



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: PHYSICS (P1)

EXEMPLAR 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 2 data sheets.

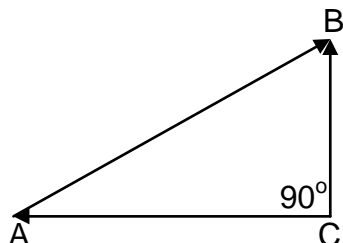
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TWELVE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 Consider the following vector diagram:



The vector which represents the resultant of the other two, is ...

A AB.

B AC.

C CB.

D BA.

(2)

1.2 Two forces of magnitudes 11 N and 5 N respectively, act simultaneously on an object. Which ONE of the following CANNOT be the resultant of the two forces?

A 5 N

B 7 N

C 9 N

D 16 N

(2)

1.3 A ball is dropped onto a concrete floor and bounces off the floor to the same height from which it was dropped. Which ONE of the following laws best explains why the ball experiences an upward force?

A Newton's first law of motion

B Newton's second law of motion

C Newton's third law of motion

D Newton's law of universal gravitation

(2)

- 1.4 A boy stands on a scale in a lift. The scale registers a reading of 588 N when the lift is stationary. The lift now starts moving. At one instant during its motion, the scale registers a reading of 600 N.

Which ONE of the following CORRECTLY describes the motion of the lift at this instant?

The lift is ...

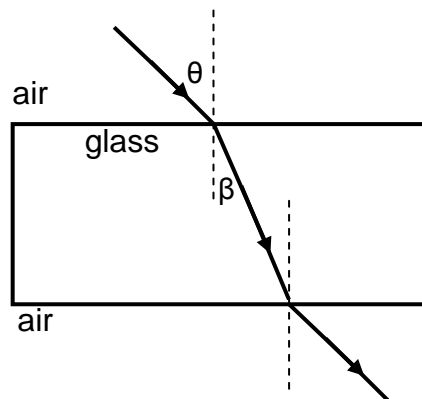
- A accelerating upwards.
- B accelerating downwards.
- C moving upwards at constant velocity.
- D moving downwards at constant velocity. (2)

- 1.5 White light passes through a single slit.

Which ONE of the following CORRECTLY describes the pattern that will be observed on a screen?

- A A broad coloured central band with coloured bands on either side
- B A broad white central band with alternate white and dark bands
- C A broad white central band with coloured bands on either side
- D A broad coloured central band with alternate white and dark bands (2)

- 1.6 A ray of light strikes a glass block at an angle θ , as shown below. The ray passes through the glass block and emerges on the opposite side.



At what angle to the normal does the ray emerge from the glass block?

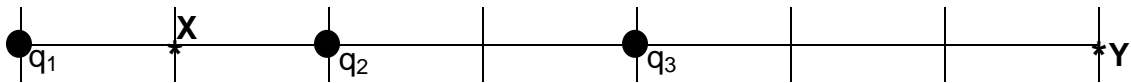
- A β
 - B θ
 - C $90^\circ - \theta$
 - D $90^\circ - \beta$ (2)
- 1.7 Two point charges, q_1 and q_2 , are placed a distance r apart. Point charge q_1 exerts a force of magnitude F on point charge q_2 .

The magnitude of each charge is now doubled and the distance between them is also doubled.

The magnitude of the force that q_1 now exerts on q_2 is ...

- A F .
- B $2F$.
- C $4F$.
- D $8F$. (2)

- 1.8 Three identical point charges, q_1 , q_2 and q_3 , are placed in a straight line, as shown below. Point charge q_2 is placed midway between point charges q_1 and q_3 . **X** and **Y** are two points on the straight line as shown.

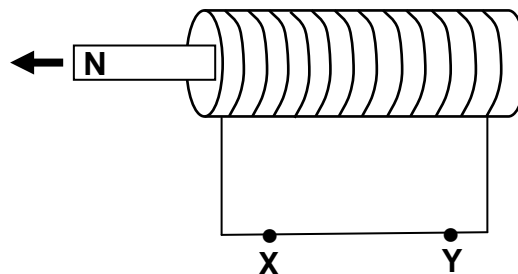


Which ONE of the following best describes how the electric field E at point **X** compares to that at point **Y**?

	DIRECTION OF E	MAGNITUDE OF E
A	Same	$E_X > E_Y$
B	Same	$E_X < E_Y$
C	Opposite	$E_X > E_Y$
D	Opposite	$E_X < E_Y$

(2)

- 1.9 A bar magnet is moved out of a coil, as shown in the diagram below. **X** and **Y** are two points on the conductor.

