basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages, 2 data sheets and 1 answer sheet.

L 8

GAUTENG

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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 10 questions. Answer ALL the questions in the ANSWER BOOK except QUESTION 10.2, which has to be answered on the attached ANSWER SHEET. The ANSWER SHEET has to be handed in together with 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.

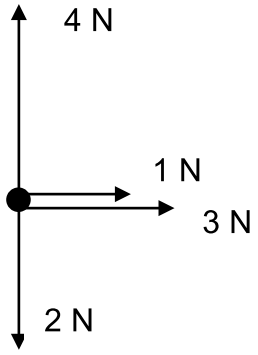
11. Give brief motivations, discussions et cetera where required.

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 Four forces act on a point, as indicated in the diagram.



The magnitudes of the components of the resultant (net) force in the horizontal (F_X) and vertical (F_Y) directions are …

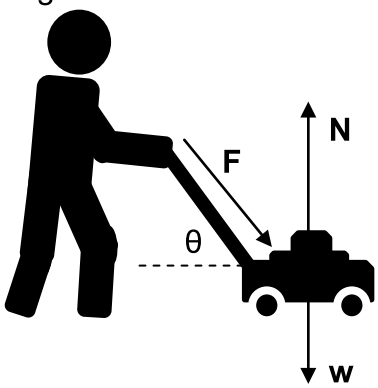
A $F_X = 3$ N and $F_Y = 6$ N.

B $F_X = 1$ N and $F_Y = 4$ N.

C $F_X = 2$ N and $F_Y = 2$ N.

D $F_X = 4$ N and $F_Y = 2$ N. (2)

1.2 A lawnmower is pushed across the ground with a force of **F** at an angle of θ with the horizontal. The weight of the lawnmower is **w**.



The normal force, in **N**, on the lawnmower is …

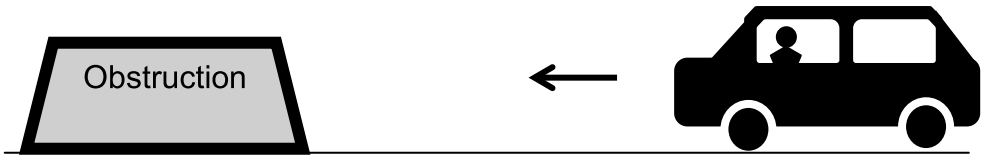
A w

B $w + F_Y$

C $w - F_Y$

D $w + F_X$ (2)

1.3 A car is travelling along a road. The driver has his seat belt on. The driver sees an obstruction in the road ahead and suddenly applies the brakes.



An action-reaction pair is the force of the seat belt on the driver and the force of the …

A driver on the seat.

B wheels on the road.

C driver on the seat belt.

D seat belt on the seat. (2)

1.4 Planet X has a mass twice the mass of the Earth and a radius one and a half times that of the Earth. If the acceleration due to gravity on the Earth is **g**, then the gravitational acceleration on planet X will be …

A $\frac{8}{9}g$

B $\frac{9}{8}g$

C $\frac{4}{3}g$

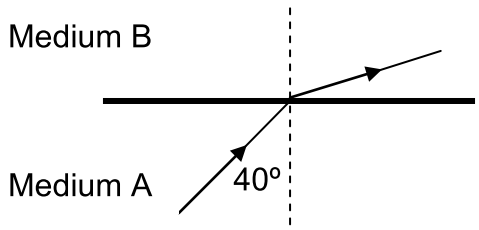
D $\frac{3}{4}g$ (2)

1.5 A light ray travels from medium A to medium B. Medium B has a lower refractive index than medium A.

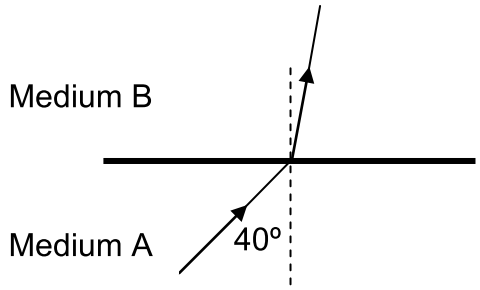
The critical angle for medium A in terms of medium B is 42°.

