education

DEPARTMENT: EDUCATION

MPUMALANGA PROVINCE

NATIONAL

SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages, a graph paper and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK and QUESTION 11.2 on the attached GRAPH PAPER.
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 open 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. 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 et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

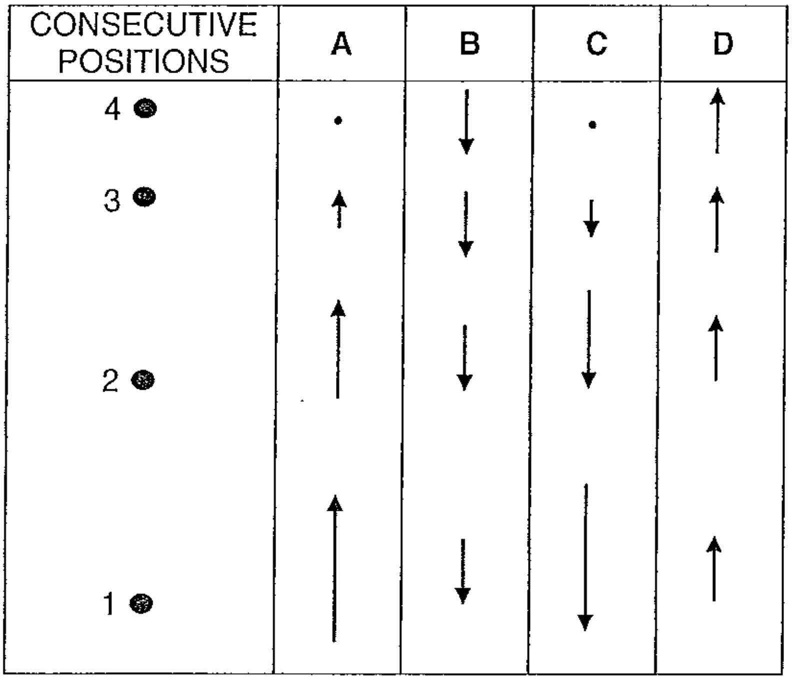
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A - D) next to the question number (1.1 - 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following quantities is a VECTOR?

A Time
B Distance
C Weight
D Speed (2)

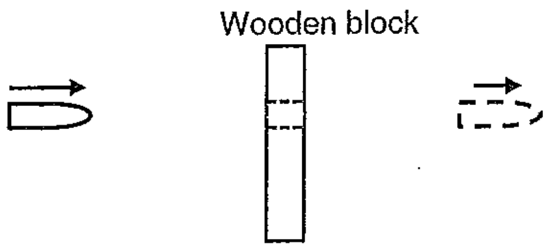
1.2 A ball is projected vertically UPWARDS. The table below shows the consecutive positions of the ball (1 to 4) as it rises with an acceleration vector indicated at each position. Assume that air friction is negligible.

Which ONE of the following, **A**, **B**, **C** or **D**, is the best representation of the magnitude and direction of the acceleration at each position?

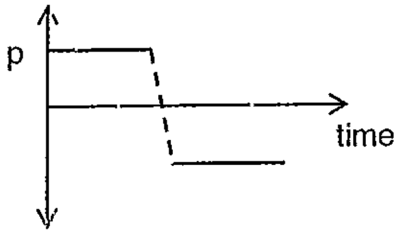


(2)

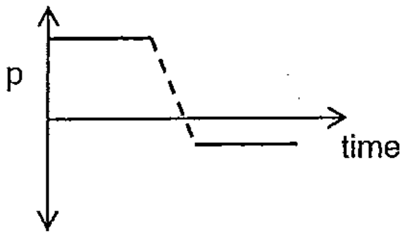
1.3 A bullet is fired towards a wooden block. The bullet hits the wooden block and moves through it. Assume that the bullet moves horizontally to the right. Ignore air resistance as well as all rotational effects of the block.