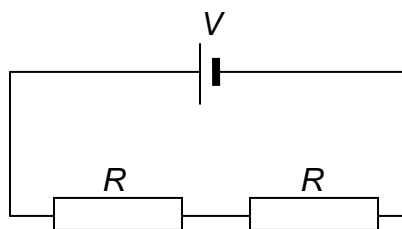


Which ONE of the following CORRECTLY describes the direction of the current and the polarity of the left end of the coil?

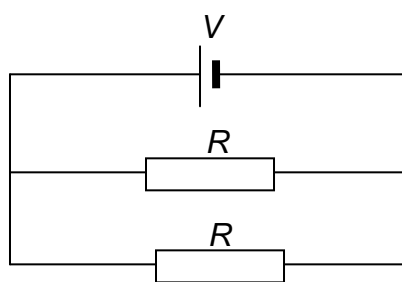
	DIRECTION OF CURRENT	POLARITY OF LEFT END OF COIL
A	X to Y	north
B	X to Y	south
C	Y to X	north
D	Y to X	south

(2)

- 1.10 The two resistors in circuit 1 below are identical. They are connected in series to a cell of emf V and negligible internal resistance. The power dissipated by each resistor is P .

Circuit 1

The two resistors are now connected in parallel, as shown in circuit 2 below.

Circuit 2

The power dissipated by each resistor in the circuit 2 is ...

- A $2P$.
- B $4P$.
- C $8P$.
- D $16P$.

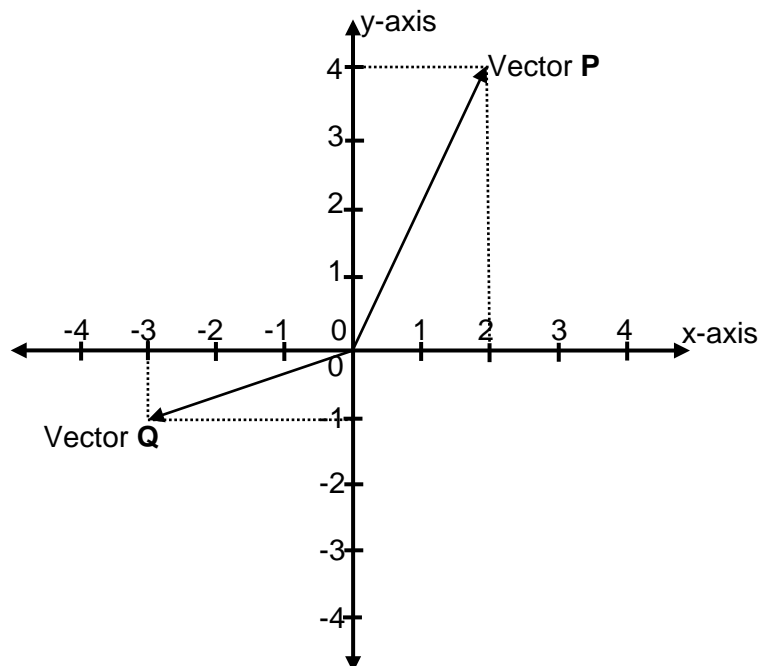
(2)
[20]

QUESTIONS 2–12**INSTRUCTIONS AND INFORMATION**

1. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show ALL formulae and substitutions in ALL calculations.
3. Round off your FINAL numerical answers to a minimum of TWO decimal places.
4. Give brief motivations, discussions, et cetera where required.

QUESTION 2 (Start on a new page.)

Force vectors **P** and **Q** were drawn to scale on the Cartesian plane shown below.

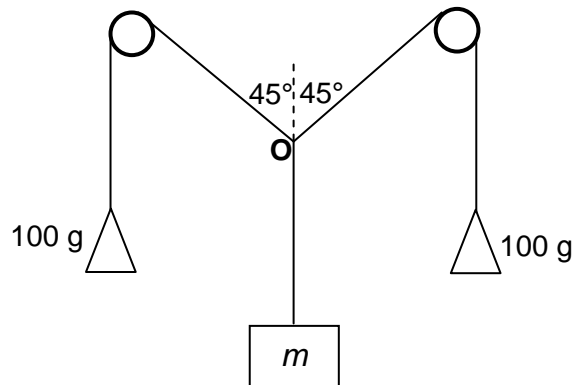


- 2.1 Define the term *resultant of two forces* in words. (2)
 - 2.2 Use a calculation to determine each of the following:
 - 2.2.1 The magnitude of vector **P** in force units (2)
 - 2.2.2 The direction of vector **Q** measured clockwise from the positive y-axis (3)
 - 2.3 Use the component method to calculate the magnitude of the resultant (in force units) of vectors **P** and **Q**. (3)
 - 2.4 Calculate the direction (measured clockwise from the positive y-axis) of the resultant of vectors **P** and **Q**. (2)
- [12]**