Which ONE of the sketches below represents the CORRECT path of the light ray?

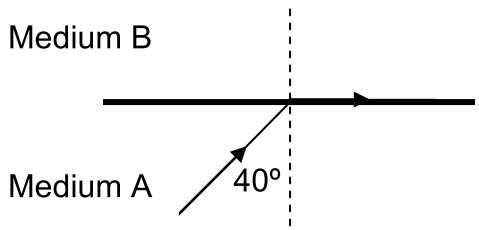
A



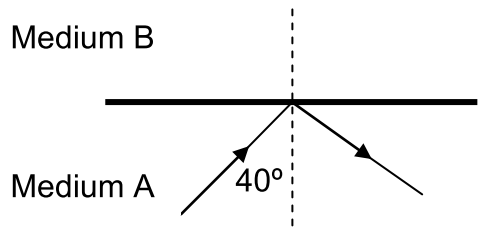
B



C



D



(2)

1.6 The ability of a wave to spread out in wave fronts as the wave passes around a sharp edge, is known as …

A Snell's law.

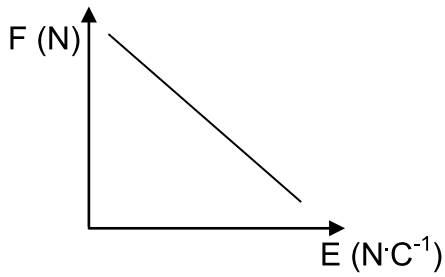
B total internal reflection.

C diffraction.

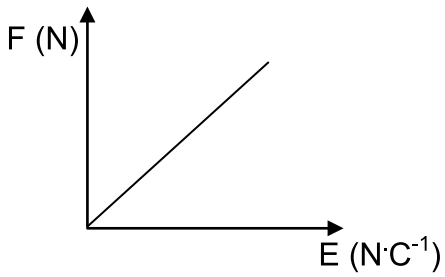
D Huygens' principle. (2)

1.7 Which ONE of the graphs below represents the correct relationship between force **F** on a charge and the electric field **E**?

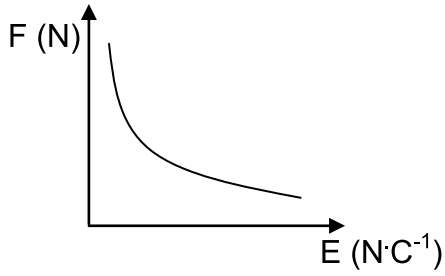
A



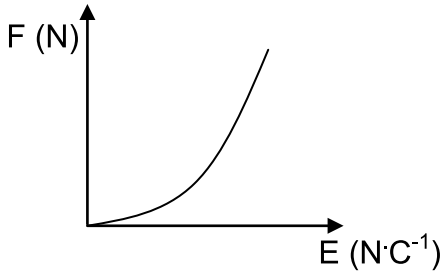
B



C

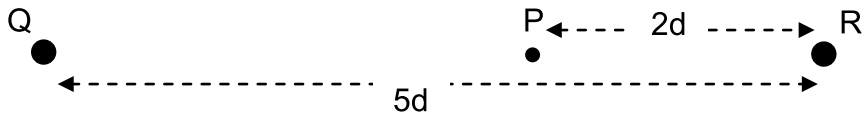


D



(2)

1.8 A negative charge Q is placed at a distance of ***5d*** from another charge R.



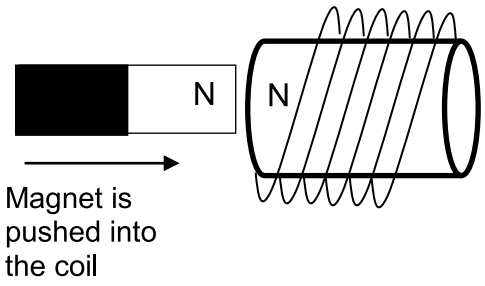
If the net electric field at point P, at a distance of ***2d*** from R, is ZERO, which ONE of the following combinations concerning the ratio of the charges Q and R and the charge on R, is CORRECT?

