GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12

2024

PHYSICAL SCIENCES (PHYSICS)

(PAPER 1)

TIME: 3 hours

MARKS: 150

15 pages + 2 data sheets

PHYSICAL SCIENCES P1

C2841E

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 9 questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line open between two subsections, e.g. between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. 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. Choose the answer and write only the letter (A – D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Two forces, F_1 and F_2, are applied on a box lying on a frictionless surface as shown below. The magnitude of F_1 is greater than the magnitude of F_2.



The box will …

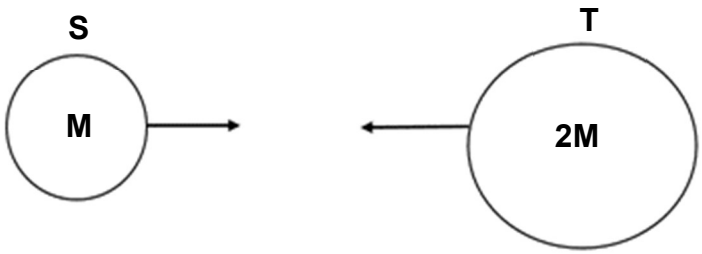
A accelerate towards the left.
B accelerate towards the right.
C move at a constant speed towards the right.
D move at a constant speed towards the left. (2)

1.2 A 5 kg iron shot putt and a 10 kg aluminium shot putt, with the same diameter, fall freely from a shelf that is 12 m above the ground. Ignore the effects of air friction.

When the shot putts are 3 m above the ground, they have the same …

A momentum.
B acceleration.
C potential energy.
D kinetic energy. (2)

1.3 Two asteroids, **S** and **T**, having masses of **M** and **2M** respectively, are on course for a collision.



If the magnitude of the acceleration on asteroid **S** is **a**, then the magnitude of the acceleration on asteroid **T** is:

A ¼ a
B ½ a
C a
D 2a (2)

1.4 A sound source approaches a stationary observer at a CONSTANT VELOCITY. Which of the following describes the observed wavelength and frequency from the sound source as it approaches?

	OBSERVED WAVELENGTH	OBSERVED FREQUENCY
A	Greater than	Greater than
B	Less than	Less than
C	Greater than	Less than
D	Less than	Greater than

(2)

1.5 Two objects, $\mathbf{m_1}$ and $\mathbf{m_2}$ a distance **r** apart, experience a gravitational force **F**. The mass $\mathbf{m_1}$ is now doubled and the distance is halved. The gravitational force between $\mathbf{m_1}$ and $\mathbf{m_2}$ is now:

A $\frac{1}{8}$ F

B $\frac{1}{2}$ F

C F

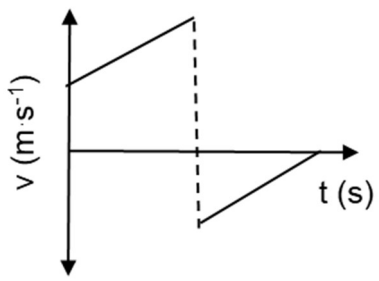
D 8F

(2)

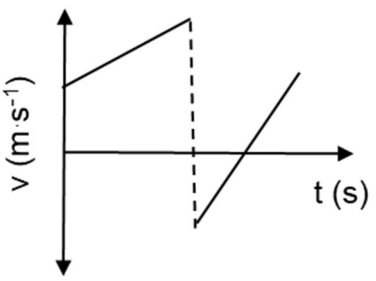
1.6 An object is thrown vertically downwards towards the ground from height **h**, with a velocity **v**. The object strikes the ground and bounces upwards. It is caught when it reaches its maximum height after the bounce.

Which of the following graphs for velocity versus time best represents the motion of the object?

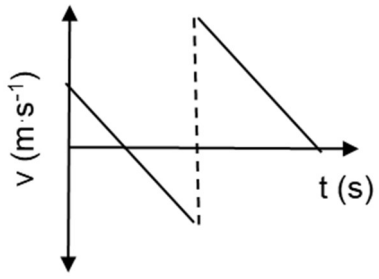
A



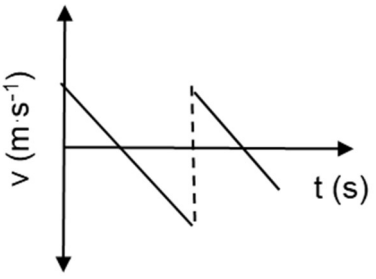
B



C



D



(2)

1.7 A crate is pulled up a slope.

Which of the forces will do zero work on the object?

