		What is the energy conversion that takes place in a battery?	(2)
1.5		Why is it that the ammeter cannot be connected across a battery or a resistor in a circuit?	(2)
QUESTION 2			
2.1		Define emf.	(2)
2.2		Calculate the potential difference across the terminals of a battery if a charge of 9 C gains 81 J of energy passing through the battery	(3)
2.3		Calculate the energy dissipated in a resistor with a potential difference of 4V when a charge of 3C passes through it.	(3)
2.4		Although potential difference and emf are both measured in volts, they are not the same. Describe the difference between emf and voltage	(2)
QUESTION 3			
3.1		The energy transferred per unit charge across the ends of a conductor is best described as ...	(2)
	A	Potential difference	
	B	Power	
	C	Electric current	
	D	Work done	

3.2		Which circuit diagram below represents voltmeter V connected correctly to measure the potential difference across resistor R_2?	(2)



3.3		The energy transferred per unit electric charge is a circuit is …	(2)
	A	Current	
	B	Charge	
	C	Power	
	D	Potential difference	
3.4		The maximum work done per unit charge by a battery is the …	(2)
	A	EMF	
	B	Current	
	C	Resistance	
	D	Terminal potential difference	

Question 3.5 and 3.6 refer to the diagram below:



3.5		When switch S is open, the reading on V_1 is 2 V. Which statement is correct with respect to the readings on the other voltmeters?	(2)

	V_2 (V)	V_3 (V)	V_4 (V)
A	2	2	2
B	0	0	2
C	2	0	0
D	0	0	0

3.6		Switch S is now closed. The new readings on the voltmeter will be …	(2)

	V_2 (V)	V_3 (V)	V_4 (V)
A	0	0	2
B	$^2/_3$	$^2/_3$	$^2/_3$
C	2	2	2
D	2	0	2

QUESTION 4

4.1		State one difference between emf and terminal potential difference?	(2)
4.2		How much electrical work is done by a 3 Ω resistor with a potential difference of 6 V experiencing 4 C of charge in 2 minutes?	(3)

CURRENT

- Conventional current is the movement of positive charge (direction is from positive to negative terminal)
  - Positive charges do not mean protons, rather the loss of electrons
- Electric current is the movement of electrons (direction is from negative to positive terminal)
- Current is defined as the rate of flow of charge: $I = \frac{Q}{\Delta t}$
- Units is the amperé (A), or as a compound unit, coulomb per second ($C.s^{-1}$)

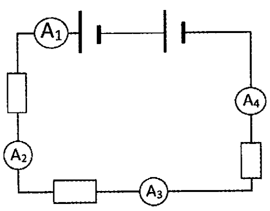
- Measured using an ammeter which is always connected in series.
- Calculations must adhere to the **FOUR** steps
  - **Step 1:** Identify the variables
  - **Step 2:** Pick the correct formula
  - **Step 3:** Substitute in SI units
  - **Step 4:** Answer the question

Example: Calculate the current that flows when 100 C of charge pass through an ammeter in 5 seconds.

Step 1: Identify the variables	I = ? Q = 100 C Δt = 5 s
Step 2: Pick the correct formula	$I = \frac{Q}{\Delta t}$
Step 3: Substitute in SI units	$I = \frac{100}{5}$
Step 4: Answer the question	$I = 20\ A$

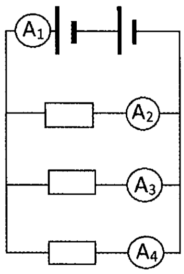
- $I_T = I_1 = I_2 = I_3$
  - $A_1 = I_T$
  - $A_2 = I_1$
  - $A_3 = I_2$
  - $A_4 = I_3$

Any ammeter tha[illegible] connected in series with the power supply will read the total current in a circuit.



- $I_T = I_1 + I_2 + I_3$
  - $A_1 = I_T$
  - $A_2 = I_1$
  - $A_3 = I_2$

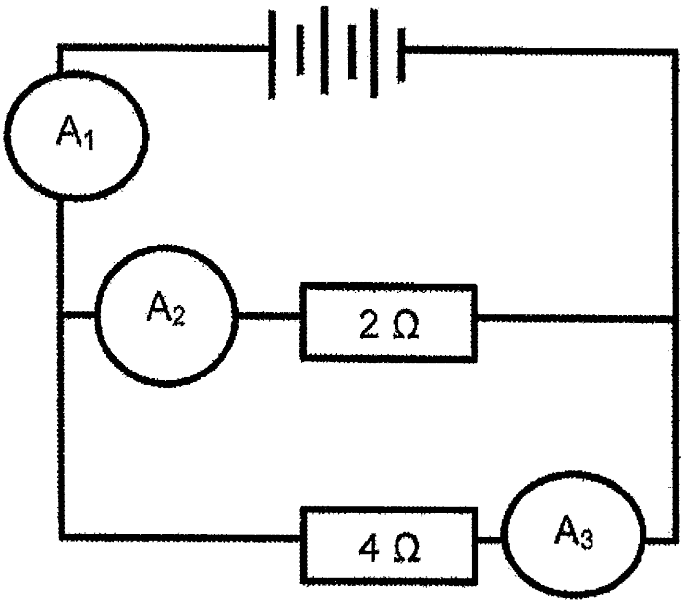
- $A_4 = I_3$



WORKSHEET: CURRENT

QUESTION 1			
1.1		In which direction does conventional current flow in a circuit?	
1.2		Identify three subatomic particles.	
1.3		Which of the subatomic particles mentioned above is responsible for current?	
1.4		Describe the relationship between current and resistance in a conductor.	
1.5		How does direction of conventional current differ from direction of flow of electric current?	
QUESTION 2			
2.1		Define current	

2.2		In which SI unit is current measured? Define this SI unit of current	
2.3		Describe how should an ammeter be connected in a circuit	
2.4		Calculate the current that flows when 240 C of charge pass through an ammeter in 8 seconds	
2.5		A current of 10 A flows through a light bulb for an hour. How much charge flows through this light bulb in an hour?	
QUESTION 3			
3.1		The unit of measurement for the rate of flow of charge in an electric circuit is …	
	A	Coulomb	
	B	Amperé	
	C	Ohm	
	D	Joule	
3.2		Consider the circuit diagram below:	



How will the readings on ammeter A_1, A_2 and A_3 compare with each other?

A	$A_1 = A_2 = A_3$	
B	$A_1 = A_2 + A_3$	
C	$(A_2 + A_3) > A_1$	
D	$A_2 < A_3 < A_1$	

QUESTION 4

4.1	Calculate the quantity of charge that flows through a 3 Ω resistor in 2 minutes experiencing a current of 2 A.	

4.2		Explain the meaning of: a current of 5 A.	
4.3		Calculate the current in the circuit if 0,3 C passes through the ammeter in 2 s.	
4.4		Determine the reading on an ammeter if 3,24 C of charge flows through it in 2 seconds.	

VOLTAGE AND CURRENT MEASUREMENT

- Practical or simulation connections of voltmeter and ammeter.
  - **https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc**

➢ Create a circuit with one lightbulb.

a. Place the ammeter in parallel with the resistor. Take the reading. What did you observe with the lightbulb?

b. Place the ammeter in series with the resistor. Take the reading.

c. Place the voltmeter in parallel with the resistor. Take the reading.

d. Place the voltmeter in series with the resistor. Take the reading. What did you observe with the lightbulb?

- A short circuit will occur in **(a)**
- The resistance it too high in **(d)**
- To calculate total values you may use the formula: $R = \frac{V}{I}$

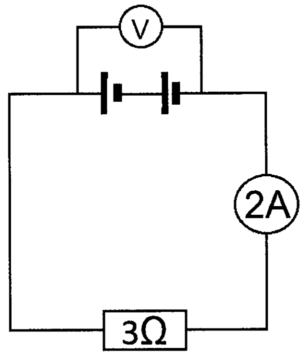
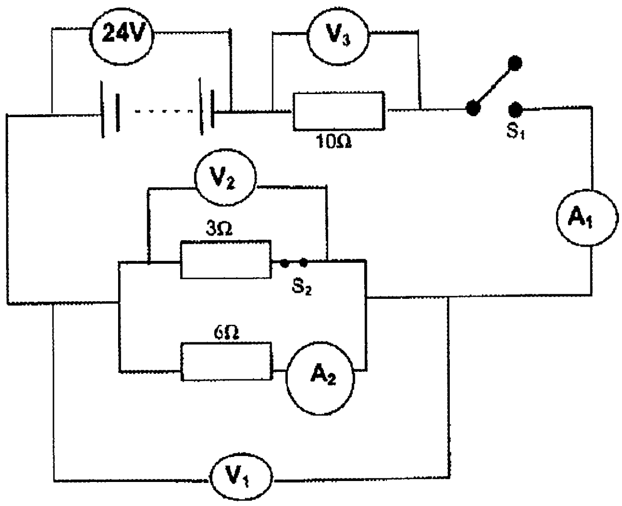
NOTE: this formula will not be included in the data sheet.

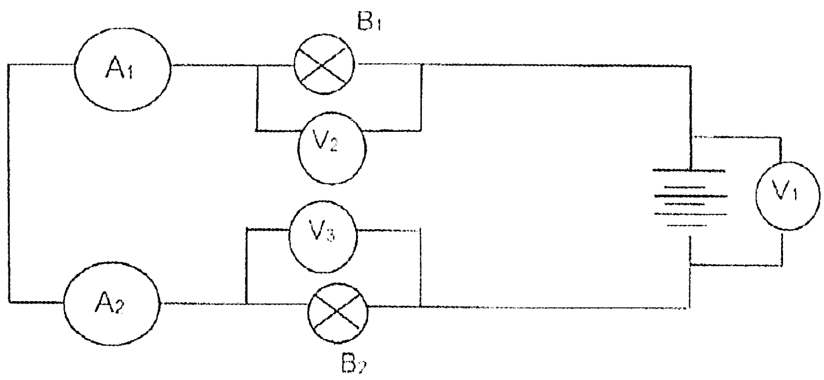
Example: Calculate the total potential difference in a circuit with a light bulb with a resistance of 2 Ω receiving a current of 1,5 A

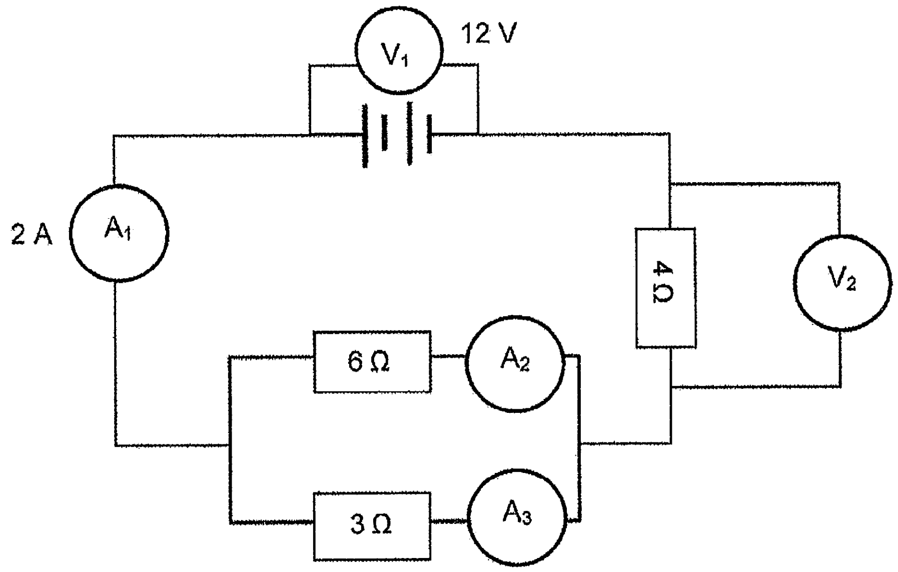
Step 1: Identify the variables	V = ? R = 2 Ω I = 1,5 A
Step 2: Pick the correct formula	$R = \frac{V}{I}$
Step 3: Substitute in SI units	$2 = \frac{V}{1,5}$
Step 4: Answer the question	$V = 3\ V$

WORKSHEET: VOLTAGE AND CURRENT

QUESTION 1			
1.1		What is an electric current?	(1)
1.2		Which instrument is used to measure current in a circuit?	(1)
1.3		What is the function of a voltmeter?	(1)
1.4		Draw the symbols for the following circuit components : A resistor, bulb, voltmeter, ammeter, a battery.	(5)
QUESTION 2			
2.1		Explain how conventional current differs from electric current by referring to the flow of electrons.	(2)
2.2		Explain why the ammeter cannot be connected any other way than in series.	(2)
2.3		What does a short circuit refer to? Why is this dangerous?	(2)
2.4		Calculate the total potential difference of the circuit below:	(3)

			
QUESTION 3			
3.1		A battery is made up of an unknown number of cells. Each of the cells in the battery is labelled 3 V. The battery is connected in a circuit as shown below. Ignore the resistance of the battery and wires. Initially switch S_1 is open and the voltmeter connected across the ends of the battery reads 24 V.	
			