	RATIO OF THE CHARGES Q : R	**CHARGE ON R**
A	4 : 9	Positive
B	3 : 2	Negative
C	5 : 2	Positive
D	9 : 4	Negative

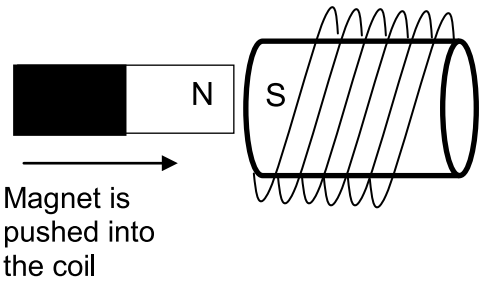
(2)

1.9 In which ONE of the sketches below is the induced polarity of the coil CORRECTLY indicated?

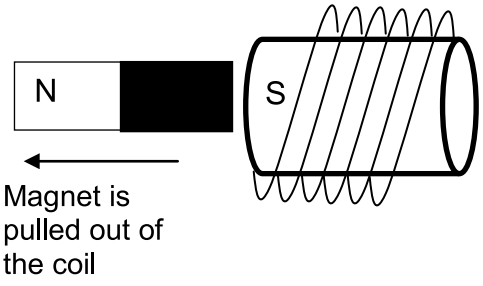
A



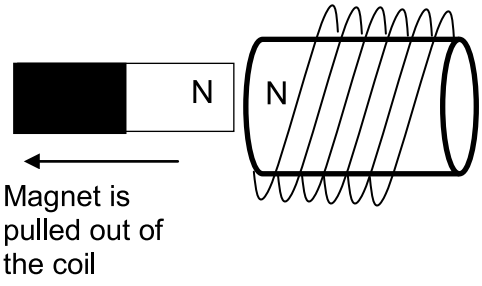
B



C

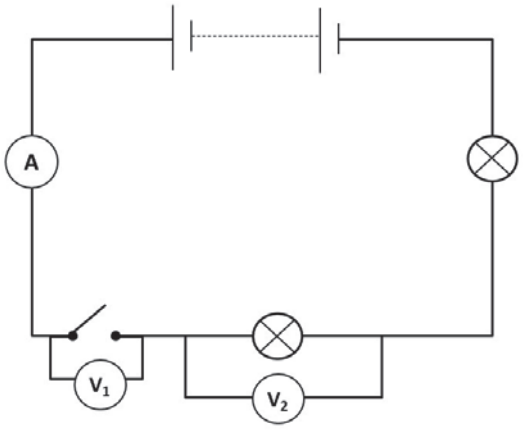


D



(2)

1.10 The potential difference of the battery in the circuit below is 12 V. The internal resistance of the battery is negligible. Two voltmeters, V_1 and V_2, are connected to the circuit, as shown in the diagram.



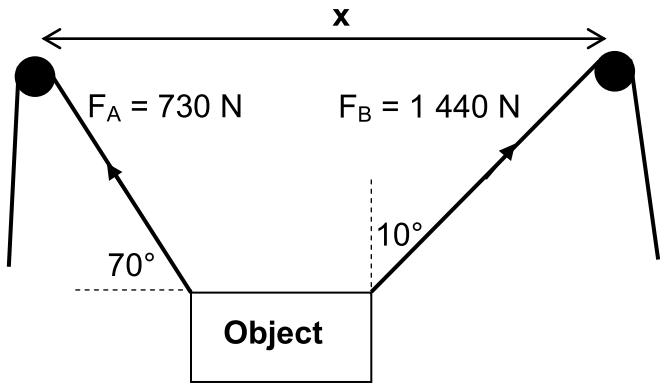
When the switch is open, the correct readings on V_1 and V_2 will be as follows:

	V_1	V_2
A	12 V	12 V
B	0 V	12 V
C	12 V	0 V
D	0 V	0 V

(2)
[20]

QUESTION 2 (Start on a new page.)

