



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 11A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 Vector **P** and vector **–P** are acting on a common point **O**. The angle between the two vectors is ...

- A 0°
- B 90°
- C 180°
- D 270° (2)

- 1.2 The statements below refer to scalars and vectors:

- (i) Vectors can be added together but scalars cannot.
- (ii) A scalar quantity can be associated with direction.
- (iii) A vector quantity is always associated with direction.

Which of the statements above are TRUE?

- A (i) and (ii) only
- B (ii) and (iii) only
- C (i) only
- D (iii) only (2)

- 1.3 A net force, **F**, is applied on an object of mass **m** kg and causes an acceleration of **a** m·s^{–2}. When the net force, **F**, on the same object is doubled, the resulting acceleration, in m·s^{–2}, will be ...

- A **a**
- B $\frac{3}{2}a$
- C **2a**
- D **3a** (2)

- 1.4 A person stands on a bathroom scale in a stationary elevator. The reading on the scale is 490 N. When the elevator is in motion, the reading on the scale changes to 470 N.

Which ONE of the following combinations best describes the DIRECTION OF THE MOTION and the DIRECTION OF THE ACCELERATION of the elevator during the motion?

	DIRECTION OF THE MOTION	DIRECTION OF THE ACCELERATION
A	Upwards	Upwards
B	Downwards	Downwards
C	Upwards	Downwards and then upwards
D	Downwards	Upwards and then downwards

(2)

- 1.5 A light ray is refracted when it travels from air into water. Which ONE of the following combinations relating to the DIRECTION OF THE REFRACTED RAY and the SPEED OF THE LIGHT RAY is CORRECT?

	DIRECTION OF THE REFRACTED RAY	SPEED OF THE LIGHT RAY
A	Towards the normal	Decreases
B	Away from the normal	Decreases
C	Towards the normal	Increases
D	Away from the normal	Increases

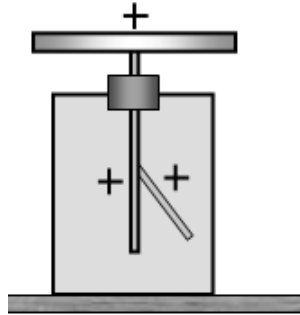
(2)

- 1.6 A learner hiding behind an open door of a room can hear people talking outside the room although he cannot see them. The reason for this is that ...

- A sound has a shorter wavelength than a light wave.
- B sound has a longer wavelength than a light wave.
- C light travels in straight lines while sound travels only around corners.
- D the energy in a sound wave is less than the energy in a light wave.

(2)

- 1.7 The leaves of the electroscope in the diagram below are positively charged.



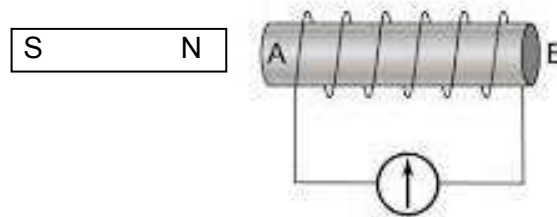
When an object is brought close to the plate, the leaves diverge more. We can therefore conclude that the object ...

- A is positively charged.
- B is negatively charged.
- C is not charged at all.
- D releases positive charges. (2)

- 1.8 Two charged objects repel each other with a force **F** when they are separated by a distance d . The distance between the charges is reduced to $\frac{1}{3}d$. The new force, in terms of **F**, will now be ...

- A **F**
- B **3F**
- C **6F**
- D **9F** (2)

- 1.9 In the diagram below, the north pole of a bar magnet approaches end **A** of a solenoid.



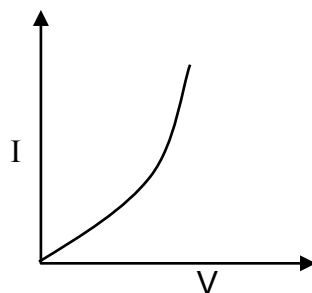
Which ONE of the following statements about the polarity of **A** and the direction of the magnetic field INSIDE the solenoid is CORRECT as the NORTH POLE approaches **A**?