	3.1.1	Does the reading of 24 V represent emf or the terminal potential difference? Give a reason for your answer.	(2)
	3.1.2	Determine the number of cells in the battery.	(2)
3.2		Learners want to determine the voltage across the resistors and the battery in a circuit. Learners use three 1,5 V cells, two identical light bulbs, ammeters and voltmeters to set up a circuit as shown below. Ignore the resistance of the	

		battery and the wires. Study the circuit below and answer the questions that follow.	
			
	3.2.1	Are the voltmeters connected in series or in parallel in the circuit?	(1)
	3.2.2	Explain why voltmeters are connected in this way.	(1)
	3.2.3	Calculate the reading on V_1	(2)
	3.2.4	Write out an equation showing the relationship between the readings on V_1, V_2 and V_3.	(1)
3.3		In the circuit diagram below the reading on voltmeter V_1 is 12 V and the reading on ammeter A_1 is 2 A.	

			
	3.3.1	Calculate the:	
		3.3.1.1 Reading on V_2	(3)
		3.3.1.2 Reading on A_2	(4)
		3.3.1.3 Amount of charge that flows through ammeter A_1 in 120 s	(3)

RESISTANCE

- A resistor opposes the flow of current
- A resistor converts electrical energy into other forms of energy
- Measured in ohm's (Ω), 1 volt per ampere $(\frac{V}{I})$
- Factors that affect resistance
  https://phet.colorado.edu/en/simulation/resistance-in-a-wire

- Temperature
  - Increase results in an increase in resistance
  - Decrease results in a decrease in resistance
- Wire width
  - Increase results in a decrease in resistance
  - Decrease results in an increase in resistance
- Wire length
  - Increase results in an increase in resistance
  - Decrease results in a decrease in resistance

♥ As resistance increases, current decreases
  - Current will flow through the path of least resistance

RESISTORS IN SERIES

- Resistors are connected in series when two or more resistors are connected consecutively, end to end, so that there is only one path along which the current can flow from one point to another.
- Resistors in series are potential dividers because the total potential difference is equal to the sum of the potential differences across all the individual components.
  $V_T = V_1 + V_2 + V_3 + \ldots\ldots\ldots$
  where V_T = reading on the voltmeter across the battery.
  By applying the definition of resistance:
  $V_T = IR_s = IR_1 + IR_2 + IR_3 + \ldots\ldots\ldots$
- Current is constant through each resistor
- The equivalent (total) resistance of resistors connected in series using:
  $R_s = R_1 + R_2 + R_3 + \ldots\ldots\ldots$

Also: $V \propto R$

The potential difference V is the greatest over the resistor with the biggest resistance.

In the circuit below, three resistors are connected to a battery, and the potential difference of the battery, **V_T, is divided across each resistor in the same ratio as their resistance values.**

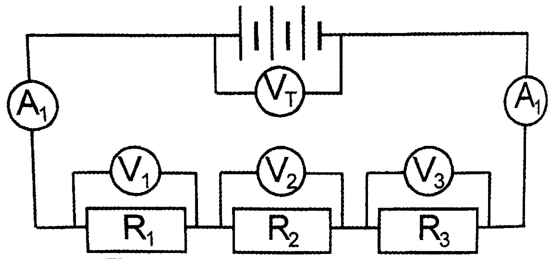


Figure 1: Three resistors connected in series in a circuit

Because the current is the same for resistor R_1:

V_1 = Imain current. R_1

= $(V_{battery} / R_s)\ R_1$

By rearranging we get: $V_1 = (R_1/R_s)V_{battery}$

In general for **resistors in series, we use division according to the ratio:**

$$V_x = (R_x/R_s)V_{battery}$$

This equation is known as the **potential difference divider formula** and it is used by resistors in series to determine the potential difference (voltmeter reading) across a resistor in series.

- The more resistors are connected in series:
  - the greater the equivalent (total) resistance of the external circuit becomes.
  - the main current decreases in the circuit.

If one resistor in series is not working, the circuit is broken and no current will flow in the circuit.

Total resistance increases and the circuit diagram, calculations to find resistance, current or potential difference can be done using:

R = V/I

- Provide learners with a simple question to demonstrate the manner in which calculation(s) should be done in physical science.

Example 1

The current through a light bulb in the section of a circuit is 0.25 A whereas the voltmeter reading is 220 V. Calculate the resistance of the light bulb.

Solution:

V = IR

220 = 0,25 R

R = 220/0,25

R = 880 Ω

ACTIVITIES

Activity 1

1.1 Define resistance

1.2 How should ammeter and voltmeter be connected in a circuit?

1.3 What is the relationship between current and resistance in a circuit?

1.4 Measure current on each resistor and record results.

1.5 Measure the potential difference on each one of the resistors and record the results.

Activity 2

2.1 What effect do resistors in series have on the total resistance of the circuit?

2.2 A circuit consists of a 12 V battery connected across a single resistor. If the current in the circuit is 3 A, calculate the size of the resistor.

2.3 Two 5Ω resistors are connected in series with a 12 V battery.
Determine:

2.3.1 the potential difference across each resistor; and

2.3.2 the current flowing in the circuit.

2.4 Three resistors of 5 Ω, 10 Ω, and 35 Ω, respectively, are connected in series to a 100 V source.

2.4.1 Sketch the circuit.

2.4.2 equivalent (effective or total) resistance of the circuit.

2.4.3 current that flows through the circuit.

2.4.4 potential difference across each resistor by applying the definition of resistance.

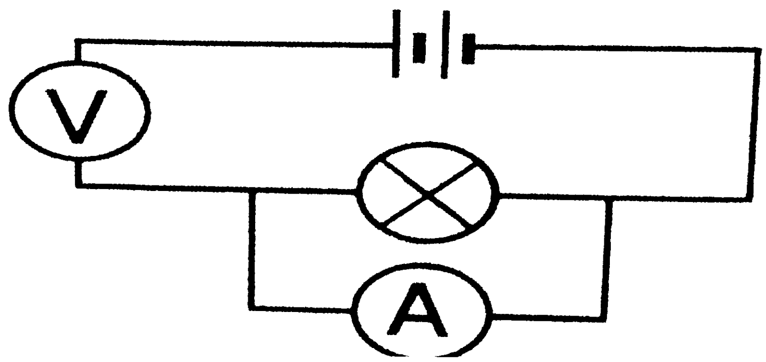
2.4.5 potential difference across each resistor by using the relationships in the circuit.

2.4.6 the amount of charge that flows through the 35 Ω resistor in 2 minutes

Homework:

Activity 3

Consider the circuit diagram.



The position of the ammeter (A) and voltmeter (V) in the circuit is accidentally swapped. Explain what will happen with the reading on the ammeter and voltmeter.

Activity 4

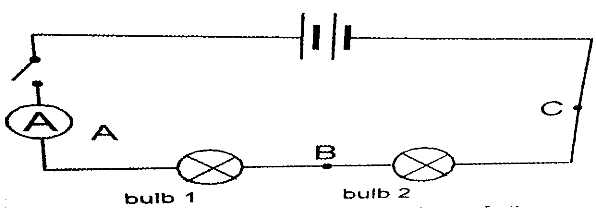
Two cells are connected in series with two resistors R_1 and R_2, together with an ammeter and a switch. A voltmeter is also connected across R_1. The voltmeter reading is 4 V and the ammeter reading is 1,5 A. The resistance of R_2 is 3 Ω.

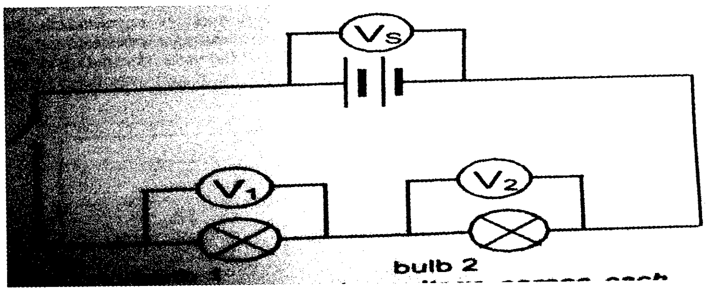
4.1 Draw the circuit diagram.
4.2 Calculate:
4.2.1 resistance of R_1
4.2.2 the potential difference across R_2
4.2.3 the emf of each cell.
4.2.4 amount of charge that passes through the 3 Ω resistor in 2 minutes.
4.2.5 amount of heat released through the 3 Ω resistor in 2 minutes

PRACTICAL ACTIVITY: CURRENT AND VOLTAGE IN SERIES CIRCUITS

Method

- Set up the apparatus as shown in the figure below, with the bulbs connected in series.





Ammeter readings

- Connect the ammeter to the circuit to measure the current at point A.
- Close the switch, take the reading I_A, and write it in the table below.
- Repeat the first step to measure I_B by B and I_C at C.

Table 1: Current Readings

Position	Current, I (A)
A: I_A	
B: I_B	
C: I_C	

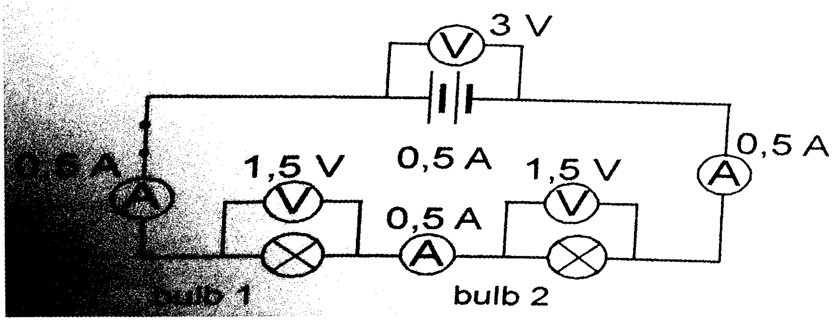
Voltmeter readings

- Connect the voltmeter across the first bulb. Close the switch, measure the reading V_1 and write it down in the table.
- Measure the voltage across the second bulb V_2 and then across the whole circuit V_s. In this circuit, the potential difference across the battery is the same as the voltage V_s across the series connection.
- Calculate the sum: $V_1 + V_2$.
- Compare your readings and make conclusions about the size of the current and the voltage in a series circuit.

Table 2: Voltage readings

Component	Voltage (V)
Bulb 1: V_1	
Bulb 2: V_2	
Sum: $V_1 + V_2$	
Battery: V_s	

Expected Results of a Series Circuit



2.2.4 Discussion

- The current through each bulb (resistor) and in each part of the series circuit is the same and stays constant, $I_A = I_B = I_C$. The reason for this is that the current cannot divide anywhere in the circuit.
- The total potential difference V_s across the battery and the circuit is equal to the sum of the potential difference across the individual bulbs (resistors) in the circuit, $V_s = V_1 + V_2$.
- In a series circuit, the bulbs (resistors) divide the voltage and are called voltage dividers.

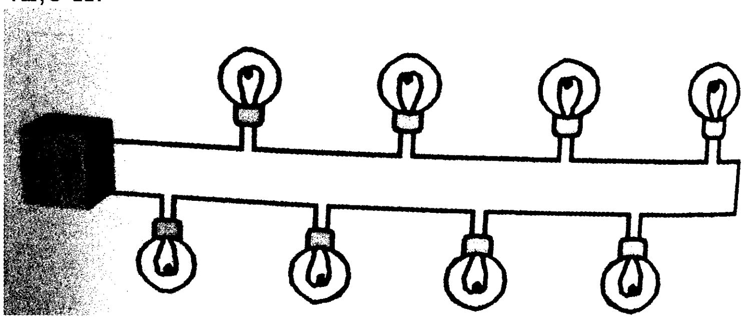
ACTIVITIES

Activity 1

1.1 Define equivalent resistance
1.2 Why is an ammeter connected in series with the circuit components?
1.3 Write down the hypothesis, investigative question and aim of this experiment
1.4 State the dependent and independent variables of the experiment.
1.5 What is the effect of increasing the number of cells in a circuit in series?
1.6 Name three aspects of resistors that are connected in series.