QUESTION 3 (Start on a new page.)

In an experiment to determine the unknown mass of an object, two 100 g masses and an object of unknown mass, m , are suspended from three strings, as shown in the diagram (not drawn to scale) below. The strings are light and inextensible. Two of the strings run over frictionless pulleys.

When the three forces acting on knot **O** are in equilibrium, the angles between the two strings and the vertical are 45° each, as shown on the diagram.

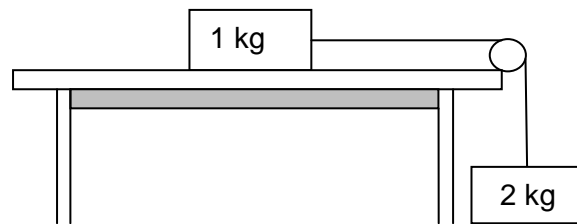


- 3.1 Define the term *equilibrium* as used in this experiment. (1)
- 3.2 Write down the most important experimental error that can occur when conducting this experiment. (1)
- 3.3 Draw a FORCE DIAGRAM showing all the forces acting on knot **O**. Indicate the magnitude of each force on the diagram. (3)
- 3.4 Determine, by ACCURATE CONSTRUCTION AND MEASUREMENT or CALCULATION, the unknown mass m .
Use scale 10 mm : 0,1 N. (7)

[12]

QUESTION 4 (Start on a new page.)

In the diagram below, a 1 kg mass on a rough horizontal surface is joined to a 2 kg mass by a light, inextensible string running over a frictionless pulley. The coefficient of kinetic friction between the 1 kg mass and the surface is 0,13.



- 4.1 State *Newton's second law of motion* in words. (2)
- 4.2 Calculate the magnitude of the:
- 4.2.1 Kinetic frictional force acting on the 1 kg mass (3)
- 4.2.2 Acceleration of the 1 kg mass (5)

The rough horizontal surface is now replaced with a smooth frictionless surface. The 2 kg mass is again released and strikes the ground before the 1 kg mass reaches the end of the horizontal surface.

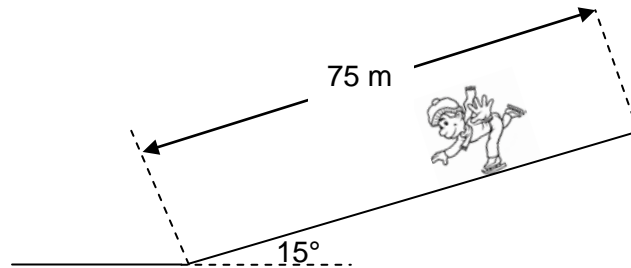
- 4.3 Will the 1 kg mass move at a LOWER, a HIGHER or a ZERO ACCELERATION?

Briefly explain the answer by referring to Newton's laws of motion.

(4)
[14]

QUESTION 5 (Start on a new page.)

A skier of mass 60 kg skies from rest down a slope inclined at an angle of 15° . The length of the incline is 75 m. He reaches the end of the incline at a velocity of $15 \text{ m}\cdot\text{s}^{-1}$. A constant frictional force acts on the skier on his way down.



- 5.1 Write down an expression for the magnitude of the normal force acting on the skier and then calculate its magnitude. (2)
- 5.2 Draw a labelled free-body diagram showing ALL the forces acting on the skier as he skies down the slope. (3)
- 5.3 Calculate the average frictional force acting on the skier during his motion down the incline. (7)
- [12]**

QUESTION 6 (Start on a new page.)

Satellite A with a mass of 615 kg is in orbit around the earth.