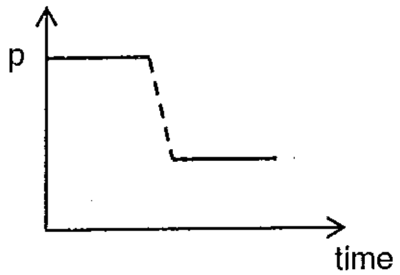
Which ONE of the following momentum-time graphs is the correct representation of the momentum (p) of the bullet?



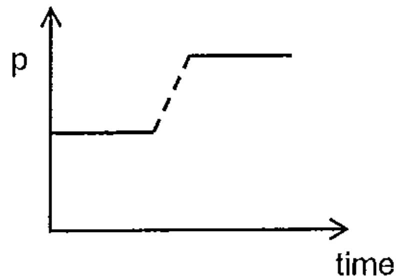
A



B



C

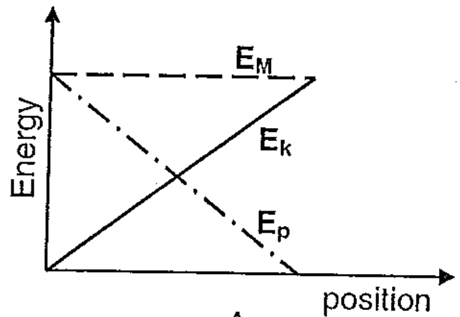


D

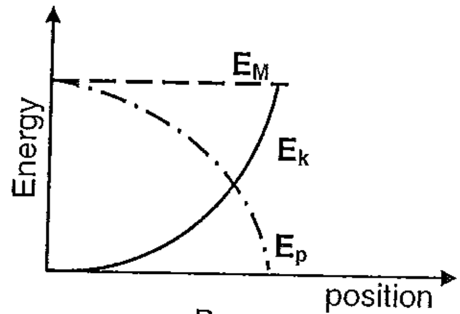
(2)

1.4 A ball is dropped from rest from a certain height.

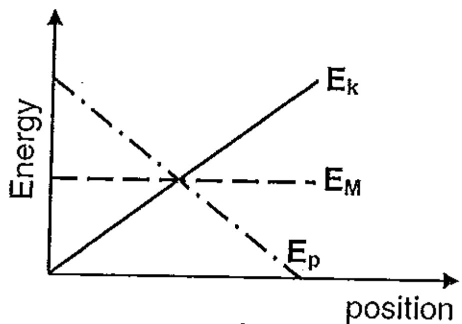
Which ONE of the following energy versus position graphs represents the relationship between the kinetic energy ($\mathbf{E_k}$), gravitational potential energy ($\mathbf{E_p}$) and mechanical energy ($\mathbf{E_m}$) during the motion of the ball?



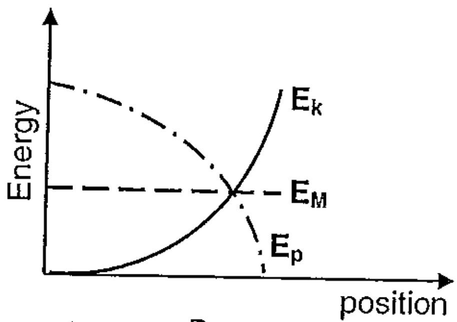
A



B



C



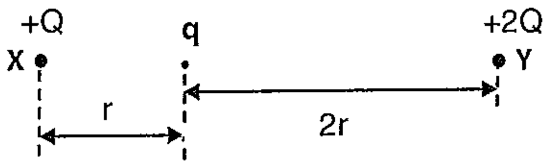
D

(2)

1.5 The wavelength of sound, observed by a stationary listener, increases because the source moves ...

A away from the listener.
B towards the listener.
C in a circle with a constant radius around the listener.
D towards and then away from the listener. (2)

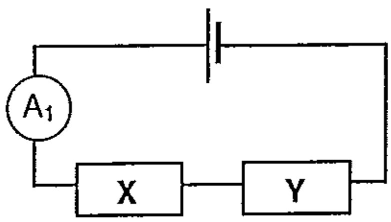
1.6 Two positive charges, +Q and +2Q, are placed at point **X** and point **Y** respectively as shown in the diagram below. A POSITIVE charge **q** is kept at rest between points **X** and **Y**.