Activity 2

A small exhibition in a shop window is lighted by means of 8 identical bulbs that are connected to a 60 V power source. The resistance of each bulb is 12,5 Ω.



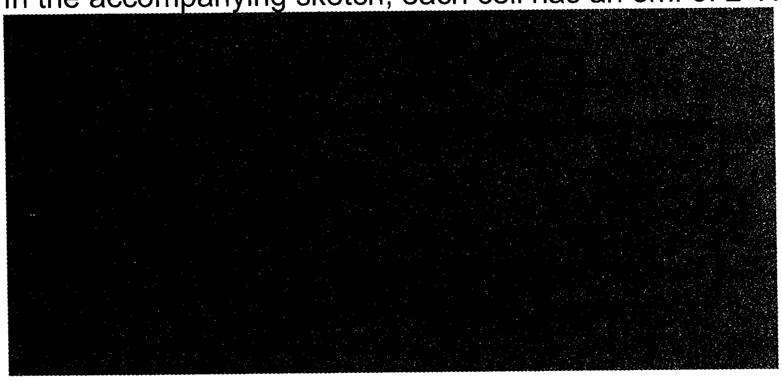
2.1 Calculate the total (equivalent) resistance of the circuit.
2.2 The bulbs all glow dimly. Give a possible reason for this?
2.3 One bulb in the circuit stops working. State how this will influence the circuit. Explain shortly.
2.4 Calculate the size of the current that flows through the circuit.

2.5 Calculate the amount of charge that moves through the bulb in 2 minutes.
2.6 What will the potential difference across each bulb be?
2.7 Calculate the energy that is transferred in the form of light and heat.

Homework:

Activity 3

In the accompanying sketch, each cell has an emf of 2 V.



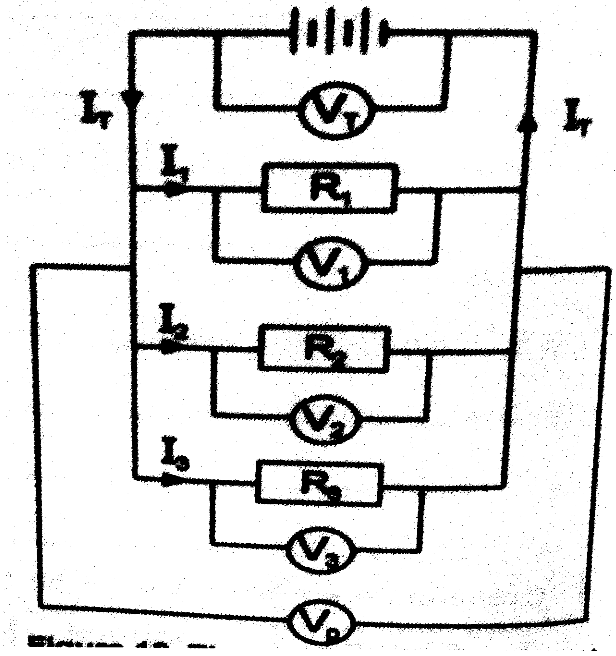
3.1 What is the reading on A, V_1, V_2 and V_3 when switch S is open?

Switch S is now closed.

Calculate:
3.2 the total resistance of the circuit
3.3 the reading on the ammeter
3.4 the reading on the voltmeter V_1
3.5 the reading on the voltmeter V_2
3.6 the reading on voltmeter V_3

RESISTORS IN PARALLEL

- Resistors are connected in parallel when two or more resistors are connected side by side, so that there is that one path whereby the current can branch from one point to another as shown in the following circuit diagram:



- When resistors are connected in parallel, the total (equivalent or effective) resistance of the parallel combination is determined by:
  $1/R_p = 1/R_1 + 1/R_2 + 1/R_3$

The answer of Rp will always be smaller than the smallest resistor in parallel combination.

- For only two resistors in parallel:
  $1/R_p = 1/R_1 + 1/R_2$
  $1/R_p = (R_1+R_2) / R_1R_2$ (rearrange)
  $R_p = R_1R_2 / R_1 + R_2$ (reverse/ invert)

For any two resistors in parallel this applies:

R_p = Product of resistors/sum of resistors
$R_p = R_1R_2/R_1+R_2$

- For two or more **identical resistors in parallel:**
  $R_p = R/n$
  Where **n** is the **number of resistors** connected in parallel and **R** is the value of **one** resistor.
- The main current is divided when it reaches the parallel combination. The value of the current through each resistor will depend on the specific resistor, so that:

$I_T = I_1 + I_2 + I_3$

- The current is thus divided between the parallel resistors so that we say, resistors in parallel are current dividers. Consider the current I_1 through resistor R_1. By applying the definition of resistance, the current through resistor R1, is equal to :

$$I_{R1} = V_p/_{R1}$$
$$V_{battery} = I_{main\ current}\ R_{parallel}$$

so that $I_{R1} = I_{main\ current} R_{parallel} /R_1$

By rearrangement we obtain:

$$I_{R1} = (R_{parallel}/R_1)I_{main\ current}$$

This equation is known as the current divide formula and is used for resistors in parallel to calculate the current (ammeter reading) through a resistor in parallel.

- From the definition of resistance, **R = V/I**, it follows that **R ∝ 1/I**

- If the main current is split by parallel resistors, the resistor with the smallest resistance allows the largest current to flow through, while the resistor with largest resistance allows the smallest current through.
- The more resistors placed in parallel, the smaller the total resistance of the circuit and the greater the main current becomes in the circuit.
- If one resistor in parallel is not working (broken) then the other resistors that are still in parallel will continue working - current can still flow.
- If there were only two resistors in parallel and one breaks, the other one will still work, but is now connected in series with the rest of the components in the circuit

- Because each resistor in parallel is connected at the same point x and y (see diagram above), the potential difference across each resistor and across all the parallel resistors is the same, which is also equal to the potential difference across the battery if there are no further resistors in the circuit .
  $V_{parallel} = V_1 = V_2 = V_3$ and also equal to $V_{battery}$ if there are not other resistors in the circuit.

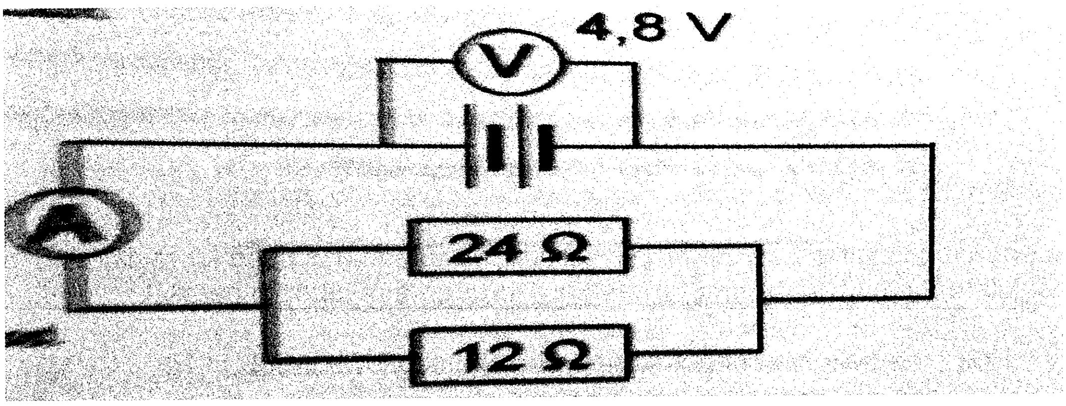
ACTIVITIES

Question 1

1.1 Define an Ohm
1.2 What is the advantage of connecting resistors in parallel?
1.3 What is the relationship between current and resistance in a circuit?
1.4 Measure current on each resistor and record results.
1.5 Measure the potential difference on each one of the resistors and record the results.

Question 2

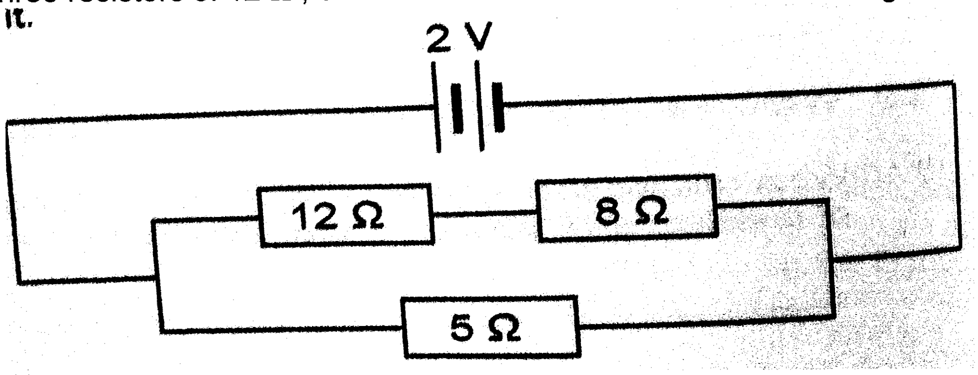
See the circuit diagram below: The potential difference of the battery is 4,8 V.



2.1 Calculate the equivalent resistance of the parallel connection.
2.2 Check your answer to **Question 2.1** with a second method.
2.3 Without any calculation, what is the potential difference across the parallel connection?
2.4 What is the potential difference across the 24 Ω branch and the 12 Ω one?
2.5 What relationship for a parallel connection of resistors exists for the potential difference across the parallel connection of resistors and across the branches of the connection?
2.6 Calculate the current reading on the ammeter and that of the 24 Ω branch.
2.7 Without any calculation, what is the current through the 12 Ω branch?
2.8 What relationship for a parallel connection of resistors exists for the current across the parallel connection of resistors and across the branches of the connection?

Question 3

Three resistors of 12 Ω , 8 Ω and 5 Ω are connected in the following circuit.



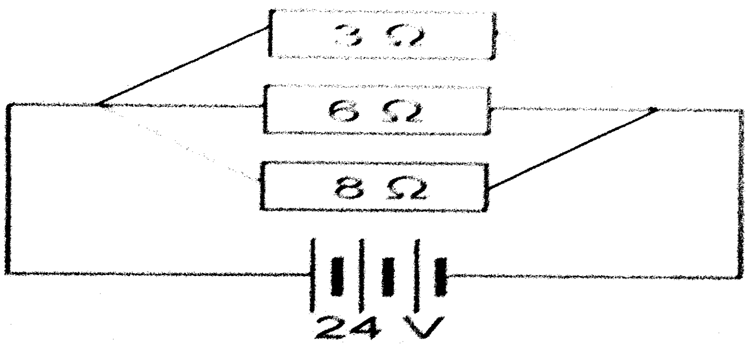
3.1 Calculate the total resistance of the circuit.
3.2 What is the potential difference across the 12 Ω and 8 Ω resistors together?
3.3 What is the potential difference across the 5 Ω resistor?
3.4.1 Calculate the:

- 3.4.1 mainstream current in the circuit.
- 3.4.2 current through the 5 Ω resistor.
- 3.4.3 current through the 8 Ω resistor.

3.5 Calculate the amount of energy that is transferred to the 5 Ω resistor in 5 minutes.

Question 4

Three resistors with values 3 Ω, 6 Ω and 8 Ω are connected in parallel to a 24 V battery as shown in below.



4.1 Calculate the equivalent resistance of the three resistors
4.2 What is the potential difference across :

- 4.2.1 all the resistors together?
- 4.2.2. across the 6 Ω resistor?
- 4.2.3 across the 3 Ω resistor?
- 4.2.4 across the 8 Ω resistor?