- 6.1 State *Newton's law of universal gravitation* in words. (3)
- 6.2 If the earth exerts a force of 5 000 N on satellite A to keep it in orbit, calculate the height, in kilometres, of the satellite above the surface of the earth. (5)
- 6.3 Another satellite of a mass double that of satellite A, orbits at a distance twice that of satellite A from the centre of the earth. Write down the magnitude of the force of attraction of the earth on this satellite. (2)
- [10]**

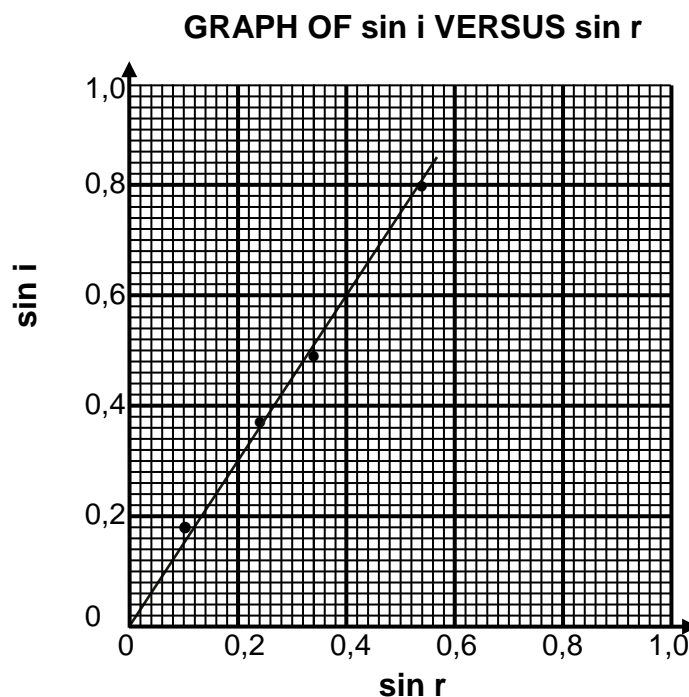
QUESTION 7 (Start on a new page.)

Learners use a rectangular glass block to verify Snell's law in a school laboratory. The six steps followed are given below, but NOT in the correct sequence.

METHOD:

1. Place the rectangular glass block on a sheet of white paper.
2. Shine a single narrow ray of light from a ray box onto one of the long faces of the glass block.
3. Mark the ray incident on the glass block and the ray emerging from it.
4. Draw an outline of the glass block.
5. Vary the angle of incidence so that you can take a number of different pairs of readings.
6. Measure the angle of incidence (i) and the corresponding angle of refraction (r).

- 7.1 State *Snell's law* in words. (2)
- 7.2 Arrange the steps (numbered 1–6) in the correct sequence. (2)
- 7.3 Give a reason why it is necessary to draw the outline of the glass block. (1)
- 7.4 The graph below shows the results obtained during the experiment.

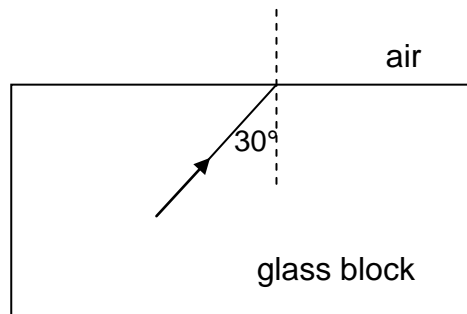


- 7.4.1 Calculate the slope (gradient) of the graph. (4)
- 7.4.2 What does the slope represent? (1)

[10]

QUESTION 8 (Start on a new page.)

A ray of light strikes a glass-air interface, as shown in the diagram below. The refractive index of the glass is 1,44. The ray then travels from the glass block into air.



- 8.1 Calculate the angle of refraction at which the light ray emerges from the glass block. Take the refractive index of air as 1. (4)
- 8.2 Give a reason why the answer to QUESTION 8.1 differs from the angle of incidence on the glass-air interface. (2)
- 8.3 How is the speed of the light ray affected as it moves from the glass block into air? Write down only INCREASES, DECREASES or NO EFFECT. (1)

The angle of incidence of the light at the glass-air interface is now increased to 50°. The critical angle for the glass is 46°.

- 8.4 Define the term *critical angle*. (2)
- 8.5 Name the phenomenon that will now be observed at the glass-air interface. (1)
- 8.6 Name ONE optical instrument that makes use of the phenomenon in QUESTION 8.5. (1)

[11]

QUESTION 9 (Start on a new page.)

The colours seen on a CD when light shines onto it can be explained in terms of diffraction.