	POLARITY OF A	DIRECTION OF FIELD IN SOLENOID
A	South pole	A to B
B	North pole	B to A
C	North pole	A to B
D	South pole	B to A

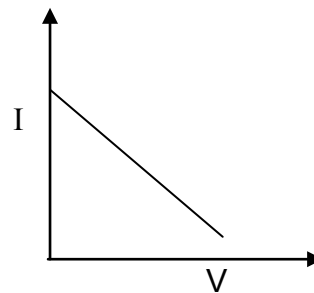
(2)

- 1.10 Which ONE of the following graphs best represents the relationship between current and potential difference for a conductor which obeys Ohm's Law?

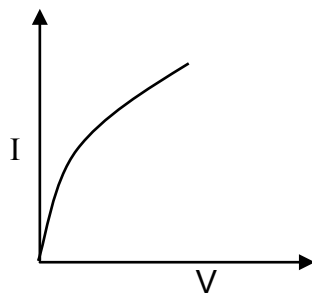
A



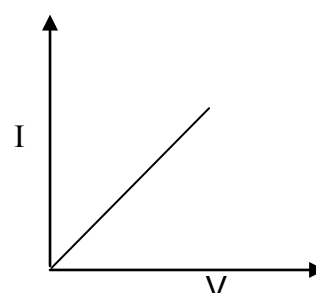
B



C



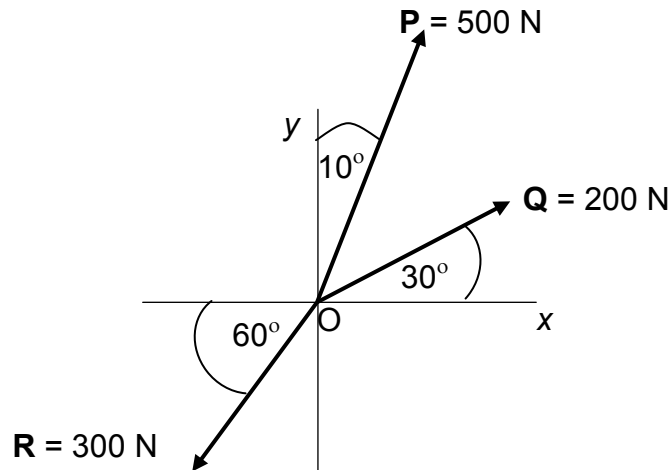
D

(2)
[20]

QUESTION 2 (Start on a new page.)

Three forces, **P**, **Q** and **R**, of magnitudes 500 N, 200 N and 300 N respectively, act on a point **O** in the directions shown in the diagram below.

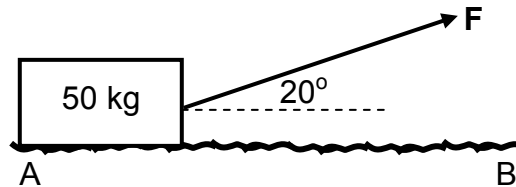
The forces are NOT drawn to scale.



- 2.1 Refer to the information in the diagram above and give a reason why forces **P**, **Q** and **R** are classified as vectors. (2)
- 2.2 Determine the magnitude and direction of the resultant force, either by CALCULATION or by ACCURATE CONSTRUCTION AND MEASUREMENT. (Use scale 10 mm = 50 N.) (8)
- [10]**

QUESTION 3 (Start on a new page.)

A constant force, **F**, pulls a 50 kg block at a constant speed over a rough horizontal surface, **AB**, as shown in the diagram below. The coefficient of kinetic friction (μ_k) between the block and the surface is 0,4.