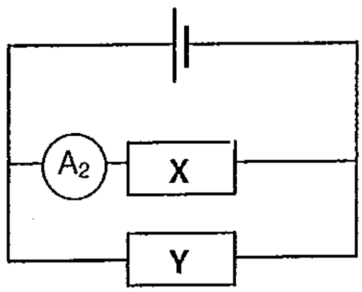
When **q** is released, **q** will ...

A stay at rest.
B move towards **X**.
C move towards **Y**.
D move vertically downwards. (2)

1.7 Two identical resistors **X** and **Y** are connected in series to a cell with negligible internal resistance as shown in the circuit diagram below.



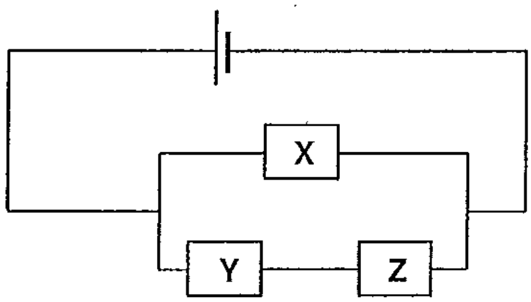
The same two resistors are now connected in parallel to the same cell as shown in the circuit diagram below.



How will the ammeter readings A_1 and A_2 compare?

A $A_1 = A_2$
B $A_2 = \frac{1}{2}A_1$
C $A_2 = 2A_1$
D $A_1 = 2A_2$ (2)

1.8 In the circuit diagram below the resistors **X**, **Y** and **Z** are IDENTICAL. The cell has negligible internal resistance.



If the power dissipated in resistor **X** is **P**, then the power dissipated in resistor **Y** is ...

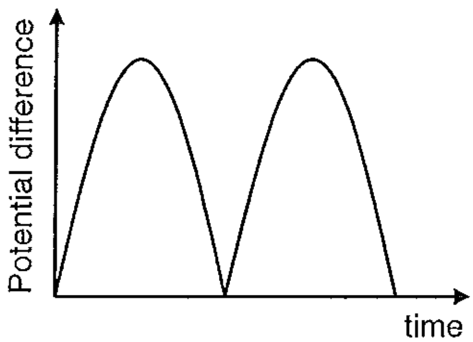
A ¼**P**.

B ½**P**.

C 2**P**.

D 4**P**. (2)

1.9 The graph below represents the output voltage of a generator.



Which ONE of the following components is needed in the generator to obtain the above graph?

A Alternating current source.
B Split ring commutator
C Slip rings
D Soft iron core (2)

1.10 GREEN light shines on the cathode of a photo-electric cell.
A milli-ammeter in the circuit registers a reading.

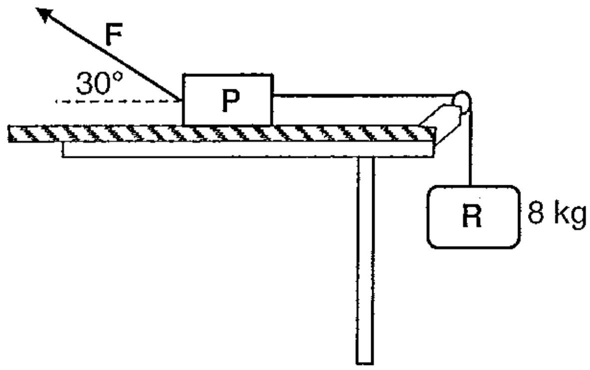
How does the number of photo-electrons released per second and the speed with which the photo-electrons move, change when the green light is replaced by a BLUE light of LOWER intensity?

	NUMBER OF PHOTO-ELECTRONS PER SECOND	**SPEED OF PHOTO-ELECTRONS**
A	Decreases	Decreases
B	Decreases	Increases
C	Stays the same	Increases
D	Increases	Decreases

(2)
[20]

QUESTION 2 (Start on a new page)

A 3 kg block **P** is attached to an 8 kg block **R** with a light inextensible string that is passing over a frictionless pulley. A force **F** exerted on block **P** at an angle of 30°, holds block **P** at REST on a rough, horizontal surface as shown in the diagram below.