- 9.1 Define the term *diffraction*. (2)
- 9.2 Learners investigate how the diffraction pattern observed on a screen changes when the wavelength of light and the slit width are changed.

They conduct two experiments, as described below.

EXPERIMENT 1

The learners keep the slit width constant and use light of different wavelengths.

They first use light of wavelength 430 nm as reference and record the width of the central bright band as 16 cm.

They then use light of wavelength 520 nm.

- 9.2.1 Will the width of the central bright band be GREATER THAN, EQUAL TO or LESS THAN 16 cm? (1)
- 9.2.2 How will the brightness of the pattern on either side of the central bright band compare to that of the central band? Write down only BRIGHTER THAN, DIMMER THAN or EQUAL TO. (1)

EXPERIMENT 2

The learners first use light of wavelength 650 nm and a slit width of 10 μm and record the width of the observed central bright band as 22 cm.

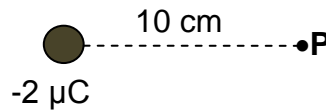
They then reduce the slit width to 8 μm .

- 9.2.3 Will the width of the central bright band be GREATER THAN, EQUAL TO or LESS THAN 22 cm? (1)
- 9.2.4 The phenomenon of diffraction can be explained by Huygens' principle. State this principle. (2)

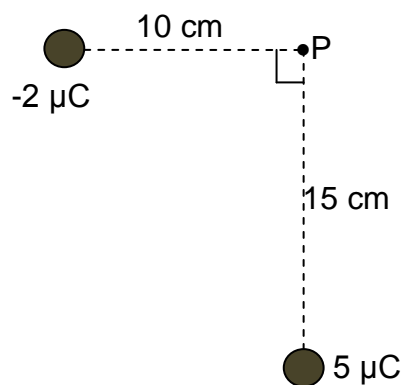
[7]

QUESTION 10 (Start on a new page.)

A negative charge of $2 \mu\text{C}$ is positioned 10 cm from point **P**, as shown below.



- 10.1 Define the *magnitude of the electric field at point P* in words. (2)
- 10.2 Draw the electric field lines associated with this charge. (2)
- 10.3 A positive charge of $5 \mu\text{C}$ is now positioned 15 cm from point **P**, as shown in the diagram below.



Calculate the magnitude of the electric field at point **P** due to both charges. (7)
[11]

QUESTION 11 (Start on a new page.)

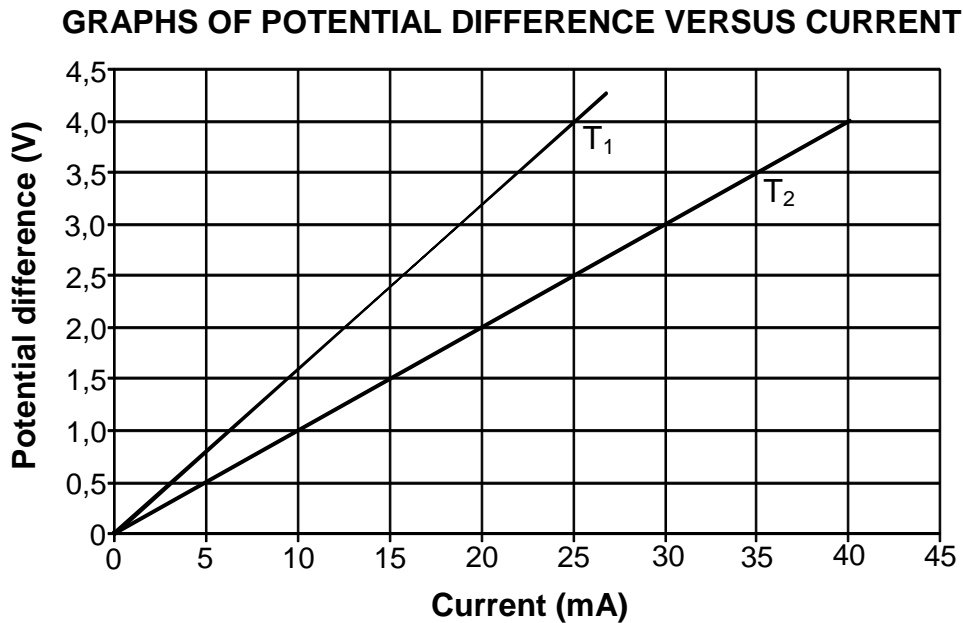
A 200-turn circular coil is placed in a magnetic field such that the field is perpendicular to the surface of each loop of the coil at all times. As the coil rotates, the magnetic field changes at a constant rate from 0,22 T to 0,42 T in $3,2 \times 10^{-2}$ s. The emf induced in the coil during this time is -15,2 V.