A Pulling force
B Normal force
C Frictional force
D Gravitational force (2)

1.8 Three identical spheres **X, Y** and **Z**, are placed together in a triangular arrangement so that each sphere touches the other. The three spheres are then moved back to their original positions.

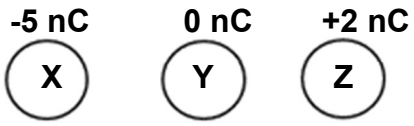


diagram 1

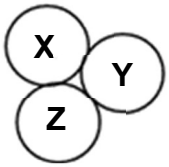


diagram 2

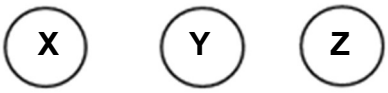


diagram 3

What is the charge on each sphere now? (diagram 3)

A -1 nC
B +1 nC
C -2 nC
D -3 nC (2)

1.9 A positively charged object has …

A fewer electrons than neutrons.
B fewer protons than neutrons.
C fewer electrons than protons.
D more protons than neutrons. (2)

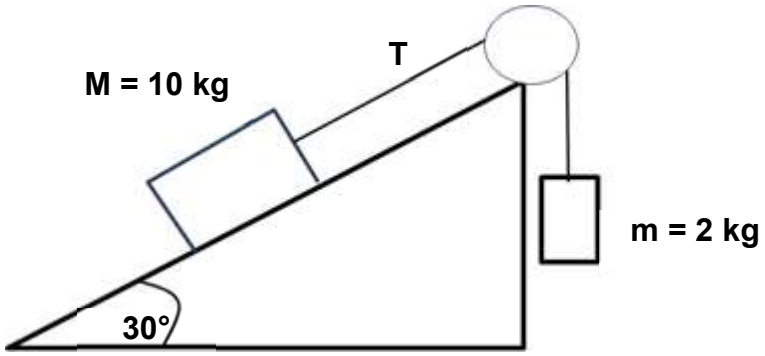
1.10 The minimum resistance that can be acquired from the connection of two 4 Ω resistors is …

A 1 Ω
B 2 Ω
C 3 Ω
D 8 Ω (2)

[20]

QUESTION 2 (Start on a new page.)

Block **M**, 10 kg, is connected to block **m**, 2 kg, with a rope, **T**, of negligible mass, over a frictionless pulley. Both blocks are at rest. The slope makes an angle of 30° with the horizontal. Friction on the slope cannot be ignored.

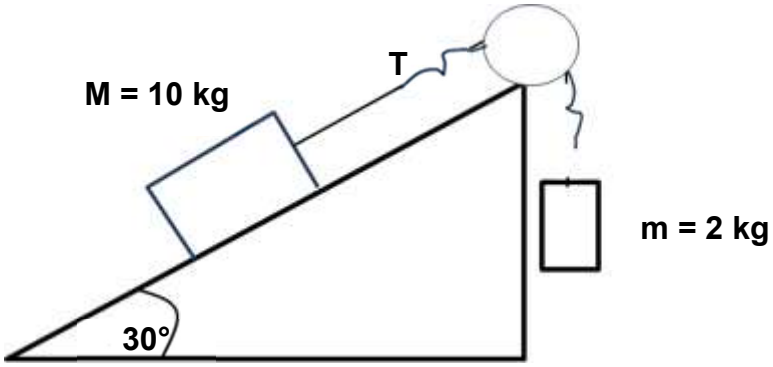


2.1 Define the term *normal force*. (2)

2.2 Draw a labelled, free-body diagram of all the forces acting on the 2 kg mass. (2)

2.3 Calculate the frictional force needed to keep the blocks at rest. (5)

2.4 The rope snaps above mass **m**, causing block **M** to slide down the slope, and block **m** to fall to the ground. The kinetic frictional force between the block and the slope is 25 N. Ignore the mass of the rope **T**.