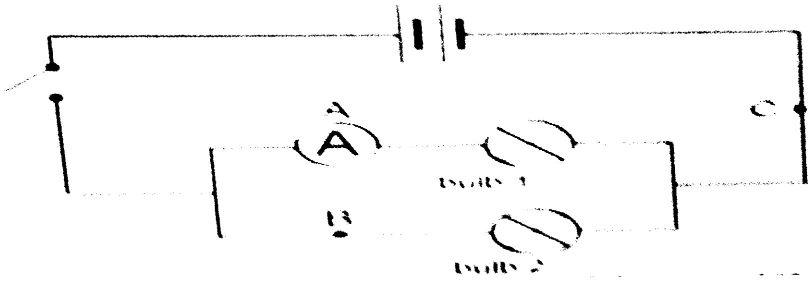
4.3 Calculate the current:

- 4.3.1 in the circuit.
- 4.3.2 through the 3 Ω resistor
- 4.3.3 through the 6 Ω resistor
- 4.3.4 through the 8 Ω resistor

PRACTICAL ACTIVITY: CURRENT AND VOLTAGE IN PARALLEL CIRCUITS

Method:

- Set up the apparatus as shown in the figure below, with the bulbs connected in parallel.



Ammeter readings

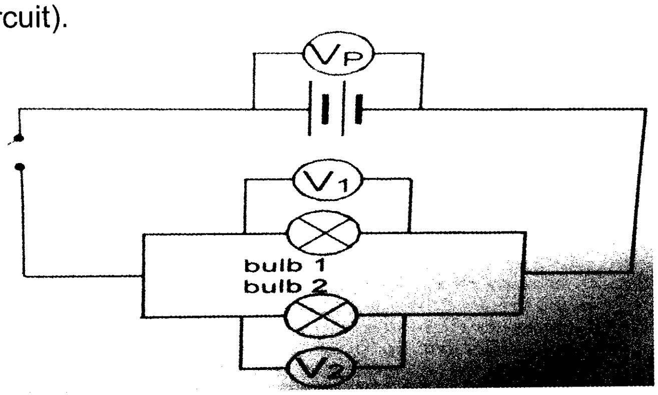
- Measure the current at points A,B and C on the circuit diagram below. Tabulate your results for I_1 at A, I_B at B and I_p at C below:

Table 1: Current Results

Position	Current/A
A: I_A	
B: I_B	
C: $I_C = I_P$	

Voltmeter readings

- Measure and draw the voltage across each resistor (V_1 and V_2) and across the whole parallel division Vp (see circuit diagram). The "P" stands for a parallel circuit).



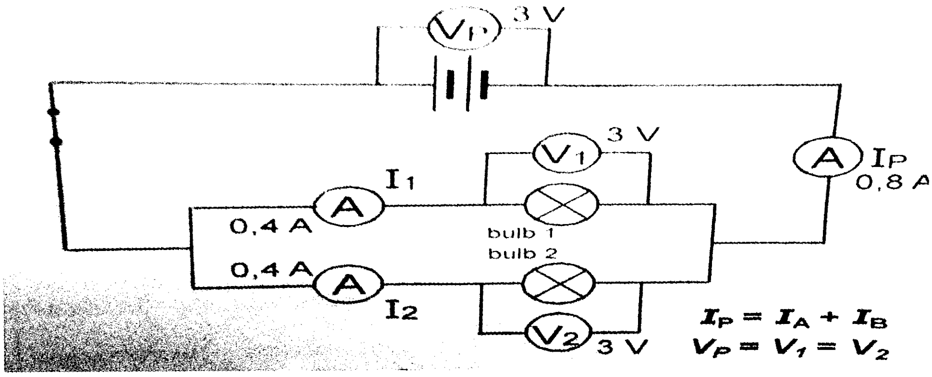
- Compare your readings and make a conclusion about the size of the current and the voltage in a parallel circuit.

Table 2: Voltmeter readings

Position	Voltage/ V
A: I_A	

B: I_B	
C: $I_C = I_P$	

Expected Results for a Parallel Circuit



Discussion

- The sum of the current through the bulbs (resistors) in parallel is equal to the current in the rest of the circuit.
- Resistors in parallel are called **current dividers**, because the sum of the current in the branches is equal to the total current in the circuit.
  $I_P = I_C = I_{main\ current} = I_A + I_B$
- The voltage across each resistor, which are connected in parallel, is the same.
  $V_P = V_{battery} = V_1 = V_2$
- By connecting more bulbs (resistors) in parallel, creates more paths for the current to flow through. The resistance decreases and the current increases.

ACTIVITIES

Question 1

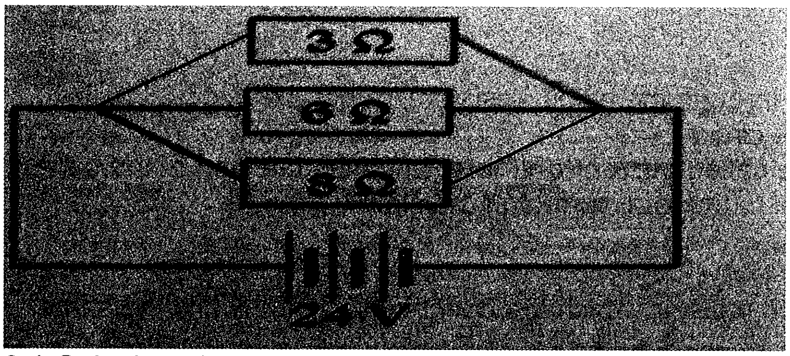
1.1 What is the aim of this experiment?
1.2 Identify the independent and dependent variables which may be derived from this experiment.
1.3 What may be the effect of adding extra resistors in a parallel circuit.
1.4 What is the advantage of connecting resistors in parallel.
1.5 Why are resistors in parallel referred to as current dividers?
1.6 What relationship can be derived from the total voltage of the battery and the voltage across
each of the resistors in parallel?

Question 2

A circuit contains four 1,5 - V cells in series, a switch, an ammeter in the main current and two parallel connected resistors of 2 Ω each. The reading on the ammeter is 6 A.

2.1 Draw a diagram of the circuit.
2.2 Show in your diagram how the voltmeter is connected in the circuit to measure the potential difference across the two resistors.
2.3 Calculate the total resistance of the resistors.
2.4 Calculate the charge that flows through both resistors in 2 minutes.
2.5 Calculate the reading on the voltmeter
2.6 Calculate the energy that is transferred to both resistors if 360 C charge flows through it.

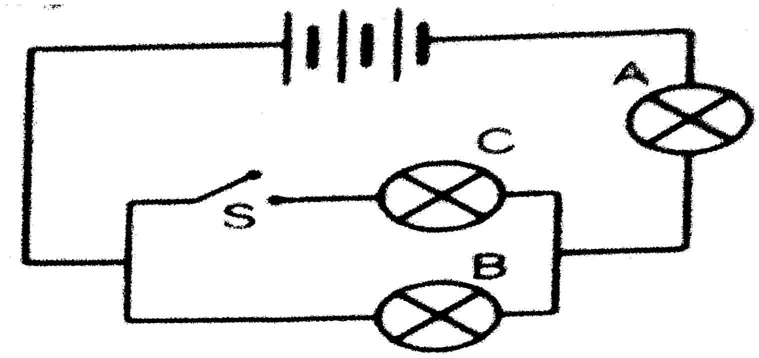
Question 3
Three resistors with values 3 Ω, 6 Ω and 8 Ω are connected in parallel to a 24 V battery as shown below.



3.1 Calculate the equivalent resistance of the three resistors.
3.2 What is the potential difference across:
3.2.1 all the resistors together?
3.2.2 across the 3 Ω resistor
3.2.3 across the 6 Ω resistor?
3.2.4 across the 8 Ω resistor?
3.3 Calculate the current
3.3.1 in the circuit
3.3.2 through the 3 Ω resistor.
3.3.3 through the 6 Ω resistor.
3.3.4 through the 8 Ω resistor.

COMBINATION OF SERIES AND PARALLEL RESISTORS
This part deals with circuits which have both series and parallel resistors in one circuit.

To achieve this, let's consider the following circuit diagram. Light bulbs **A**, **B** and **C** are identical with the same resistance.

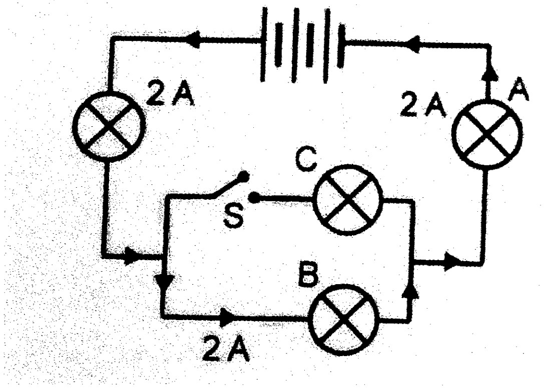


- With the switch S open (OFF):
  Observation :
  Light bulb **A** and **B** will shine brighter. **C** will not shine.
  Explanation:
  Light bulbs **A** and **B** are connected in series so that the same current flows through **C.**
- With the switch S closed (ON):
  Observation:
  All the bulbs will now shine.
  A will now shine brighter than when the switch S was open.
  B will be dimmer than when the switch was open.
  C will also now shine but just as bright as B.

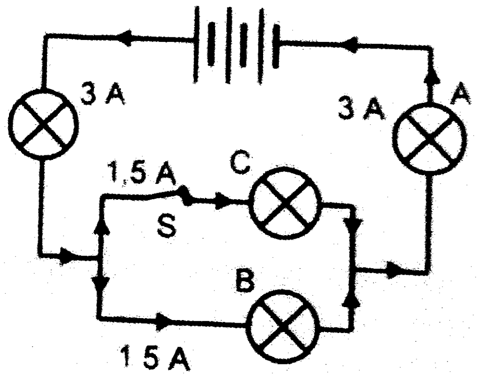
  Explanation:
  When switch S closed, the light bulbs B and C are in parallel and light bulb A in series . With the parallel connection, the effective (total) resistance of the circuit decreases (becomes smaller) and the current in the circuit will thus become greater.The new larger current flows through light bulb A which is in series so that it shines brighter. Half of this current now flows through each of the light bulbs B and C.
- With S open, the current in A = current in B. With no current through C.
- With S closed, the current in A = 2 x current in B = 2 x current in C.

Practical Representation when S is open:

With S open



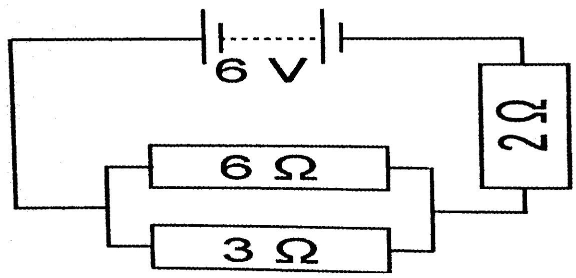
With S closed



Equivalent decreases so that $I_{mainstream}$ increases.

Example

Consider the following circuit, where the battery's internal resistance is neglected.



Determine:

a. equivalent resistance of the circuit.

b. Current through the 2 Ω resistor.

c. the current through the 3 Ω resistor.

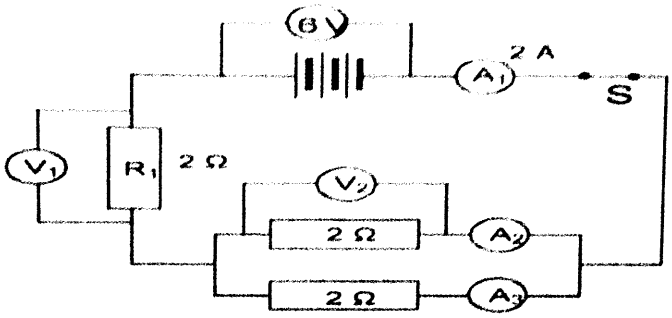
d. the potential difference across the 6 Ω resistor.

e. the amount of heat released through the 6 Ω resistor in 5 minutes.

ACTIVITIES

Question 1

Consider the following circuit, where the battery's internal resistance is neglected.