A heavy object is lifted using two ropes and two pulleys, as shown in the diagram below. The two pulleys are a distance **x** apart. The force F_A, in rope A, is 730 N and the force F_B, in rope B, is 1 440 N. Rope A makes an angle of 70° with the horizontal and rope B makes an angle of 10° with the vertical.



2.1 Define the term *resultant vector*. (2)

2.2 Explain why the vector diagram of force F_A, force F_B and the weight will NOT be a closed vector diagram. (2)

2.3 Calculate the:

2.3.1 Vertical component of F_A (2)

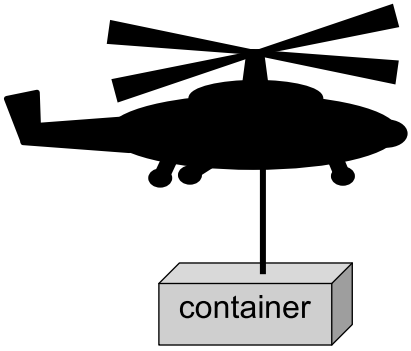
2.3.2 Horizontal component of F_A (2)

2.4 Calculate the maximum weight that force F_A and force F_B will be able to lift from the ground. Show ALL calculations. (4)

2.5 Explain why the rope and pulley system will be less effective if the distance **x** between the pulleys is increased. (2)
[14]

QUESTION 3 (Start on a new page.)

A hovering rescue helicopter has a container of supplies, with a weight of 1 960 N, hanging from a cable. The tension in the cable is 2 100 N.



3.1 State *Newton's First Law of Motion* in words. (2)

3.2 Draw a labelled force-diagram of ALL the forces acting on the container. (3)

3.3 Why does the container remain stationary despite the tension being greater than the weight? (2)

Now the winch inside the helicopter starts to pull the container upwards with an acceleration of 0,13 $m \cdot s^{-2}$, while the helicopter remains in its position.

3.4 Calculate the mass of the container. (2)

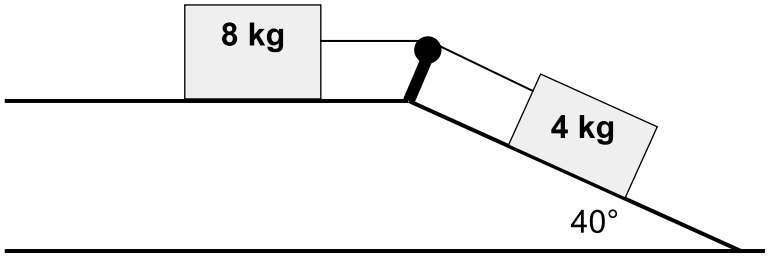
3.5 Calculate the magnitude of the tension in the cable while the container is being pulled upwards. (4)

After an acceleration of a few metres the container is pulled up at a constant velocity of 0,8 $m \cdot s^{-1}$.

3.6 What will be the magnitude of the tension in the cable while the container moves upwards at a constant velocity? (1)
[14]

QUESTION 4 (Start on a new page.)

Two blocks, of mass 8 kg and 4 kg respectively, are joined with an inelastic string of negligible mass. The string runs over a frictionless pulley. The 8 kg block is on a horizontal surface while the 4 kg block is on an inclined plane of 40° with the horizontal. The coefficient of kinetic friction for both blocks is 0,2. The 4 kg block accelerates down the slope.