2.4.1 Draw a free-body diagram of all the forces acting on mass **M**. (3)

2.4.2 Calculate the magnitude of the acceleration of mass **M**. (4)

2.5 Block **m** takes 0,5 s to reach the ground.

2.5.1 Calculate the final velocity of block **m**. (3)

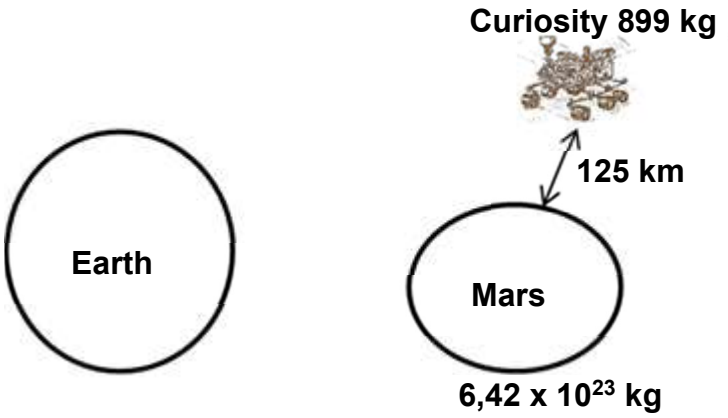
2.5.2 How would the final velocity of **m** be affected if the mass was doubled and it is dropped from the same height? Write only INCREASE, DECREASE or REMAIN THE SAME.

Explain the answer. (3)

[22]

QUESTION 3 (Start on a new page.)

The Curiosity rover was dropped from 125 km above the surface of Mars. The mass of the Curiosity rover is 899 kg and the mass of Mars is 6,42 x 10^{23} kg. The radius of Mars is 53,25% that of Earth.



3.1 State Newton's Law of Universal Gravitation in words. (2)

3.2 Calculate the weight of the Curiosity on Earth. (2)

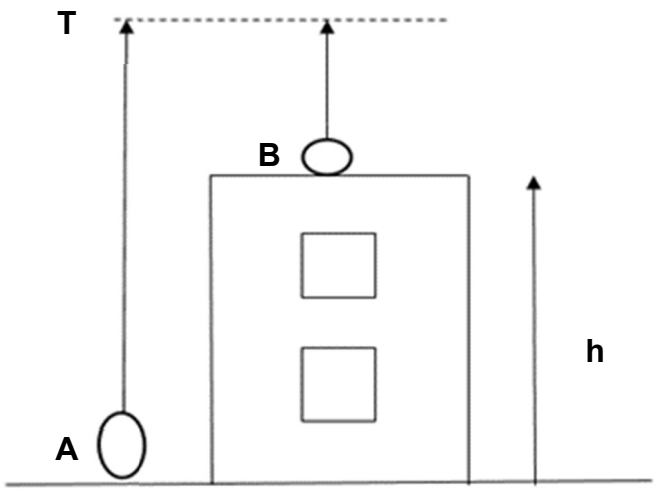
3.3 Calculate the gravitational acceleration on Mars. (4)

3.4 Would the mass of the Curiosity be different on Mars than on Earth? Choose from YES or NO.

Give a reason for the answer. (2)
[10]

QUESTION 4 (Start on a new page.)

A learner standing at the bottom of a building, throws ball **A** vertically upwards at a speed of 11 $m \cdot s^{-1}$ and ball **A** reaches a maximum height **T**. After 0,72 s, another learner standing on the roof of the building throws ball **B** upwards. The two balls reach point **T** at the same time, as shown in the diagram below.



4.1 What is the difference between *free fall* and *projectile motion*? (2)

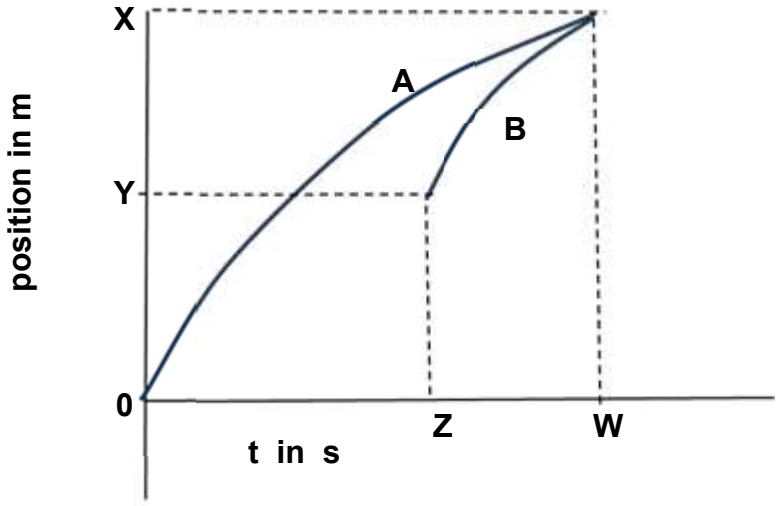
4.2 Calculate the:

4.2.1 Time taken by ball **A** to reach the maximum height at **T** (3)

4.2.2 Initial velocity of ball **B** (4)

4.2.3 Height, **h**, of the building (6)

4.3 The following position-time graph is given for the motion of the two balls, **A** and **B**, as described above. Study the graphs and answer the questions below.