3.1 Draw a labelled free-body diagram showing ALL the forces acting on the block. (4)

3.2 State Newton's first law of motion in words. (2)

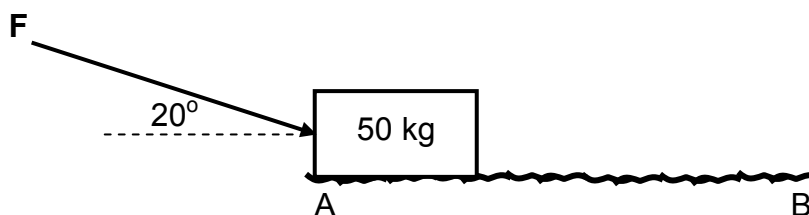
Calculate the magnitude of the:

3.3 Force **F** (6)

3.4 Normal force (2)

3.5 Frictional force (2)

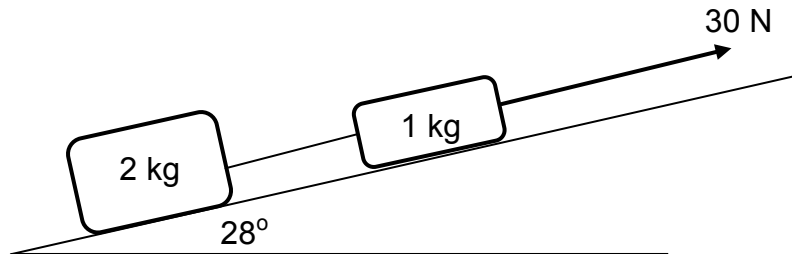
The same constant force, **F**, is now applied to the block over the same rough horizontal surface as before, but in the direction shown below.



3.6 Give a reason why the block will move slower than before. (2)
[18]

QUESTION 4 (Start on a new page.)

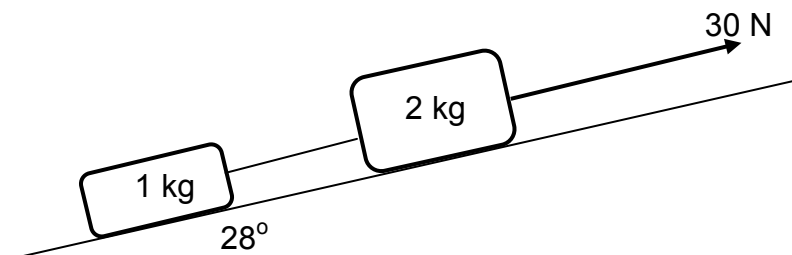
- 4.1 In the diagram below, a 2 kg block is connected to a 1 kg block by means of a light inextensible string. The blocks are pulled up an inclined plane, which forms an angle of 28° to the horizontal. The sides of the blocks which touch the inclined plane have the same area.



The kinetic frictional force between the 1 kg block and the inclined plane is 4 N while the kinetic frictional force between the 2 kg block and the inclined plane is 8 N.

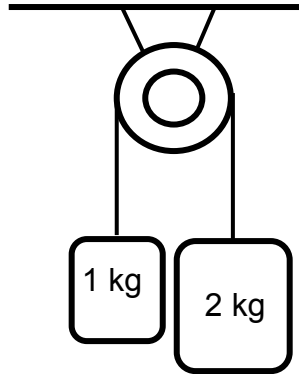
- 4.1.1 Draw a labelled free-body diagram showing ALL the forces acting on the 1 kg block. (5)
- 4.1.2 State Newton's second law of motion in words. (2)
- 4.1.3 Calculate the magnitude of the tension in the string connecting the blocks. (5)

The two blocks are interchanged so that the SAME 30 N force is now acting on the 2 kg block along the inclined plane, as shown in the diagram below.



- 4.1.4 How will the acceleration of the system change? Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)
- 4.1.5 How will the tension in the string connecting the two blocks change? Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)

- 4.2 In the diagram below, a 1 kg mass and a 2 kg mass are connected by an inextensible string of negligible mass. The string is passed over a light frictionless pulley so that the masses hang down as shown. Initially the system is held stationary.



- 4.2.1 Draw a labelled free-body diagram showing ALL the forces acting on the 2 kg mass. (2)
- 4.2.2 Calculate the time it will take the 1 kg mass to move a distance of 1 m when the system is released. (7)
- [23]**

QUESTION 5 (Start on a new page.)

Gravitational force exists between the sun and the Earth.

- 5.1 State Newton's law of Universal Gravitation in words. (2)
- 5.2 The mass of the sun is 330 000 times greater than that of the Earth. The distance between the centres of the sun and the Earth is $1,38 \times 10^9$ m. Calculate the gravitational force that the sun exerts on the Earth. (4)
- 5.3 How will the gravitational force that the Earth exerts on the Sun compare to the answer to QUESTION 5.2? Write only GREATER THAN, LESS THAN OR EQUAL TO. Give a reason for the answer. (2)
- [8]**

QUESTION 6 (Start on a new page.)