4.1 State *Newton's Second Law of Motion* in words. (2)

4.2 Draw a labelled free-body diagram of ALL the forces acting on the 4 kg block. (4)

4.3 Calculate the frictional force between the surface and the 4 kg block. (4)

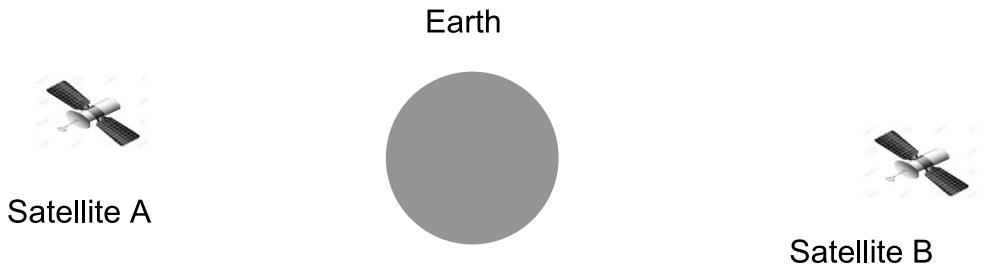
4.4 Calculate the magnitude of the acceleration of the system. (6)

4.5 How will the acceleration compare if the positions of the 8 kg block and 4 kg block are switched? Choose from GREATER THAN, LESS THAN or THE SAME. Explain the answer. (4)

[20]

QUESTION 5 (Start on a new page.)

Two satellites orbiting the Earth are situated on opposite sides of the Earth. Satellite A has a mass of 3 800 kg and Satellite B has a mass of 4 500 kg. Satellite A is at a height of 25 000 km above the surface of the Earth.



5.1 State *Newton's Universal Gravitational Law* in words. (2)

5.2 Explain the term *weightlessness*. (2)

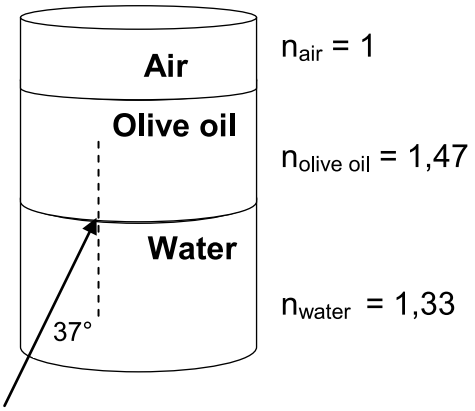
5.3 Calculate the force between the Earth and Satellite A. (4)

5.4 What distance above the surface of the Earth should Satellite B be to experience the *same* force towards the Earth as Satellite A?

Choose from: GREATER THAN, LESS THAN or EQUAL TO the distance above the Earth. Explain how you arrived at the answer. (4)
[12]

QUESTION 6 (Start on a new page.)

Olive oil floats on water because its density is less than the density of water. However, the refractive index of olive oil is 1,47 while the refractive index of water is 1,33.



6.1 Define the term *refractive index.* (2)

6.2 Calculate the speed of light through olive oil. (3)

6.3 If light travels through water and hits the water-olive oil boundary at an angle of 37°, calculate the angle of refraction of the light in olive oil. (4)

6.4 What does the refractive index of oil tell us about the *optical density of olive oil* compared to the *optical density of water*? (2)

6.5 6.5.1 If the light ray exits the oil into the air, will it refract TOWARDS or AWAY from the normal? (1)

6.5.2 Give a reason for the answer to QUESTION 6.5.1. (2)

6.6 6.6.1 At which surface is total internal reflection most likely to occur? Choose from *oil and air* or *water and oil*. (1)

6.6.2 Give a reason for the answer to QUESTION 6.6.1. (2)

6.7 Which other wave characteristic, WAVELENGTH or FREQUENCY, will change together with the speed, when a wave moves from one medium to another? (1)

[18]

QUESTION 7 (Start on a new page.)

Two learners investigate the effect of the slit width on the degree of diffraction. They use a green light with a wavelength 520 nm. They set up an experiment, as shown below, and measure the position of the first dark line from the centre of the bright, central band when changing the slit width.