Write down the value and unit for:

4.3.1 **X** (1)

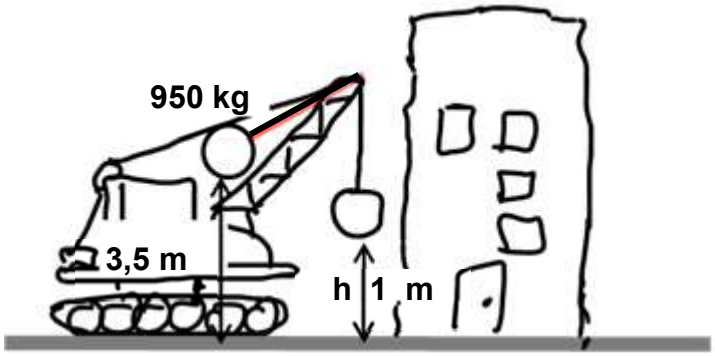
4.3.2 **Y** (1)

4.3.3 **Z** (1)

4.3.4 **W** (1)
[19]

QUESTION 5 (Start on a new page.)

5.1 A wrecking ball is used to demolish an old building by smashing into it. The wrecking ball has a mass of 950 kg and is suspended in the air with a second rope, 3,5 m above the ground. The ball is then released to smash into the building. At the lowest point of swing, the ball is at a height of **h** (1 m) above the ground. Ignore air friction.



5.1.1 State the law of *conservation of mechanical energy*. (2)

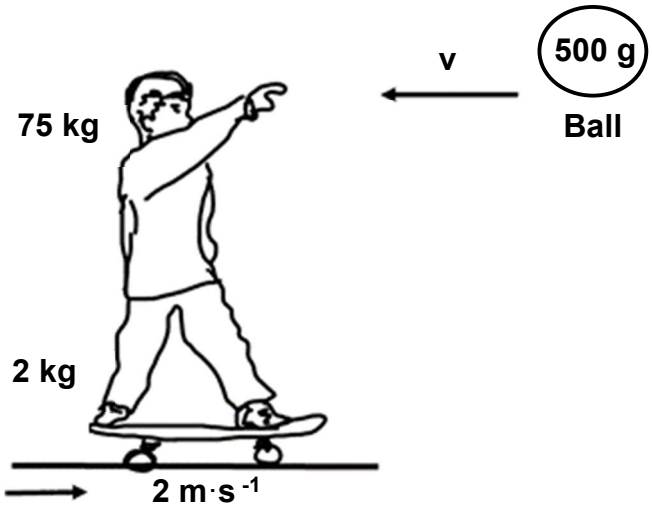
5.1.2 The ball swings and hits the building at height **h**. Calculate the speed at which the ball hits the building using only energy principles. (4)

5.1.3 The ball hits the wall. It takes 0,1 s to stop, and then rebounds. Calculate the magnitude of the force with which the ball hits the wall. (3)

5.1.4 Write down the force that the wall exerts on the ball.

Name and state the law in physics that is used to arrive at this conclusion. (3)