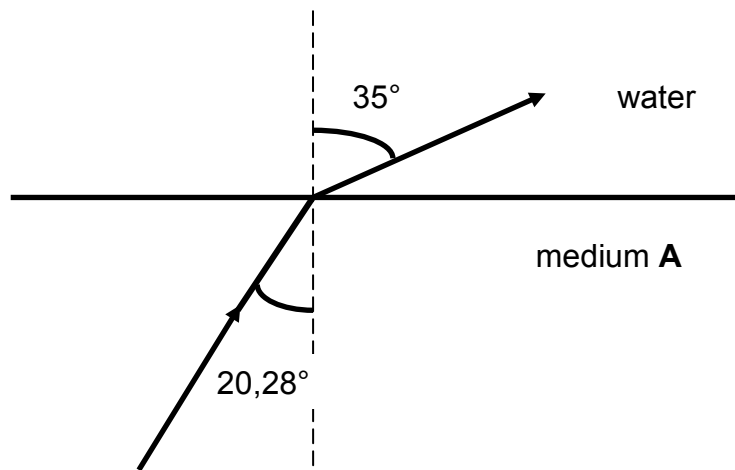
The table below shows accurate values for the refractive indices (relative to air) of some optical media obtained during refraction experiments. The optical densities of the media increase from water to diamond.

MEDIUM	REFRACTIVE INDEX
Water	1,33
Crown glass	1,52
Cubic zirconium	2,20
Diamond	2,42

6.1 What important deduction about the relationship between a medium and its refractive index can be made from the information above? (2)

6.2 Define the term *refraction*. (2)

The diagram below shows a light ray moving from medium **A** into water.



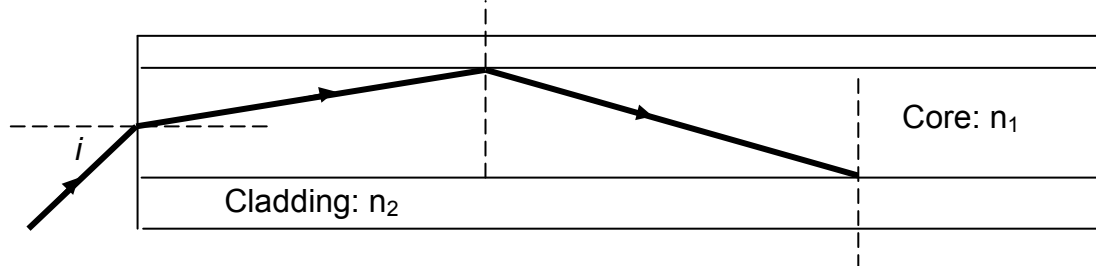
6.3 Provide a suitable calculation to identify medium **A**. (5)

Light travels from water into crown glass.

6.4 Will the refractive index of the crown glass relative to water be GREATER THAN, LESS THAN or EQUAL TO the refractive index of crown glass in the table above? (1)
[10]

QUESTION 7 (Start on a new page.)

The diagram below shows a light ray travelling through an optical fibre. The fibre is made from two different glass materials known as the core glass and the outer cladding glass. These two types of glass materials have different refractive indices.



7.1 State the TWO conditions necessary for total internal reflection to occur. (4)

7.2 Which part of the optical fibre will have a higher refractive index? Write down only CORE or CLADDING. (1)

The refractive index of the core glass is 1,5.