The following results are obtained:

SLIT WIDTH (mm)	POSITION OF FIRST DARK LINE FROM THE CENTRE (mm)
$5,3 \times 10^{-5}$	19,6
$4,9 \times 10^{-5}$	21,2
$4,2 \times 10^{-5}$	24,8

7.1 State *Huygens' principle* in words. (2)

7.2 For this experiment, write down:

7.2.1 The independent variable (1)

7.2.2 The dependant variable (1)

7.2.3 ONE controlled variable (1)

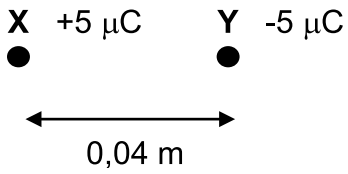
7.3 Give a conclusion for the results obtained in this experiment. (2)

7.4 7.4.1 How will the pattern on the screen change if red light, with a wavelength of 660 nm, is used instead of green light? (2)

7.4.2 Explain the answer to QUESTION 7.4.1. (1)
[10]

QUESTION 8 (Start on a new page.)

Two charged spheres, **X** and **Y**, are placed in a vacuum at a distance of 0,04 m apart.



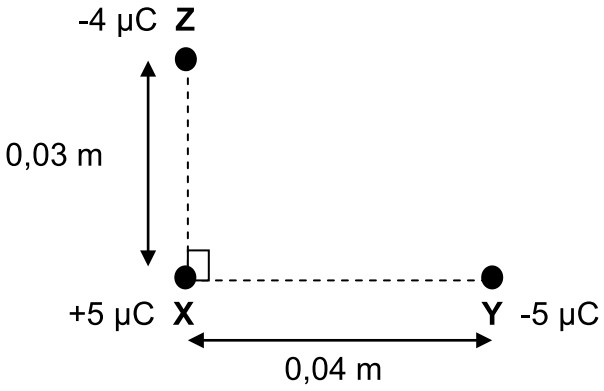
8.1 Draw the resulting electric field pattern between the two charges. (3)

8.2 Calculate the electrostatic force sphere **X** experiences due to the charge on sphere **Y**. (4)

8.3 8.3.1 If sphere **Y** is at a fixed position and sphere **X** is free to move, will the acceleration experienced by sphere **X** towards sphere **Y** be constant? Write down YES or NO. (1)

8.3.2 Explain the answer to QUESTION 8.3.1 by referring to the electric field and the force. (2)

A third sphere, **Z**, with a charge of -4 μC, is placed at right angles to sphere **X** and at a distance of 0,03 m from sphere **X**.

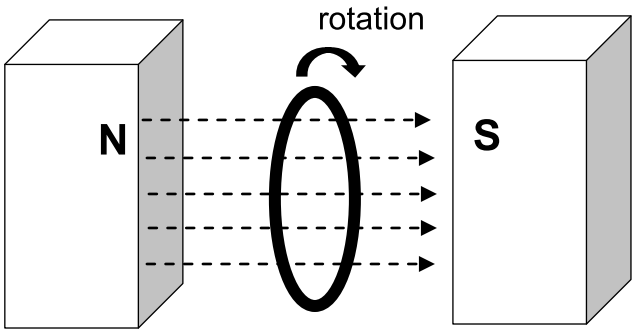


8.4 Calculate the magnitude of the net force on sphere **X** due to sphere **Y** and sphere **Z**. (4)

[14]

QUESTION 9 (Start on a new page.)

A circular coil with 250 windings (turns) and a radius of 0,04 m, is rotated clockwise inside a magnetic field with a field strength of 3,2 T.



9.1 Calculate the magnetic flux through the coil at the position indicated on the diagram, where the coil is perpendicular to the field. (3)

9.2 If the coil rotates clockwise through 25°, and the potential difference induced is 2,8 V, calculate the time in which this rotation took place. (4)

9.3 Which law can be used to explain the phenomenon described in QUESTION 9.2?

Name and state the law. (2)

9.4 9.4.1 If the circular coil is replaced with a square coil with a side length of 0,04 m, and the same movement is made in the same amount of time, will the induced emf be the same as, larger than or smaller than the circular coil?