The maximum static frictional force ($f_{s(max)}$) on block **P** is 15 N to the LEFT.

2.1 State Newton's Second Law of motion in words. (2)

2.2 Draw a labelled free-body diagram for block **P**. (5)

2.3 Calculate the magnitude of the applied force **F**. (5)

Force **F** is now removed and block **P** accelerates to the right. The coefficient of kinetic friction, μ_k, between block **P** and the horizontal surface is 0,4.

2.4 Calculate the magnitude of the acceleration of block **P**. (4)
[16]

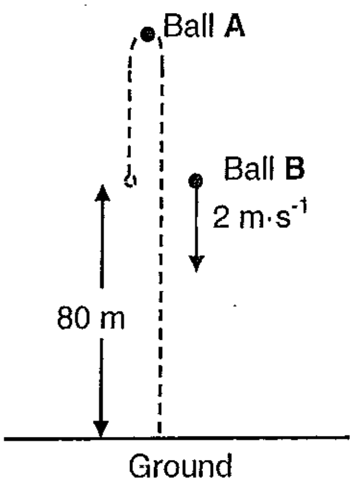
QUESTION 3 (Start on a new page)

A learner throws ball **A** vertically upwards at 5 $m \cdot s^{-1}$ from a height of 80 m above the ground. Ignore the effects of air resistance.

3.1 Is the ball in free fall directly after it was released by the learner? Motivate the answer. (2)

3.2 Calculate the magnitude of the velocity with which ball **A** will hit the ground. (3)

When ball **A** reaches its maximum height above the ground, the learner throws a second ball, **B**, vertically downwards at 2 $m \cdot s^{-1}$, as shown in the diagram below.



3.3 How will the distance between ball **A** and ball **B** change during their motion? Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)

3.4 How long after ball **B** will ball **A** hit the ground? (4)

3.5 Sketch velocity-time graphs for the COMPLETE motion of ball **A** and ball **B** ON THE SAME SET OF AXES.

Label the respective graphs clearly as **A** and **B**.

Show the following on the graphs:

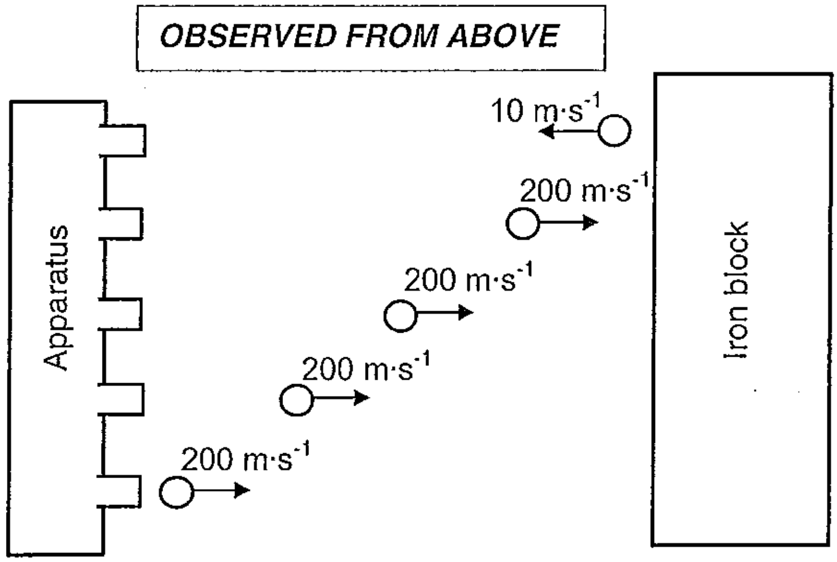
- The velocity with which ball **A** is projected upwards.
- The velocity with which ball **B** is projected downwards. (3)

[13]

QUESTION 4 (Start on a new page)

4.1 Define the term *impulse* in words. (2)

The diagram below, as observed from above, shows an apparatus that shoots 40 marbles per minute. The mass of each marble is 0,05 kg. The marbles roll over a frictionless surface and hit an iron block at 200 $m \cdot s^{-1}$.