7.3 Calculate the critical angle for the boundary between the two glass materials. (3)

7.4 State TWO advantages of optical fibre cables over copper cables when used in telecommunication. (2)
[10]

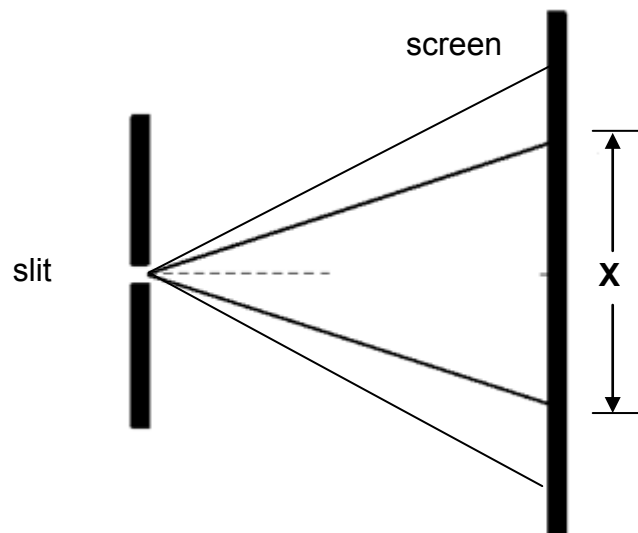
QUESTION 8 (Start on a new page.)

8.1 All types of waves undergo diffraction.

8.1.1 Define the term *diffraction*. (2)

8.1.2 State the condition necessary for diffraction to occur in a single slit. (2)

8.2 Light of wavelength 460 nm passes through a single slit of width 7×10^{-6} m. A diffraction pattern is observed on a screen, as shown in the diagram below.



8.2.1 Describe the pattern observed on the screen. (2)

8.2.2 Describe how each of the following changes will affect the width (broadness) of portion X in the diagram above:

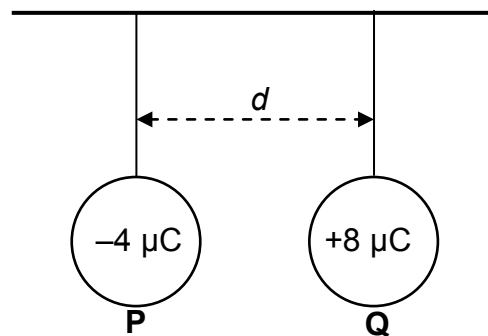
(a) Light of wavelength 470 nm is used while the slit width is kept constant (1)

(b) The slit width is changed to 7×10^{-7} m while the original wavelength is left unchanged (1)

[8]

QUESTION 9 (Start on a new page.)

- 9.1 Two identical metal spheres, **P** and **Q**, separated by a distance d , are suspended from an insulated rigid wooden bar, as shown in the diagram below. The charge on the spheres are $-4\ \mu\text{C}$ and $+8\ \mu\text{C}$ respectively.



- 9.1.1 Sphere **Q** experiences an electrostatic force.

In which direction will sphere **Q** move? Write down only TO THE LEFT or TO THE RIGHT.

(1)

The spheres are now made to touch and are then separated.

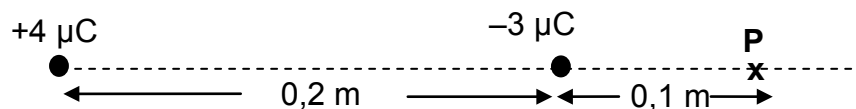
- 9.1.2 Were electrons REMOVED FROM or TRANSFERRED TO **P**? Give a reason for the answer.

(2)

- 9.1.3 Calculate the distance d between the two spheres if the magnitude of the force experienced by **P** is $0,8\ \text{N}$.

(3)

- 9.2 Charges of $+4\ \mu\text{C}$ and $-3\ \mu\text{C}$ are placed a distance $0,2\ \text{m}$ apart on a straight line, as shown below. Point **P** is located $0,1\ \text{m}$ to the right of the $-3\ \mu\text{C}$ charge.



Calculate the:

- 9.2.1 Net electric field at point **P**

(5)

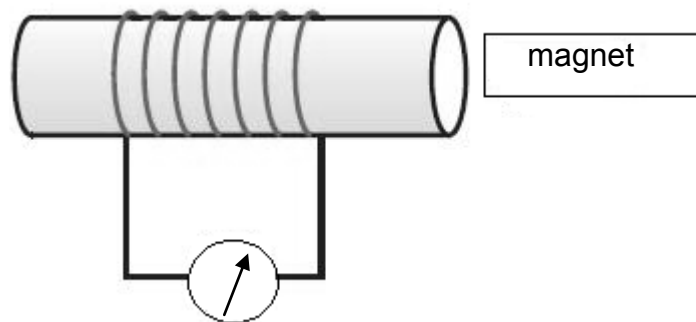
- 9.2.2 Mass of a $+6\ \mu\text{C}$ charge placed at **P** that will experience an acceleration of magnitude $5 \times 10^2\ \text{m}\cdot\text{s}^{-2}$

(3)

[14]

QUESTION 10 (Start on a new page.)