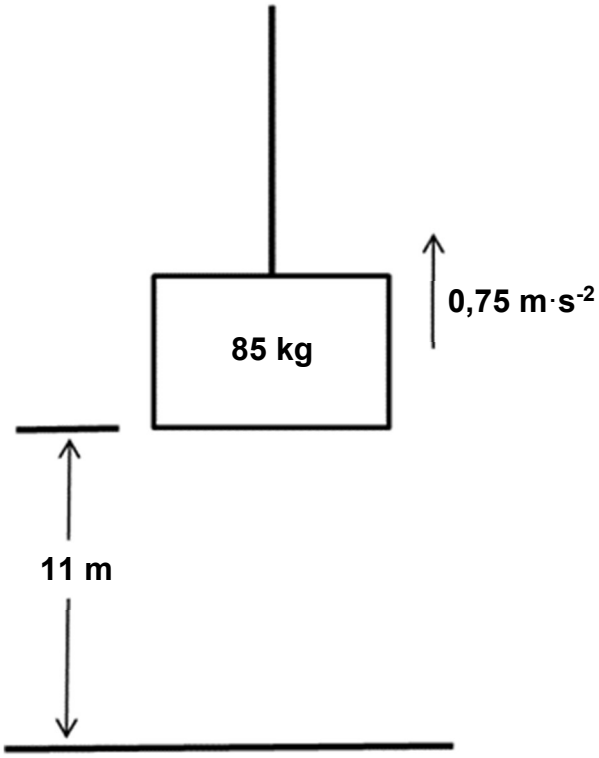
5.2 A Grade 12 learner, with a mass of 75 kg, is on a skateboard with a mass of 2 kg, which is moving at a constant velocity of 2 $m \cdot s^{-1}$ east over a frictionless surface. A ball, mass 500 g, moving at a speed of **v** $m \cdot s^{-1}$ west, is thrown at the learner. The learner catches the ball. The final kinetic energy after this collision is 146 J.



Calculate the initial speed of the ball. (5)
[17]

QUESTION 6 (Start on a new page.)

An object with a mass of 85 kg is initially at rest on the ground. It is then pulled vertically upwards at a constant acceleration of 0,75 $m \cdot s^{-2}$ by means of a light, inextensible rope, as shown in the diagram below. Ignore air resistance, the mass of the rope or any rotational effects.



6.1 Draw a labelled, free-body diagram for the mass while it moves upward. (2)

6.2 Name the non-conservative force acting on the mass. (1)

6.3 Calculate the work done on the mass by the gravitational force when the mass has reached a height of 11 m. (3)

6.4 State the *work-energy theorem* in words. (2)

6.5 Use the work-energy theorem to calculate the speed of the mass when it is at a height of 11 m. (5)

6.6 A 30 kW motor is used to lift the mass of 85 kg to this height of 11 m. Calculate the percentage efficiency of this motor if it is working at maximum power. (6)

[19]

QUESTION 7 (Start on a new page.)

7.1 The siren of a rescue vehicle emits waves at a frequency of 360 Hz. The frequency of the sound as heard by a listener standing along the road is 405 Hz.

7.1.1 Define the *Doppler effect*. (2)

7.1.2 Was the rescue vehicle moving TOWARDS or AWAY FROM the listener?
Explain the answer, making specific reference to *frequency*, *wave fronts* and *wavelength*. (4)

7.1.3 Take the speed of sound in air to be 340 $m \cdot s^{-1}$. Calculate the speed at which the rescue vehicle was moving. (4)

7.2 The driver of the rescue vehicle continues at this speed past the stationary listener. What change(s), if any, would occur in the following?

Write down the values of:

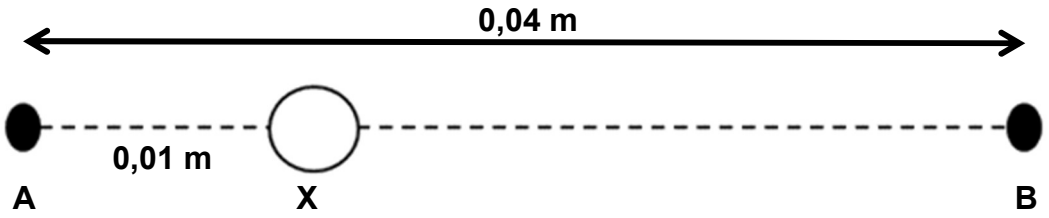
7.2.1 The frequency of the siren as heard by the driver (1)

7.2.2 The frequency observed by the listener (1)

7.2.3 The speed of sound in the air (1)
[13]

QUESTION 8 (Start on a new page.)

Point **A** and point **B** are 0,04 m apart, as shown below. (The sketch is not drawn to scale.) Sphere **X** lies 0,01 m from point **A**. Sphere **X** has 1 238 electrons removed from the surface.