Each marble is in contact with the iron block for 0,1 s and bounces back at 10 $m \cdot s^{-1}$. Ignore any rotational effects of the iron block.

4.2 Calculate the:

4.2.1 Magnitude of the momentum of each marble just before it hits the iron block (3)

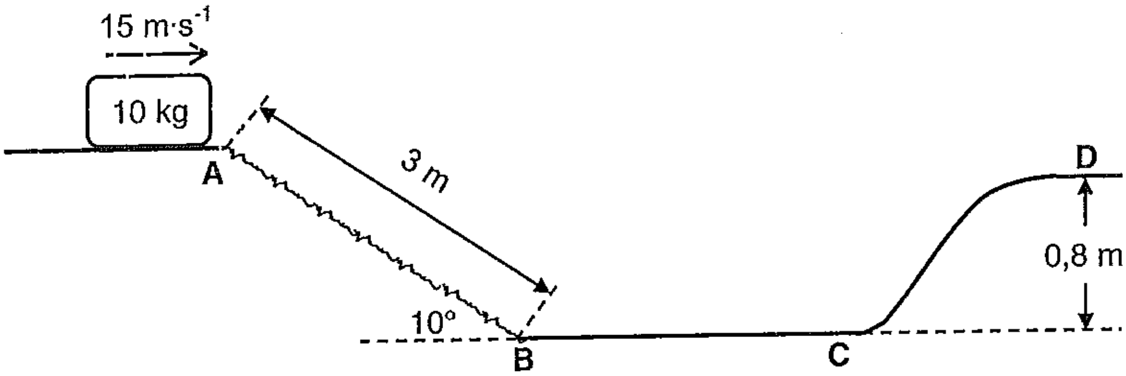
4.2.2 Magnitude and direction of the average net force that is exerted on each marble during the collision with the iron block (4)

4.2.3 Magnitude of the average net force that is exerted on the iron block in 6 seconds (2)

[11]

QUESTION 5 (Start on a new page)

A 10 kg block reaches point **A** at 15 m·s^{-1} and then slides on a track **ABCD** as shown in the diagram below.



The block experiences a kinetic frictional force of 50 N when it slides down slope **AB**. The remaining part of the track, **BCD**, is frictionless.

5.1 Calculate the kinetic energy of the block at point **A**. (3)

5.2 Draw a labelled free-body diagram of the block when it slides down slope **AB**. (3)

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

5.4 Use ENERGY PRINCIPLES to calculate the speed of the block at point **B**. (5)

5.5 Explain, in terms of FORCE and SPEED, why the kinetic energy of the block remains constant from points **B** to **C**. (2)

5.6 Calculate the speed of the block at point **D**. (4)
[19]

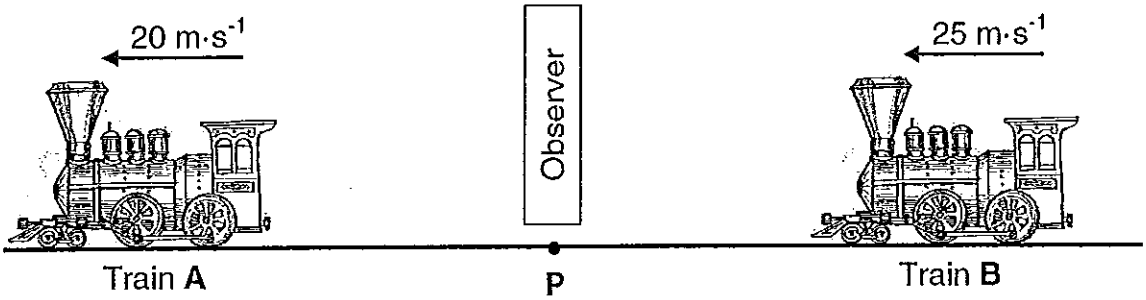
QUESTION 6 (Start on a new page)

6.1 Define the term *wavelength* in words. (2)

6.2 Calculate the wavelength of sound waves released by a stationary siren with a frequency of 1 520 Hz. (3)

Two trains, **A** and **B**, move at a constant velocity of 20 $m \cdot s^{-1}$ and 25 $m \cdot s^{-1}$ respectively on a straight, horizontal track as shown in the diagram below. An observer is at rest at point **P**. The siren of each train is emitting sound waves with a frequency of 1 520 Hz.