- 10.1 The arrangement of apparatus to demonstrate Faraday's law of electromagnetic induction is shown below.



10.1.1 State Faraday's law of electromagnetic induction in words. (2)

10.1.2 State TWO ways in which the deflection on the galvanometer can be increased. (2)

- 10.2 A coil with area $0,6 \text{ m}^2$ is held with its axis coinciding with the direction of a magnetic field of strength $0,4 \text{ T}$.

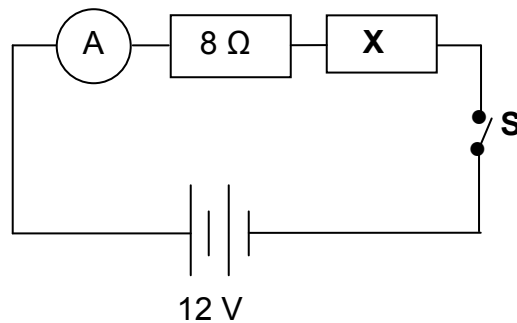
10.2.1 Calculate the magnetic flux linkage. (3)

In order to produce an emf of 9 V , the area of the coil, with its axis coinciding with the direction of a magnetic field, is halved from $0,6 \text{ m}^2$ to $0,3 \text{ m}^2$ in 2 minutes.

10.2.2 Calculate the number of turns in the coil. (4)
[11]

QUESTION 11 (Start on a new page.)

11.1 The circuit below is used to determine the resistance of resistor **X**.

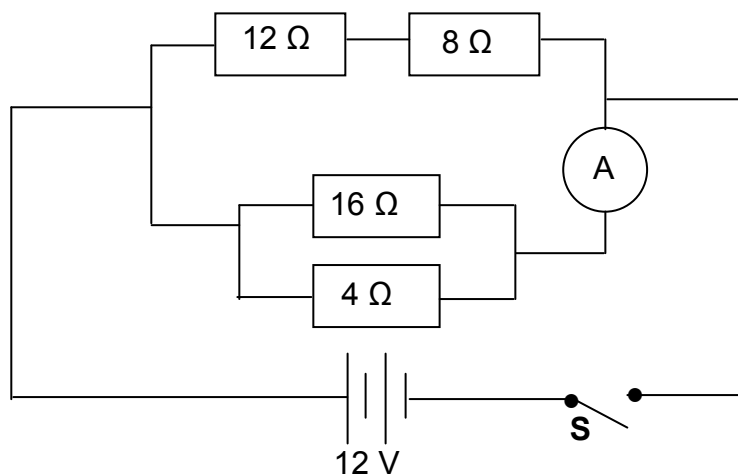


The 12 V battery has negligible internal resistance. When switch **S** is closed, the reading on the ammeter is 0,5 A.

11.1.1 State Ohm's law in words. (2)

11.1.2 Calculate the resistance of resistor **X**. (5)

11.2 Study the circuit below. The battery has an emf of 12 V with negligible internal resistance.



Switch **S** is closed.

11.2.1 Write down the potential difference across the 4 Ω resistor. (1)

11.2.2 Calculate the reading on the ammeter. (5)

11.2.3 Calculate the energy dissipated in the 12 Ω resistor in 2 minutes. (5)
[18]

TOTAL: 150

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

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 11
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE 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
Radius of Earth <i>Straal van Aarde</i>	R _E	6,38 x 10 ⁶ m
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>Spoed 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
Mass of the earth <i>Massa van die Aarde</i>	M	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

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

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

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

ELECTROMAGNETISM/ELEKTROMAGNETISME

$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$	$\Phi = BA \cos \theta$
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ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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