8.1 What is the nature of the charge on sphere **X**? Choose either POSITIVE or NEGATIVE. (1)

8.2 Calculate the magnitude of the charge on sphere **X**. (3)

8.3 Define the term *electric field*. (2)

8.4 Draw the net electric field pattern for two identical spheres with opposite charge. (3)

8.5 At what point, **A** or **B**, is the magnitude of the electric field, due to the charged sphere **X**, greater? Explain the answer. (3)

8.6 Calculate the electric field of sphere **X** at point **B** if sphere **X** is replaced with a charge of -2×10^{-9} C. (3)

8.7 A negative point charge **Y** with a charge of -2,8 nC is NOW placed at point **B**, and a point charge **Z** with a charge of +3,2 nC is placed at point **A**.

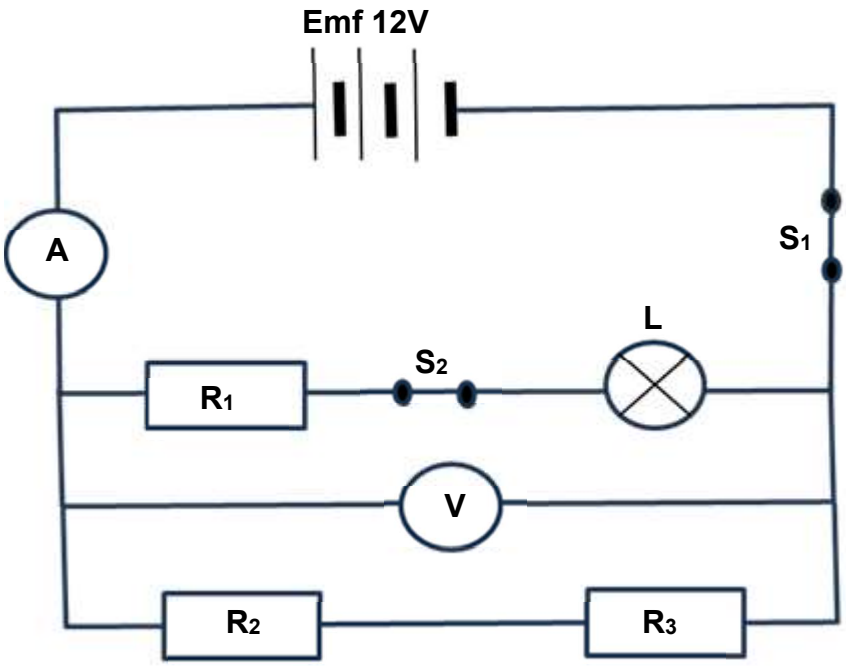
8.7.1 Draw a vector diagram to show the direction of the forces on charge **X** because of charges **Y** and **Z**. (2)

8.7.2 Calculate the net electrostatic force on sphere **X** because of charges **Y** and **Z**. (5)

[22]

QUESTION 9 (Start on a new page.)

A circuit diagram is set up as in the diagram below. Resistors R_1, R_2 and R_3 are identical. Switches S_1 and S_2 are closed. Ignore all internal resistance.



Use the diagram above to answer the following questions.

9.1 State *Ohm's law* in words. (2)

9.2 Name the component of a non-ohmic conductor in the diagram above. (1)

9.3 Write down the reading on the voltmeter with both switches closed. (1)

9.4 Switch S_2 is opened. Write down the reading on the voltmeter **V**. (1)

9.5 Switch S_2 is closed and switch S_1 is opened. Write down the reading on the voltmeter **V**. (1)

9.6 Switch S_2 is opened. How would this affect the ammeter reading?

Write only INCREASES, DECREASES or STAYS THE SAME. (1)

9.7 Both switches are closed. Resistor R_1 is removed. How would this affect the voltmeter reading?

Write only INCREASES, DECREASES or STAYS THE SAME. (1)
[8]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant	h	6,63 x 10^{-34} J·s
Coulomb's constant	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron	e	–1,6 x 10^{-19} C
Electron mass	m_e	9,11 x 10^{-31} kg
Mass of the Earth	M	5,98 x 10^{24} kg
Radius of the Earth	R_E	6,38 x 10^6 m

TABLE 2: FORMULAE

MOTION

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

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ of $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ of $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER

$W = F\Delta x \cos\theta$	$U = mgh$ or $E_P = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or $E = W_o + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or $K_{max} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
W = Vq W = VIΔt W= $I^2R\Delta t$ W= $\frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ P = VI P = I^2R P = $\frac{V^2}{R}$

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ $P_{ave} = I^2_{rms}R$ $P_{ave} = \frac{V^2_{nms}}{R}$