1.1 Is the voltmeter reading of 6 V the emf or the potential difference of the circuit? Explain your answer.

1.2 How much charge flows through the circuit per second?

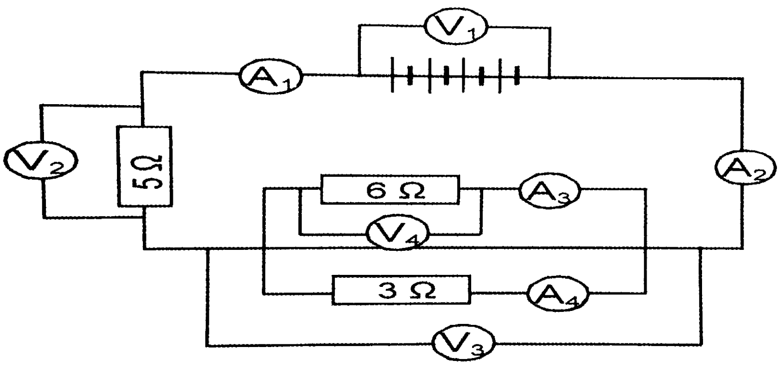
1.3 Determine the readings at:

- 1.3.1 A_2
- 1.3.2 A_3
- 1.3.3 V_1
- 1.3.4 V_2

1.4 How much warmth is released to send 3 C charge through R_1?

Question 2

In the accompanying circuit diagram each cell has an emf of 3 V.



2.1 What is the reading on V_1 ?

2.2 the total resistance of the circuit.

2.3 Calculate the reading on ammeter A_1.

2.4 What is the reading on the ammeter A_2?

Explain.

2.5 Calculate the reading on V_2 .

2.6 Calculate the reading on A_3

2.7 What is the reading of V_3 and V_4? Give a reason for your answer.

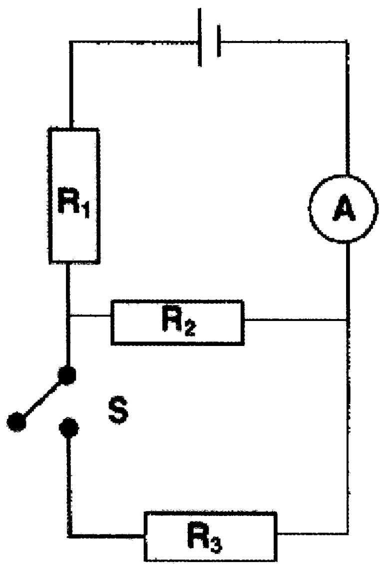
2.8 Calculate the amount of charge that flows through the ammeter A_1 in 2 minutes.

2.9 Calculate the amount of energy that is converted by the 3 Ω resistor into heat and light.

WORKSHEET: RESISTANCE

QUESTION 1			
1.1		Define resistance	(2)
1.2		What is a resistor?	(2)
1.3		Describe the energy conversion that take place in:	
	1.3.1	Radio speaker	(2)
	1.3.2	Light bulb	(2)
	1.3.3	Electric stove	(2)
1.4		What factor(s) affect resistance in a conductor?	(3)
QUESTION 2			
2.1		What is the relationship between resistance and current? Which one is the independent variable?	(2)
2.2		In which SI unit is resistance measured? Define this SI unit as a compound unit.	(2)
2.3		Describe how resistance in a wire may be increased in three different ways.	(3)
2.4		What is the scientific name given to the ratio: $\frac{V}{I}$?	(1)
2.5		A long nichrome wire has more resistance to current than a short one of the same thickness. Explain why.	(3)
QUESTION 3			

3.1		The resistance of a resistor can also be expressed as ...	(2)
	A	Joules per coulomb	
	B	Volt per amperé	
	C	Joule per second	
	D	Volt per coulomb	
3.2		Refer to the circuit diagram below:	(2)

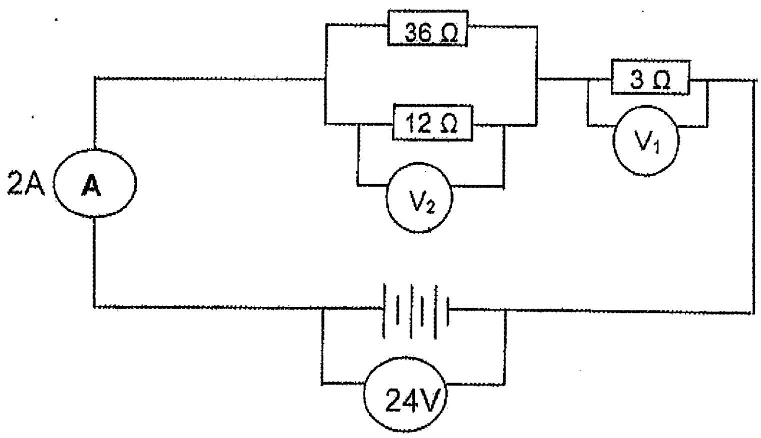


When switch S is now CLOSED, which ONE regarding the total resistance and current strength reading on ammeter A is correct?

	Total resistance	Current Strength on Ammeter A
A	Increases	Increases
B	Decreases	Increases
C	Increases	Decreases
D	Decreases	Decreases

QUESTION 4

4.1		How will each of the following changes affect the resistance of a conductor? (Choose from INCREASE, DECREASE or REMAIN THE SAME)

	4.1.1	Heating the conductor	(1)
	4.1.2	Increasing the cross-sectional area (thickness) of the conductor.	(1)
4.2		Study the following diagram and answer the questions set. The resistance of the battery and conducting wires may be ignored.	
			
	4.2.1	A third resistor is now added in parallel to the 36 Ω resistor. How will this affect the emf of the battery? (Choose from INCREASES, DECREASES or REMAIN THE SAME).	(1)
	4.2.2	Give a reason for your answer above	(2)

STOICHIOMETRY

LEANER NOTES LESSON 1

Atomic mass and the mole concept

- The mole is described as the SI (standard international) unit for amount of substance.
- One mole of any substance is defined as the amount of substance having the same number of particles as there are atoms in 12 g carbon-12.

There are 6,023 x 10^{23} atoms in 12g carbon -12

Avogadro's number N_A

This is the number of particles (atoms, molecules, formula units) present in mole (N_A = 6,023 x 10^{23} mol^{-1})

Converting a given amount of a substance to moles, use $n = N/N_A$

n is the number of moles of a substance

N is the number of particles of a substance

N_A is Avogadro number

Worked examples

1. How many moles will each of these make
   (a) 12g of carbon atom
   Answer: 1 mole

3. How many atoms will be there in each of the following

ANSWERS

(a)12g of carbon atoms — 6.02 x 10 23 atoms
(b)14g of Nitrogen atoms — 6.02 x 10 23 atoms
(c)24 g of Magnesium atoms — 6.02 x 10 23 atoms

4 Convert the following to moles:
(a)1,204 x 1024 atoms of carbon
ANSWER: $n = \frac{N}{NA}$
$n = 1{,}204x\ 1024\ /(6.02x1023) =\ 2moles$

<u>Lesson 1 learner activities</u>

1. Define a mole

2. How many moles will each of these make
   (b) 60g of carbon atoms
   (c) 28g of Nitrogen gas
   (d) 72 g of Magnesium atoms

3. How many atoms will be there in each of the following
   (a) 12g of carbon atoms
   (b) 24 g of chlorine atoms in Magnesium chloride

4. Calculate the number of moles in :
   (a) 1,204 x 10^{24} atoms of carbon
   (b) 3x10^{26} atoms of oxygen

LEANER NOTES LESSON 2

Relative formula mass, molar mass and relative molecular mass

Molar mass

This is the mass of one mole of a substance. It is measured in g.mol^{-1}.

Relationship between relative formula mass, relative molecular mass and molar mass

Relative formula mass, relative molecular mass and mass are all the same in magnitude but have different units

Units for molar mass is g.mol^{-1}

Units for relative formula mass is amu

Molecular mass has no units

Formula for calculating number of moles given mass

n= m/M

n = number of moles

m = mass of a substance

M = molar mass (this always comes from the periodic table)

Worked example

What is the atomic mass of Cu and S. ?
Expected answers: 65 units and 32 units respectively.

1. Calculate the molar mass of a substance given its formula:
   (a) Calculate the molar mass of H_2SO_4?
   Solution: relative atomic mass of H = 1 x2 =2
   Relative atomic mass of S = 32
   Relative atomic mass O = 16 x 4 = 64
   Therefore molar mass of H_2SO_4= 2 +32+64 = 98g.mol^{-1}
   OR
   M(H_2SO_4)= (2x1)+(32)+(4x16) = 98 g. mol^{-1}

   (b) Write down the value of relative molecular mass of H_2SO_4

Answer: 98 (no units)

(c) Write down the value of relative formula mass of H_2SO_4

Answer: 98 amu

2. Calculate mass, molar mass and number of moles according to the relationship $n = \frac{m}{M}$

Determine the number of moles in 120g of carbon atom

$$n = m/M$$

$$n = \frac{120}{12}$$

n=10 moles

Lesson 2 learner activities

1. Calculate:
   (a) relative molecular mass of sodium hydroxide (NaOH)
   (b) the value of formula mass of NaOH
   (c) the value of molar mass of NaOH
   (d) the number of moles of NaOH in 128g of the salt

2. A diatomic substance has a mass of 128g this makes 4 moles of the substance identify the substance using calculation

3. Other activity on oxford successful physical science grade 10, page 203 activity 1.

LEANER NOTES LESSON 3

Percentage composition of a substance

This the mass of each atom present in a compound expressed as a percentage of the total mass of the compound.

$$\text{Percentage of composition} = \text{mass of each atom in a compound}/\text{total mass of a compound X } 100$$

Concentration

This is the number of moles of solute per cubic decimetre of solution

Formula for calculating concentration

$$C = n/V$$

c = concentration measured in $mol.dm^{-3}$

n = number of moles

v = volume dm^3

Conversions

1 dm^3 = 1000ml = 1000cm^3

Worked example

1. Calculating the percentage of oxygen in water

   $\% O = \frac{mass\ of\ the\ atom}{mass\ of\ the\ compound} x100$

   $\% O = \frac{16}{18} x\ 100$

   % O = 88.8 %

2. Determining percentage of oxygen in H_3PO_4

   $\% O = \frac{mass\ of\ the\ atom}{mass\ of\ the\ compound} x100$

   $\% O = \frac{64}{98} x\ 100$

   % O = 65.31%

✓ Concentration as the number of moles of solute per cubic decimetre of solution

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

SI, units for concentration is $mol.dm^{-3}$

Note: always convert volume to dm^3 before substituting in the equation

1 L = 1 dm^3

Calculating concentration

Example

There are 4 moles of H_2SO_4 in a volume of $20dm^{-3}$determine the concentration of this acid

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

$C = \frac{4}{20}$

$C = 0{,}2mol.dm - 3$

<u>Lesson 3 learner activities</u>

1. Given a substance Al_2O_3
   Calculate the percentage of
   (a) Al
   (b) O in Al_2O_3

2. Calculate the concentration of NH3 of volume 500cm3 and only 3 moles present in this volume
3. How many moles of substance X will give concentration of 0.01mol dm^{-3} in a volume of 600ml
4. 240g of carbon dioxide is dissolved in a volume of $100dm^{-3}$. Determine the concentration of the carbon after all the carbon dioxide has dissolved

LEANER NOTES LESSON 4

Empirical formula

An empirical formula as the simplest whole-number ratio of atoms in a compound.