Write down only THE SAME AS, LARGER THAN or SMALLER THAN. (1)

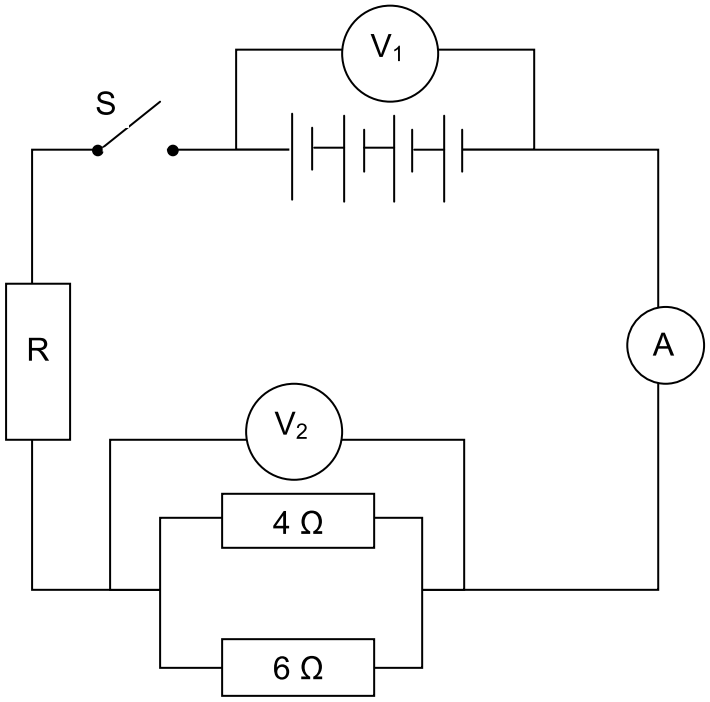
9.4.2 Explain the answer to QUESTION 9.4.1. (2)
[12]

QUESTION 10 (Start on a new page.)

An experiment is done to verify that the potential difference across a conductor is directly proportional to the current in the conductor if the temperature stays constant.

Four cells, each with an emf of 1,5 V, are connected in series with an ammeter, switch S and a combination of a resistor R and resistors of 4 Ω and 6 Ω, as shown in the diagram.

Voltmeters V_1 and V_2 are connected across the battery and the parallel resistors respectively. The internal resistance of the battery and wires are negligible.



10.1 Which law is represented by the underlined phrase above? (1)

The switch is now closed and six resistors (R_1–R_6), each with a different resistance, are placed in the place of R, one at a time. The voltmeter and ammeter readings are recorded. The results are as follows:

RESISTORS AT R	READING ON VOLTMETER V_2 (V)	READING ON AMMETER (A)
R_1	1,2	0,5
R_2	1,4	0,6
R_3	1,9	0,8
R_4	2,4	1
R_5	2,9	1,2
R_6	3,6	1,5

10.2 Use the attached graph paper and draw a graph of potential difference versus current using the data in the table. (4)

10.3 What does the gradient of the graph represent? (1)

10.4 If voltmeter V_2 is only connected across the 4 Ω resistor, how will the gradient of the graph change? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

10.5 If the 4 Ω resistor is removed, how will the gradient of the graph change? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

10.6 Calculate the resistance of resistor R_3 using the values in the table. (5)

10.7 Calculate the energy dissipated in resistor R_4 in 10 seconds. (3)
[16]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 1 (FISIKA)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 m·s^{-2}
Gravitational constant *Swaartekragkonstante*	G	6,67 x 10^{-11} N·m^2·kg^{-2}
Radius of Earth *Straal van Aarde*	R_E	6,38 x 10^6 m
Coulomb's constant *Coulomb se konstante*	K	9,0 x 10^9 N·m^2·C^{-2}
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 m·s^{-1}
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of the earth *Massa van die Aarde*	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*