- 11.1 State *Faraday's law of electromagnetic induction* in words. (2)
- 11.2 Calculate the:
- 11.2.1 Change in magnetic flux through the circular loop (4)
- 11.2.2 Radius of the coil (4)
- 11.3 The coil now rotates in the opposite direction and the magnetic field changes from 0,42 T to 0,22 T in the same time interval. Write down the induced emf. (1)

[11]

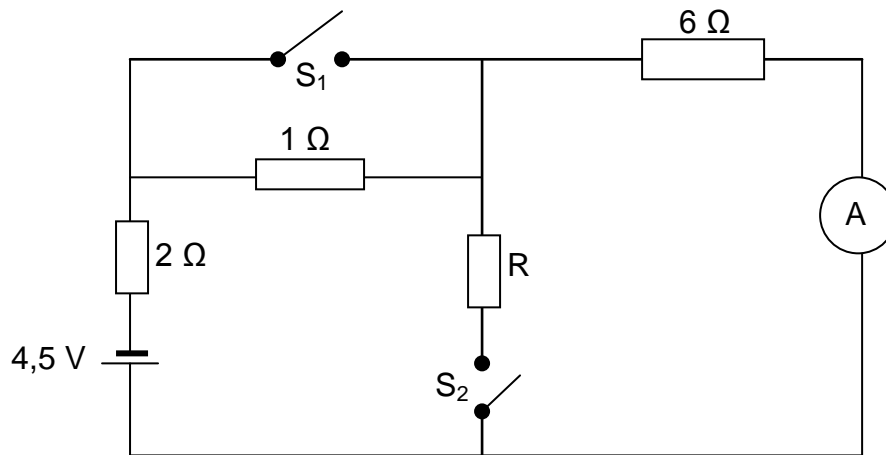
QUESTION 12 (Start on a new page.)

- 12.1 The two graphs below represent the relationship between potential difference and current in a metal wire at two different constant temperatures, T_1 and T_2 .



- 12.1.1 Calculate the resistance of the metal wire at temperature T_1 . (3)
- 12.1.2 Which graph was obtained at the higher temperature?
Give a reason for the answer. (3)
- 12.1.3 The metal wire is an ohmic conductor. Justify this statement by referring to the graphs. (1)
- 12.1.4 Calculate the power dissipated in the metal wire when the current in it is 25 mA at temperature T_2 . (3)

- 12.2 The ammeter in the circuit below shows the same reading regardless whether switches S_1 and S_2 are both open or both closed. (The internal resistance of the cell, as well as the resistances of the ammeter and the connecting wires, are negligible.)



Calculate the:

- 12.2.1 Reading on the ammeter (4)
- 12.2.2 Resistance R (6)

[20]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESTE WETENSAPPE GRAAD 11
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Gravitational constant <i>Swaartekragkonstante</i>	G	6,67 x 10 ⁻¹¹ N·m ² ·kg ⁻²
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 ⁹ N·m ² ·C ⁻²
Speed of light in a vacuum <i>Spoe van lig in 'n vakuum</i>	c	3,0 x 10 ⁸ m·s ⁻¹
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 ⁻¹⁹ C
Electron mass <i>Elektronmassa</i>	m _e	9,11 x 10 ⁻³¹ kg
Radius of earth <i>Radius van aarde</i>	R _E	6,38 x 10 ⁶ m
Mass of earth <i>Massa van aarde</i>	M _E	5,98 x 10 ²⁴ kg

TABLE 2: FORMULAE/TABEL 2: FORMULES

MOTION/BEWEGING

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a \Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$f_{s(\text{max})} = \mu_s N$
$f_k = \mu_k N$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$n_i \sin \theta_i = n_r \sin \theta_r$	$n = \frac{c}{v}$

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$ ($k = 9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$)	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$ ($k = 9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$)	$V = \frac{W}{Q}$

ELECTROMAGNETISM/ELEKTROMAGNETISME

$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$	$\Phi = BA \cos \theta$
--	-------------------------

CURRENT ELECTRICITY/STROOMELEKTRISITEIT

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \dots$	$R = r_1 + r_2 + r_3 + \dots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$