Take the speed of sound in air as 340 $m \cdot s^{-1}$. Ignore the effects of wind.



6.3 Calculate the:

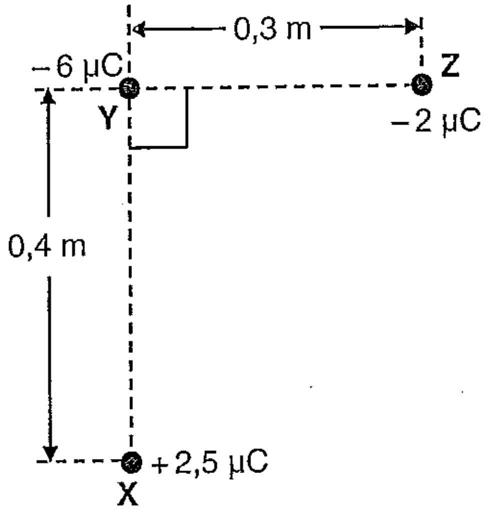
6.3.1 Observed frequency of the siren of train **A** (4)

6.3.2 Difference between the frequencies observed for trains **A** and **B** (4)

[13]

QUESTION 7 (Start on a new page)

Three charged spheres **X**, **Y** and **Z** are placed perpendicular to each other, as shown in the diagram below.



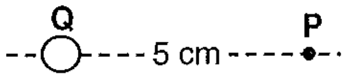
7.1 State Coulomb's law in words. (2)

7.2 Draw a labelled vector diagram to show the directions of the electrostatic forces **AND** the net force that the charged sphere **Y** experiences due to the presence of the charged spheres **X** and **Z** respectively. (3)

7.3 Calculate the magnitude of the net force experienced by sphere **Y** due to the presence of spheres **X** and Z. (5)
[10]

QUESTION 8 (Start on a new page)

Point **P** is 5 cm from a sphere, with charge **Q**, as shown in the diagram below.



The electric field at point **P** is **E** TO THE LEFT.

8.1 Define the term *electric field at a point.* (2)

8.2 Draw the electric field pattern around the charged sphere. (2)

A charge of -4×10^{-9} C is added to the charged sphere. The magnitude of the electric field at point **P** is now 3**E.**

8.3 Calculate the:

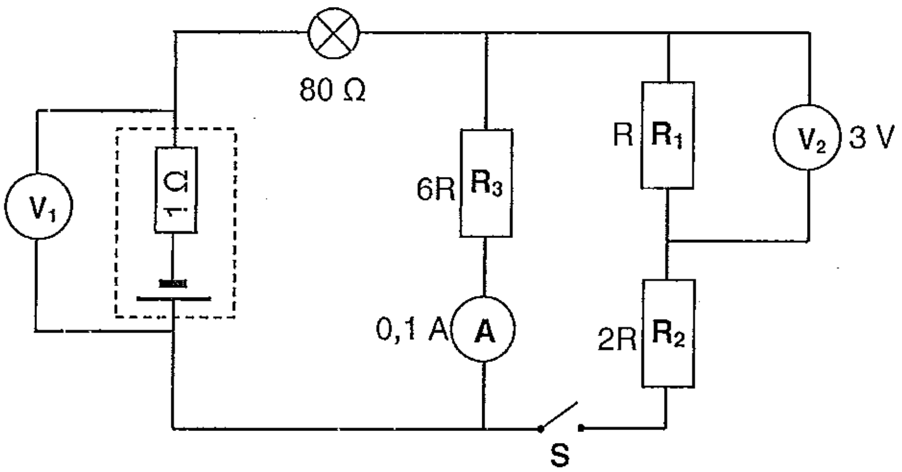
8.3.1 Number of electrons added to the sphere (3)

8.3.2 Magnitude of the initial charge **Q** on the sphere (4)
[11]

QUESTION 9 (Start on a new page)

Three resistors, a light bulb and a cell, with an internal resistance of 1 Ω, are connected as shown in the circuit diagram below. The resistance of the three resistors are R, 2R and 6R respectively and the resistance of the bulb is 80 Ω.