Determining empirical formula of a compound

Step 1: change the percentage composition of elements in a compound to masses
Step 2: change the masses into number of moles using the formula $n = m/M$
Step 3: determine the simplest ratio by dividing all moles with the smallest number of moles
Step 4: write the empirical formula

Water of crystallisation calculation

Step 1: calculate number of moles of water

Step 2: calculate number of moles of anhydrous salt

Step 3: determine the ratio of water to anhydrous salt

Step 4: write the formula for the hydrate

Worked example

Pupils calculate the percentage composition of each element in CO_2

carbon = 12/44x100 = 27.3%

oxygen = 32/44 x100 = 72.7%

Using these percentages above determine the empirical formular

Atoms	Carbon	Oxygen
Percentages	27.3%	72.7%
Masses	27,3 g	72,7g
number of moles n=m/M	27.3/12	72,7/16
number of moles	2.2750	4,544
Ratio of	2,2750	4,544
Simplest ratio	2,2750/2,2750	4.544/2.2750
	1	1.997(2)

empirical formula CO_2

Teacher defines water of crystallisation as water that is stoichiometrically bound into a crystal. Teacher demonstrates how to calculate the molar mass of water of crystallization in $CuSO_4 \cdot 5H_2O$

Cu 63.5	H 1g.mol-1 x2 =2
S 32	O 16g.mol-1 16x4= 64
• 64 +32+63.5= 159,5gmol-1	5H2O =(2+16)x5 =80

•

Total 159,5 +80= 239.5g.mol-1

Mass of water of crystal given the mass of the hydrate 239.5 -159.5 = 80g

Teacher demonstrates how to calculate the molar mass of water of crystallization in $CuSO_4 \cdot 5H_2O$

$n(H_2O)$ =m (80)/M(16) =5

n(AS) = m159.5/M(159,5)=1

Ratio of $CuSO_4$:$5H_2O$

1: 5

Lesson 4 learner activities

1. A gas ethane is analysed and found to contain 117.44g carbon and 28.56g hydrogen
   (a) Calculate the percentage of carbon
   (b) Percentage of hydrogen
   (c) Determine the number of moles of each element present in the compound
   (d) What the simplest ratio the number of moles in (c)
   (e) Write the empirical formula

2. A sample of Barium chloride dehydrate ($BaCl_2$.$2H_20$) has a mass of 1,060g after heating. Calculate the mass of crystallisation
   Mass of water = 1,250-1,060= 0,190g

LEARNER NOTES LESSON 5

Molar volume of gases

Avogadro's Law

It states that one mole of any gas occupies the same volume at the same/standard temperature and pressure

Standard or same temperature and pressure

Standard/same temperature 273K or 0^0C
Standard/same pressure 1atmosphere or 101,3 kPa
There according to Avogadro's law all gas will occupy the same volume at the above given temperature

Formula for calculating number of moles given volume at STP

$n = V/Vm$

n = number of moles

V= volume of the gas

V_m = 22,4 at STP

Steps when doing basic stoichiometric calculations

STEP 1: ALWAYS balance the equation

STEP 2(a): identify the quantities given for a substance and if the question wants other quantities for the same substance always convert to moles then to the required quantity

STEP 2 (b): identify the quantities given for a substance and if the question wants other quantities for a different substance in the chemical equation always convert to moles then use the ratio to identify the moles for the other substance then convert to any other magnitude needed

Theoretical Yield

Theoretical yield is the calculated yield of a product in a chemical reaction.
Actual yield is the quantity physically obtained from a chemical reaction.

Worked example

Given the equation $2\,H_{2(g)} + O_{2(g)} \rightarrow 2\,H_2O(g)$

(a)Calculate the volume of 4moles of hydrogen at STP

n=V/Vm

4=V/22,4

V= 89.6dm ^{3}

(b) Calculate the mass of hydrogen gas of volume 89,6dm^3 at STP

n=V/Vm

n=89.6/22.4 =4moles

n=m/M

4=m/2

m= 8g

(c) using the balance equation above determine the volume of H_2O that will be produced at STP if 8g of hydrogen gas if used

Step 1: calculate number of moles of hydrogen used

n= V/Vm
n= 89.6/22.4 =4moles

Step 2: use of mole ratio from balance equation

	H_2	H_2O
Ratio	2	2
Moles used /produced	4	4

Volume of water produced

$$n = \frac{V}{Vm}$$
$$4 = \frac{V}{22,4}$$
$$V = 89,6\ dm^3$$

Lesson 5 learner activities

1. In the following chemical reaction: $2\ H_{2(g)} + O_{2(g)} \longrightarrow 2\ H_2O(g)$

1.1. How many moles of water will be produced from 6 moles of O_2?
A. 6 moles B. 8 moles C. 9 moles D.16 moles

1.2. How many moles of $H_{2(g}$ will react with 40g of $O_{2(g)}$

1.3. How many grams of $H_2O(g)$ will be produced by 18g of H_2

2. Given the formular $CuSO_4 \cdot 5H_2O$ show using calculation why there are 5 waters of crystallisation

Mechanics Grade 10 Notes and Activities

NOTES

Define the following terms- baseline

- *Speed*
- *Distance*
- *period*

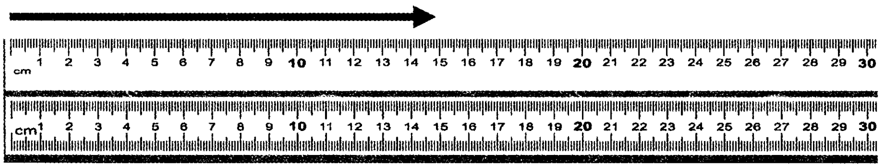
- Define *physical quantity* as a measurable property of object/substance /quantity that are found in nature. Like time, mass, weight, power, electric charge etc

- There are two types of *physical quantities,* namely: **Vector** and **Scalar** quantities.
- **Vector**- Is a physical quantity with magnitude and direction.
  Examples: *displacement(x), velocity (v), acceleration (a), forces (F) and weight (w).*
- **Scalar**-Is a physical quantity with magnitude (size) **only**.
- Examples: time (t), mass (m), distance (D), speed (v) and a charge (Q).
- *NEGATIVE* vectors and scalars: A negative vector (-F) of any given vector (+F) has the same size/magnitude **(equal)** as the given vector (F), but works in the opposite **direction**. E.g. **(F= -F).**
- In a case of scalar quantities, the negative number often represents the quantity less/ below zero
- E.g. A temperature of -12 ^{0}C is not the same/equal in magnitude with a temperature of +12 ^{0}C.
- In grade 10 vectors in 1-dimensional, *along a straight line* only that are considered.
- Horizontal directions: (Left or Right), (West or East) OR (Negative or Positive)
- Vertical Directions: (Up or Down), (North or South) OR (Positive or Negative)

- A vector quantity is represented by a **straight line** and an **arrow head**

Example

tail   arrowhead-for direction



Magnitude of vector is **15 cm** and direction to the **right**

- The **starting point** of a vector is called the **tail** and **the endpoint (where arrow is**) is called the **head.**
- The **graphic representation** of a vector is called a **vector diagram.**
- **The sketch of a vector diagrams is** vector diagrams that are *not drawn to scale*
- **Vector diagram drawn to scale -** Vector diagrams that are *drawn accurately according to a suitable scale.*
- Scale is used to represent the following
  - Quantity that cannot fit on a page

  e.g. ***1cm : 1N*** ⟶

Example

Use the scale 1 cm : 10 N to draw a 100 N vector to the left

Solution

1 cm ⟶ 10 N

X (cm) ⟶ 100N √

Steps

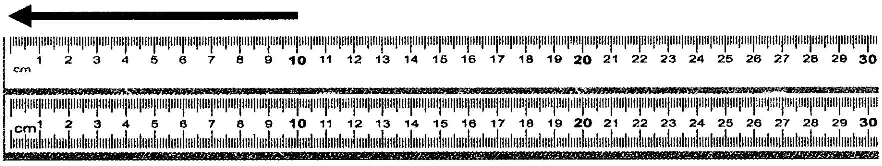
- Use given scale to calculate 100 N has to be represented by how many centimetres.
- Draw vector and measure its magnitude using a ruler
- Use arrow head to show the direction of vector

1 cm x 100 N = x(cm) x 10 N√

$x = \frac{1cm \: X \: 100 \: N}{10 \: N}$

x = 10 cm√

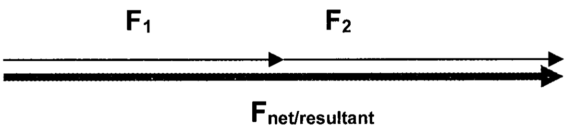
100 N



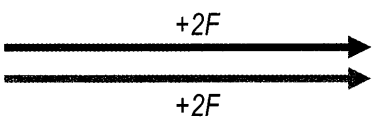
Vector Notation: symbolic representation of vector

- $\vec{V}$ Represents the vector (size and direction).
- V Represent the size/magnitude of the vector only, without direction.

- Resultant/net vector is a single vector having the same effect as two or more vectors together.



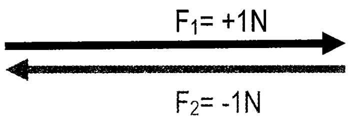
- Equality of vectors: Two vectors are equal if they have the *same size* and *same direction.*



Examples: **2F= +2F**

- Negative vectors: Is a vector with the same size, but in exactly the opposite direction as a give positive vector. Also equal but in opposite direction.

Example:



($F_1 = -F_2$)

- Addition of vectors and scalars: Two scalars can be added easily algebraically. But addition of vectors can require more attention. Here the *direction* needs to be taken into account when adding using the linear equation $\mathbf{F_1+F_2}$...

1. Example A force F_1 of 20N east and a force F_1 of 15N west act on the same object. Calculate the resultant vector using the equation. $F_{RES} = F_1 + F_2$
$= +20N + (-15N)$
$= +5N$

- The resultant/net vector: Is the single vector that has the same effect as two or more vectors added together. $\mathbf{F_{res} = F_1 + F_2 + F_3 ...}$

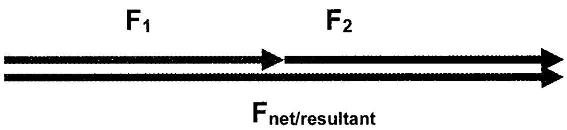
2. Example: $F_{RES} = F_1 + F_2 + F_3$
$= +20N + (-15N) + 7N$
$= +12N$

Graphical method of vector additions

Tail-to-head method

- In this method a vector is drawn with its tail to the head of the first vector.

Example:



NB: Vectors in same direction

Example:

NB: Vectors in opposite direction

ATIVITIES
1. What is meant by the term *physical quantity?* 2. Distinguish between a scalar and a vector quantity and give three (3) examples of each. 3. Can the magnitude of a scalar quantity be negative? YES or NO. Explain. 4. Can the magnitude of a vector be negative?
ACTIVITIES
1. Draw and label a sketch-vector diagram indicating the, tail, heard and length. 2. Use the ratio scale 2 cm: 20 N to draw a 100 N vector to the right.

3. Use the ratio scale 3 cm: 5 N to draw a 10 N vector to the right.
4. Measure the length of the vector below using a ruler and write down the correction magnitude of force vector. Use ratio scale: *1cm : 10 N*

ACTIVITIES

1. We can graphically represent vectors through sketch vector diagrams and scale vector diagrams. What is the difference between these two vector diagrams?
2. A force F_1 of 2N east and a force F_1 of 12N west act on the same object. Calculate the resultant vector using the equation.
3. A force F =20N is acting to the right on an object. Make a scale drawing with complete labels of the 20N force by making using of the ration scale 10mm : 2N
4. F=6N to the right. Draw according to a scale and give labels of the following vectors
   a. 2F
   b. 0.5F
   c. –F
   d. -2F

ACTIVITIES

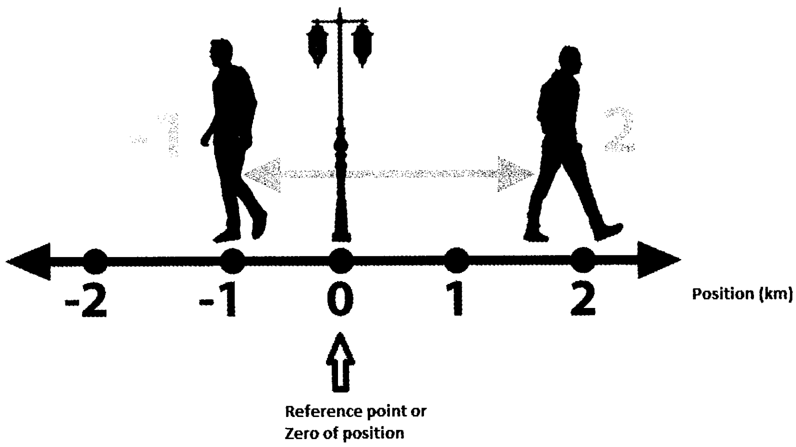
1. Alice and Chris exert forces F_1 and F_2 respectively on a rope. F_1= 60N Eastwards and F_2=150N Westwards.
   1.1 Draw a *tail-to-head sketch vector diagram* to determine the resultant force of these two forces. (Choose a suitable scale)
   1.2 Calculate resultant force
2. A child exerts a force of 20N on a cart. The cart resist with a force of 8N.
   2.1 Draw a tail-to-head vector diagram to determine the resultant force that a child exerts on a cart (Choose a suitable scale)
3. A child exerts a force of 20N on a cart. The cart resist with a force of unknown magnitude. The resultant force is 7N
   3.1 Calculate the resistance force by a cart on the girl.