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

Copyright reserved

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*

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

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

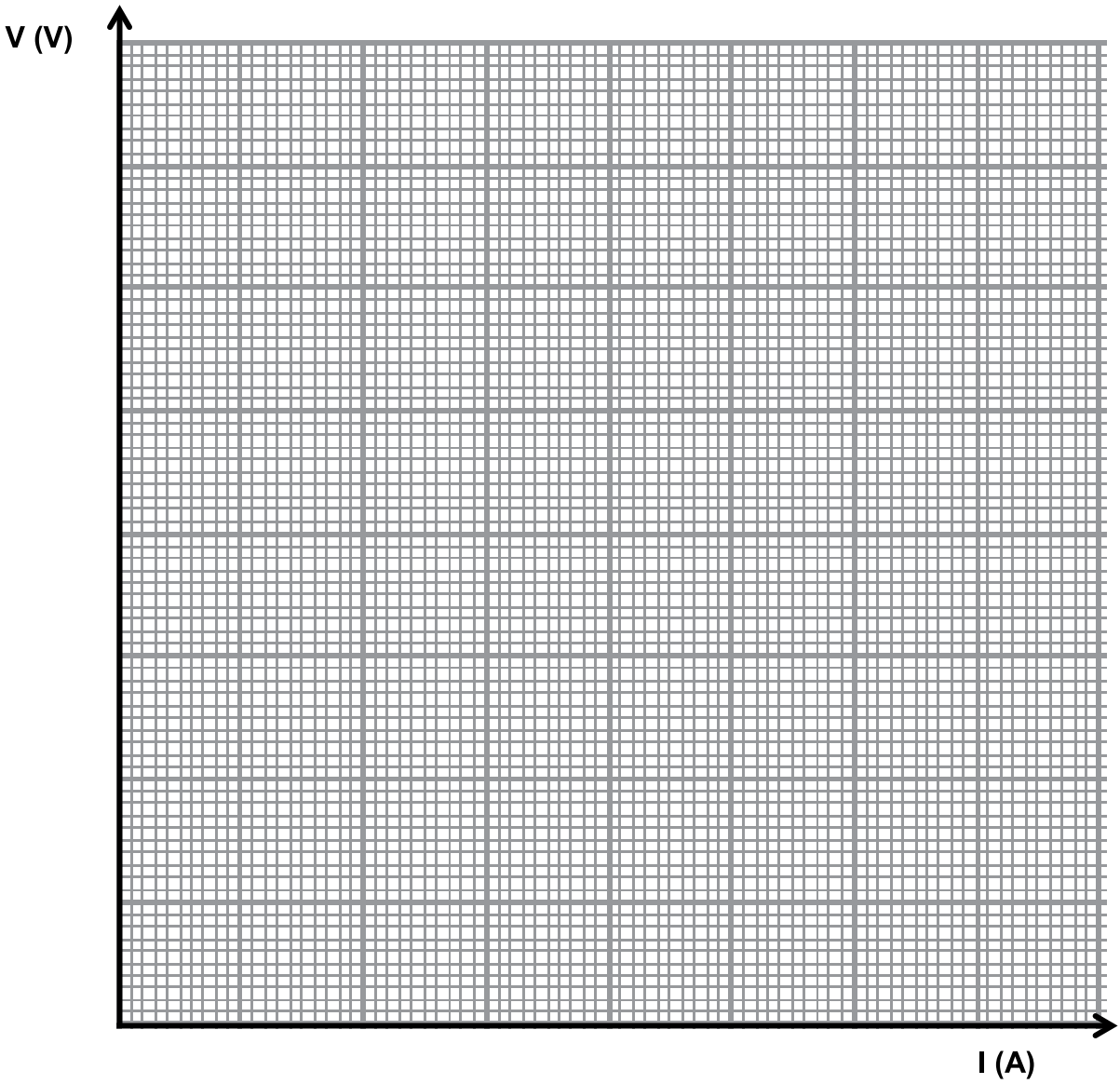
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NAME _____ **CLASS** _____

ANSWER SHEET FOR QUESTION 10.2

HAND IN THIS ANSWER SHEET TOGETHER WITH THE ANSWER BOOK.

Graph of potential difference versus current



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