NOTES

- Explain, demonstration, Illustrate and answer questions
- **Frame of Reference** is the coordinate system or set of exes within which to measure the position of object in it
- **Frame of reference** has an origin and the set of direction. e.g east and west or up and down
- **One dimensional motion** (movement) as a motion along a straight line. An object may move forward or backward along a straight line.
- Demonstrate Position of an object relative to a reference point (Position can be positive or negative)

Example

John walks 2km in an easterly direction from the streetlight (reference point) while Sipho walks 1 km in a westly direction from the same street light.



Determine

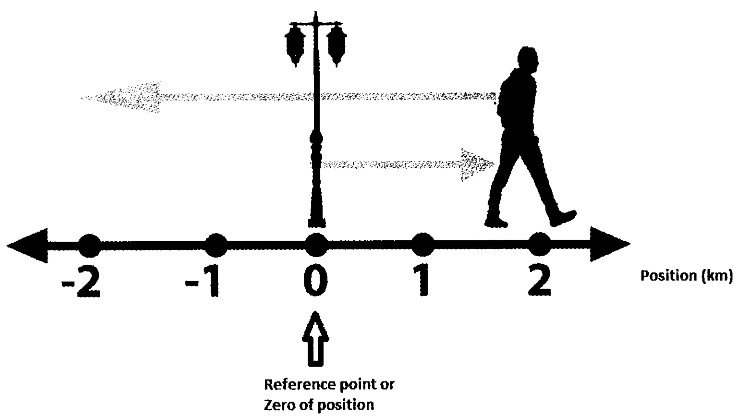
a) John's position from the streetlight
b) Sipho's position from the streetlight

Distance is the total path length travelled.

Distance measured in SI unit (m)

Example

John walks 2 km east from the streetlight and walks back 4 km west. As shown on the diagram below.



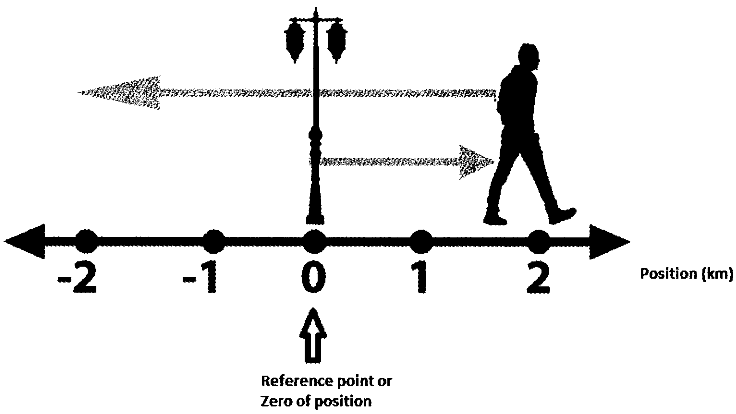
a) Calculate the total distance travelled by John.

Displacement is the difference in position in space.

Displacement is vector quantity measured in SI units (m)

Example

John walks 2 km east from the streetlight and walks back 4 km west. As shown on the diagram below.



Determine John's displacement

1. **Define average speed** as the total distance travelled per total time
   Average speed is a scalar quantity

2. **Define average velocity** as the rate of change in position
   Velocity is a vector quantity

3. Start by showing learners how to convert:
   km.h^{-1} to m.s^{-1}
   300km.h^{-1} = 300 000/3600
   = <u>83.33m.s^{-1}</u>

   m.s^{-1} to km.h^{-1}
   30m.s^{-1} = 30 x 3.6
   <u>= 108km.h^{-1}</u>

4. **Mathematical equations to use**

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time taken}}$$

5. Use of Ticker timer

The teacher will use a ticker timer to solve the problem of reaction time. A ticker timer has vibrating arm that draws dots a paper tape at regular time intervals. A ticker timer is connected to an alternating current source with a frequency of 50Hz, 50 dots are drawn on the tape every second and as the tape moves the dots are spaced out.

Example 1

A van is travelling at a speed of 54km/h in a 40km/h zone

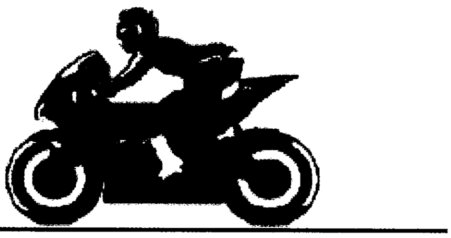
a) Convert 54km/h to metres per second (m/s)

Solution

Option 1	**Option 2**
54 000/ 3600	55/3.6
=15m/s	15m/s

Example 2

The rider travels at 44.44 m/s westwards against the wind from point A to point B in a time of 2 hours which is 160km. The rider immediately turns around and rides back to the starting point in a time of 1,67 hours, this time with the wind.



B **160km** **A**

a) Convert 44.44m/s to km/h.

b) Calculate the average speed of the motor bike for the entire journey.

c) Calculate the average velocity of the motor bike for the entire journey.

Explain, demonstration, Illustrate and answer questions

- Define acceleration as the rate of change in velocity
- $V = \frac{\Delta x}{\Delta t}$
- Acceleration is a vector (it has both magnitude and direction)

  e.g 5 $m.s^{-2}$ to the right (east)

POSITIVE ACCELERATION

It where an object moving in the positive direction is experiencing an increase in speed and an object moving in a negative direction is experiencing a decrease in speed

Example 1

Time (s)	Velocity (m/s)
0	0
1	2
2	4
3	6
4	8

- **NEGATIVE ACCELERATION**

  An object moving in the positive direction is experiencing a decrease in speed and an object moving in the negative direction is experiencing an increase in speed

Time (s)	Velocity (m/s)
0	8
1	6
2	4
3	2
4	0

- **Deceleration:** An object is experiencing a decrease in speed.

Example 2

A car is moving at a velocity of 20m/s on a straight road, suddenly the driver of a car sees a dog crossing the road and he applies the brakes to bring the car into a stop. It takes the car 7s to come to a stop. Calculate the magnitude of the car's acceleration

- a $= \frac{\Delta x}{\Delta t}$

$= \frac{0 - 20}{7}$

$= - 2.86 m/s^{-2}$

$= 2.86\ m/s^{-2}$ in the opposite direction

Base Line Assessment

1. Average velocity change in the object's position over a specific time.
2. Acceleration is the rate of change in velocity
3. Acceleration

Instantaneous velocity is the rate of change in position

e.g displacement divided by a small interval or the velocity at the particular time.

It is a vector quantity

Instantaneous speed is the magnitude of the instantaneous velocity

It is a scalar quantity.

NB: There is one important difference between average velocity and instantaneous velocity: The magnitude of the average velocity and the average speed may not be equal, but the magnitude of instantaneous velocity is always equal to instantaneous speed.

Example

1. An athlete starts his 200 m race on an oval track at A. He completes the first 100 m (marked B) in 11,0 s and eventually finishes the race in a total time of 23,5 s.

1.1 Calculate the average speed of the athlete over the first 100 m of the race.

200/23.5 = 8.51m/s

1.2 Distinguish between instantaneous velocity and average velocity.

Instantaneous velocity is the rate of change of position over a very short time interval, whereas the average velocity is the rate of change in position over the total time taken

1.3 At C and at D the athlete runs at a constant speed of 9,1 m·s−1.

a). What is the magnitude of his instantaneous velocity at C?

9.1 m/s

b) Explain why his instantaneous velocity at C differs from that at D.

The magnitude is 9.1 m/s but the direction differs

1.4 Calculate his average velocity over the last 100 m of the race.

100 / (23.5 – 11) 80 m/s

Baseline assessment

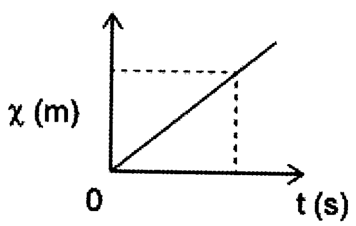
Define the following terms:

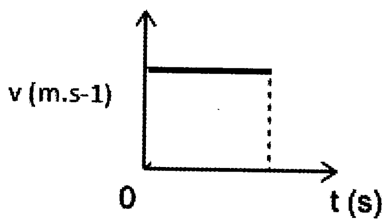
1. Frames of reference
2. Average speed
3. Average velocity
4. Instantaneous speed and
5. Velocity

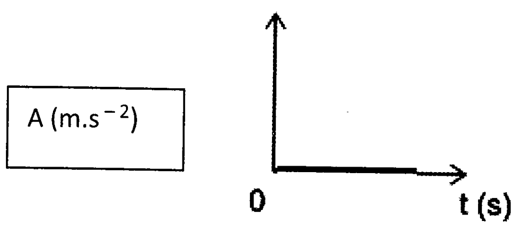
1.Explain, demonstration, Illustrate and answer questions

Uniform Velocity: Motion at constant velocity e.g No acceleration

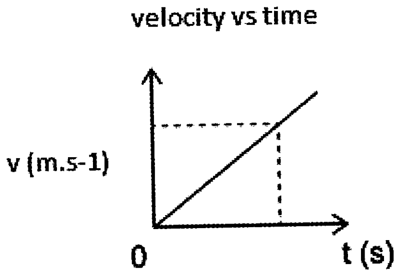
Position vs Time

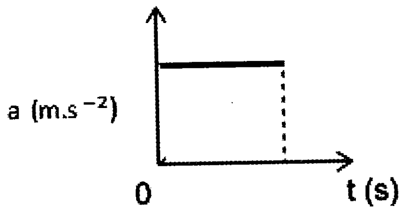


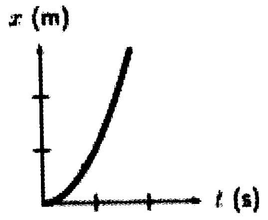




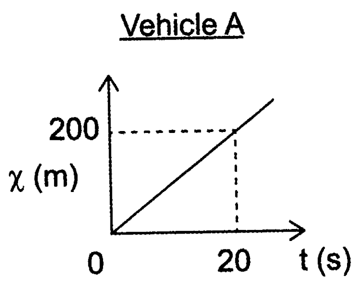
Uniform accelerated Motion: The velocity of an object changes with the same amount during each time interval.







Graphs

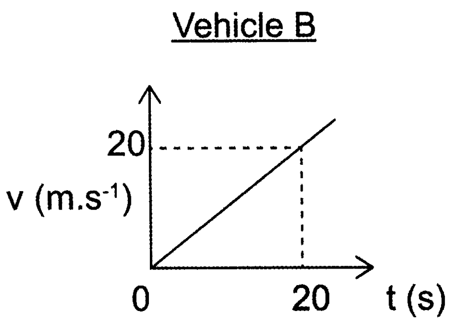


Position Time graph

The gradient of the graph represents velocity

The graphs above represent a vehicle moving at a constant velocity.

Velocity Time Graph



The gradient of the graph represents acceleration

The graph above represents a vehicle moving at constant acceleration

Define

a) Acceleration Is the rate of change in velocity
b) Velocity Is the rate of change in displacement
c) acceleration is a vector.
d) Displacement is a vector

Equations of Motion

$$v_f = v_i + a\Delta t$$

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

$$v_f^2 = v_i^2 + 2a\Delta x$$

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

V_f is the final velocity
V_i is the initial velocity
Δx is the displacement
Δa is the acceleration
Δt is the time taken

Worked examples

A racing car accelerates uniformly from 0 to 100 km.h-1 in 7,5 s.

1. Define the term acceleration.
   Is the rate of change in velocity

2. Convert 100 km.h-1 to m.s-1.
   100000/3600 = 27.77m/s

3. Calculate the magnitude of the car's acceleration.

$v_f = v_i + a\Delta t$

$a = \frac{v_f - v_i}{\Delta t}$

$= \frac{27,78 - 0}{7,5}$

$= 3,70 \text{ m·s}^{-2}$

4. How far does the car travel during this time? Show your calculation.
   $\Delta x = v_i \Delta t + \frac{1}{2} a\Delta t^2$
   $= 0 + \frac{1}{2}(3,7)\times(7,5)^2$
   $= 104,06 \text{ m}$

5. The driver applies the brakes and brings the car to a stop from 100 km.h-1 in 10 s. Calculate the car'saccelerationduringthese10 s.

$a = \frac{v_f - v_i}{\Delta t}$

$= \frac{0 - 27,78}{10}$

$= -2,78 \text{ m·s}^{-2}$

ACTIVITIES

A taxi-driver drives his taxi at 25 m.s-1 in an 80 km.h-1traffic zone. He suddenly notices a traffic officer operating a speed trap in the road 24m ahead of him. He applies brakes and decelerates constantly at 1,8 m.s-2.

1. Calculate the speed of the taxi when it passes the traffic officer.
2. Determine whether the taxi was breaking the speed limit when it passes the traffic officer. Show your calculation.

ACTIVITY

A cyclist accelerates uniformly from rest on a straight, horizontal road at point A and reaches point Y, covering the last 10 m of his ride in 2 s.

1. Calculate the magnitude of his average velocity over the last 2s.
2. What is his instantaneous velocity 1s before reaching point Y?
3. Calculate his constant acceleration over this time, if he reaches a velocity of 9 $m.s^{-1}$ at point Y.

NOTES

a) BASELINE ASSESSMENT

Questions for the baseline assessment

i) List different forms of potential energy

ii) Define potential energy

iii) Which factors affect potential energy of an object

iv) Convert 15 g to kg

v) Convert 15 cm to m

vi) Convert 20 mm to m

<u>New Knowledge</u>

i) Educator define gravitational potential energy

Gravitational potential energy of an object is the energy an object has because of its position in the gravitational field relative to some reference point.

ii) Use the equation to show mathematical representation of gravitational potential energy

$E_p = mgh$

iii) Explain symbols and SI units

E_p gravitational potential energy (measured in joules J)

m mass of the object (measured in Kg)

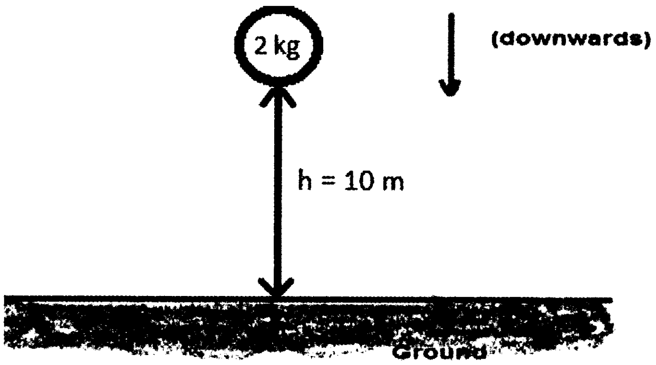
g gravitational acceleration constant near surface of Earth (9.8 $m.s^{-2}$)

h perpendicular height from reference point (measured in m)

iv) Example: Use of equation to calculate quantities.

Example

- A 2 kg ball is dropped 10 m above the ground.



Calculate

a) Gravitational potential energy of the ball 10 m above the ground

b) Height of the ball when its potential energy is 385 J.

BASELINE ASSESSMENT (educator ask learners:

a) Write down the definition of kinetic energy.

b) Convert 120 $km.h^{-1}$ to $m.s^{-1}$

Corrections

a) Kinetic energy is the energy that a body has when it is moving.

b) $\frac{120}{3.6}$ = 33.33 $m.s^{-1}$

New knowledge

i) **Educator define kinetic energy in words**

Define kinetic energy as the energy an object possess as a result of its motion

ii) **Write down equation to calculate kinetic energy**

$E_k = \frac{1}{2}mv^2$

iii) **Explain symbols and SI units**

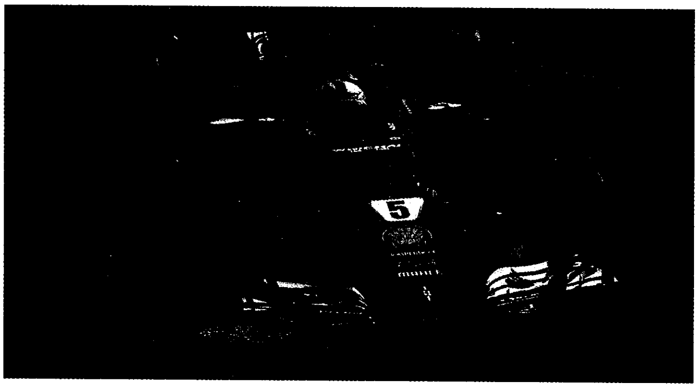
E_k kinetic energy (measured in joules J)

m mass of the object (measured in Kg)

v velocity of an object (measured in $m.s^{-1}$)

Example

A 120 kg racing car in a formula 1 is moving at a velocity of 230 km/h.



a) Calculate the kinetic energy of the car

Solutions

a) $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(120)(63.89)^2$

= 244915.93 J

Example

2.2.1 A 1 kg brick freely falls off a 4 m high roof. It reaches the ground with a velocity of 8.85 m.s^{-1}.

Calculate the kinetic energy of the brick

a) When it starts to fall?

b) when it reaches the ground?

Corrections

a) $E_K = 0$ J

b) $E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(1)(8.85)^2$

$= 39.16$ J

BASELINE ASSESSMENT (educator to design a worksheet/ write questions on the board to gauge the learner's understanding of their relevant prior knowledge.

QUESTIONS for the BASELINE ASSESSMENT

i) Define gravitational potential energy and kinetic energy

ii) What is the sum of kinetic energy and gravitational potential energy called?

a) Do corrections

New knowledge

Define **mechanical energy** as the sum of the gravitational potential and kinetic energy

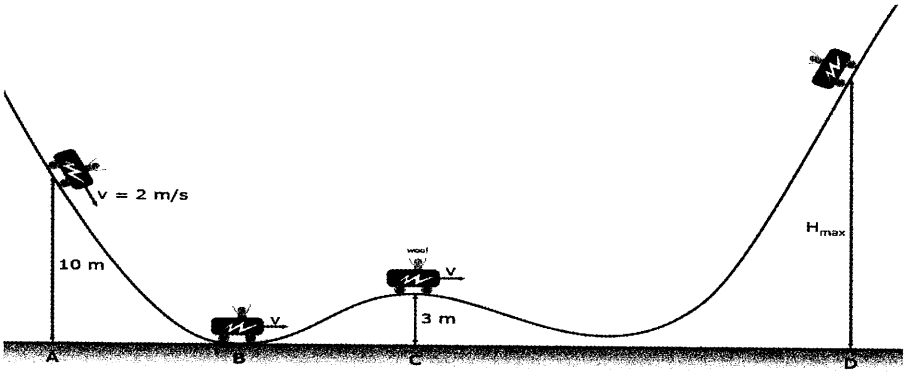
$E_m = E_p + E_k$

The equation can be expanded and written as $E_m = mgh + \frac{1}{2}mv^2$

Mechanical energy is measured in Joules J as gravitational potential energy and kinetic energy

Example

A toy car of mass 35 g moves on a curved toy track from position marked A to D and reaches the maximum height at D where it stops and return back.



Calculate:

a) Mechanical energy when the toy car is in position A

b) The velocity of the toy car in position c if the mechanical energy of the toy car is 1.25J at position c.

c) The maximum height reached by the toy car in position D if the mechanical energy of the toy car is 7.23 J in position D.

Solution

a) $E_m = E_k + E_p$

$= \frac{1}{2}mv^2 + mgh$

$= \frac{1}{2}(0.035)(2)^2 + (0.035)(9.8)(10)$

$= 0.07 + 3.43$

$= 3.50$ J

b) $E_m = E_k + E_p$

$1.25 = \frac{1}{2}mv^2 + mgh$

$1.25 = \frac{1}{2}(0.035)\,v^2 + (0.035)(9.8)(3)$

$1.25 = 0.0175\,v^2 + 1.029$

$v = 3.55\ m.s^{-1}$

c) $E_m = E_k + E_p$

$7.23 = 0 + mgh$

$7.23 = (0.035)(9.8)h$

$h = 21.08\ m$

Teacher teaches learners to state **Law of Conservation of Mechanical Energy** in words

Law of Conservation of Mechanical Energy: In the absence of air resistance, the mechanical energy of an object moving in the earth's gravitational field is constant (Conserved)

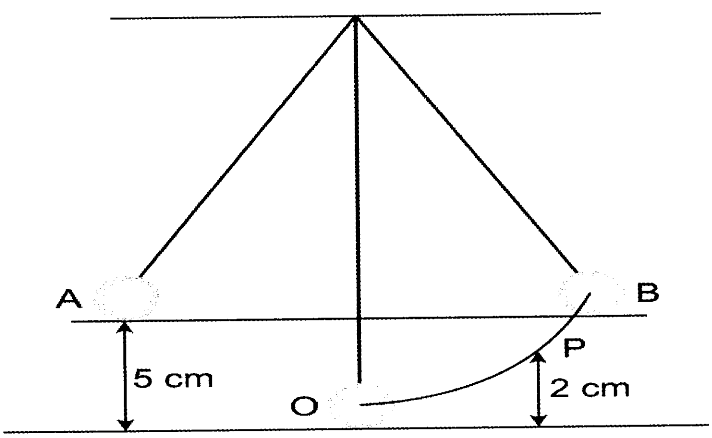
Explain the mathematical representation of **Law of Conservation of Mechanical Energy equation**

$(E_k + E_p)_A = (E_{k\,P} + E_p)_B$

Example

1. A 50 g ball is hanged on an inelastic string hooked from a ceiling. The ball is released from point A move pass point O, P and reaches maximum height at point B, as shown on the diagram below.

   Ignore the effect of air resistance



Calculate the magnitude of the velocity of the ball at point P

$$(E_k + E_p)_A = (E_{k\,P} + E_p)_p$$

$$0 + mgh = \frac{1}{2}mv^2 + mgh$$

$$(0.05)(9.8)(0.05) = \frac{1}{2}(0.05)\,v^2 + (0.05)(9.8)(0.02)$$

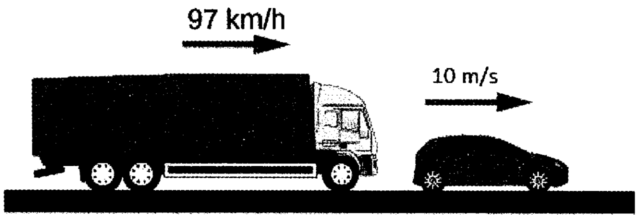
$$0.0245 = 0.025\,v^2 + 0.0098$$

$$V^2 = 0.588$$

$$v = 0.767\ m.s^{-1}$$

ACTIVITIES

A 5000 kg truck moving at 97 km/h speed follows a car with a 22500 J kinetic energy moving a velocity of 10 $m.s^{-1}$



Calculate

a) The kinetic energy of the truck
b) Mass of the car

ACTIVITY

A girl sliding on a playground slide reaches the middle of the slide with 16.80 J kinetic energy and 1.5 $m.s^{-1}$ velocity. She reaches the bottom of a slide with a velocity of 3.7 $m.s^{-1}$.

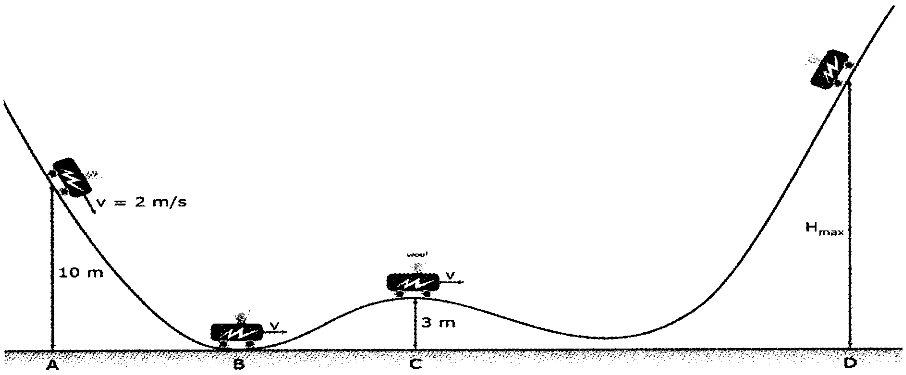
Calculate

a) Mass of the girl
b) Kinetic energy of the girl when she reaches the bottom of the slide

ACTIVITIES

Classwork

A toy car of mass 35 g moves on a curved **frictionless** toy track from position marked A to D and reaches the maximum height at D where it stops and return back.



Calculate

a) Velocity of the toy car in position B
b) Kinetic energy of toy car in position C