When switch **S** is closed, the voltmeter and ammeter have readings as shown in the diagram below.



9.1 Write down the value of the:

9.1.1 Potential difference across resistor $\mathbf{R_2}$ (1)

9.1.2 Current through $\mathbf{R_2}$ (1)

9.2 Calculate the:

9.2.1 Resistance of resistor $\mathbf{R_1}$ (3)

9.2.2 Emf of the cell (6)

9.2.3 Power dissipated in the light bulb (3)

Switch **S** is now OPENED.

9.3 Write down the reading on voltmeter $\mathbf{V_2}$. (1)

9.4 A learner makes the following statement:

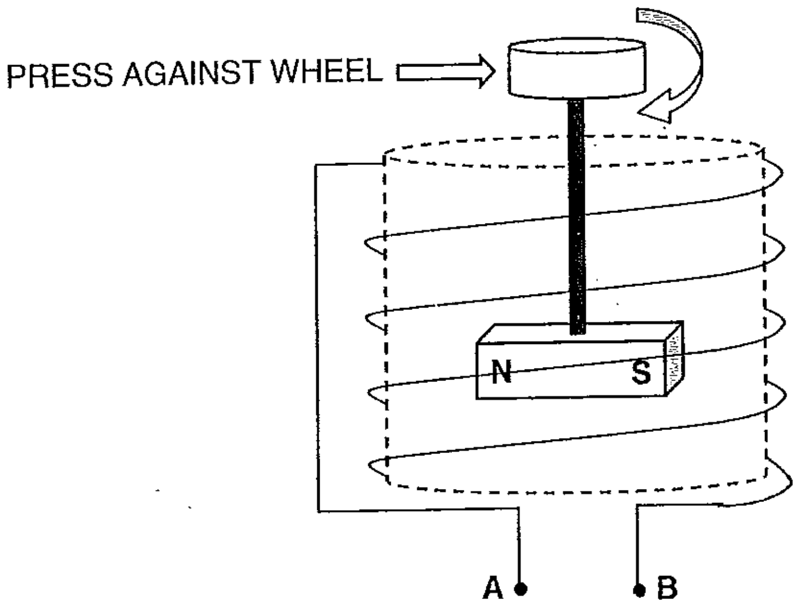
"When the switch is opened, the 'lost volts' will increase."

Explain, in terms of TOTAL RESISTANCE and CURRENT, why this statement is NOT TRUE. (3)

[18]

QUESTION 10 (Start on a new page)

The diagram below shows a small generator that can provide light when fitted to a bicycle. The top of the generator presses against the rim of the wheel, making it to rotate when the wheel is turning.



10.1 Write down the energy conversion that takes place in the generator. (2)

10.2 What type of generator is indicated in the diagram above?
Choose from: AC or DC (1)

A 5 Ω light bulb is connected between points **A** and **B**. The peak voltage produced by the generator is 7,78 V.

10.3 Calculate the average power dissipated in the bulb. (4)
[7]

QUESTION 11 (Start on a new page)

During an experiment to determine the work function of caesium metal, light of different wavelengths are shone on the metal surface. The maximum kinetic energy of the ejected photo-electrons are recorded in the table below.

INVERSE OF WAVELENGTH $^1/_\lambda$ ($\times 10^6$ m^{-1})	**MAXIMUM KINETIC ENERGY** $E_{k(max)}$ ($\times 10^{-19}$ J)
2,1	1,05
2,4	1,65
2,8	2,45
3,1	3,0

11.1 Define the term *work function.* (2)

11.2 Use the data in the table above to draw a graph of $E_{k(max)}$ (y-axis) versus $^1/_\lambda$ (x-axis) on the attached GRAPH PAPER.

Extrapolate (extend) the graph to the x-axis. (3)

11.3 USE THE GRAPH to calculate the:

11.3.1 Threshold frequency of the caesium metal (3)

11.3.2 Work function of the caesium metal (3)

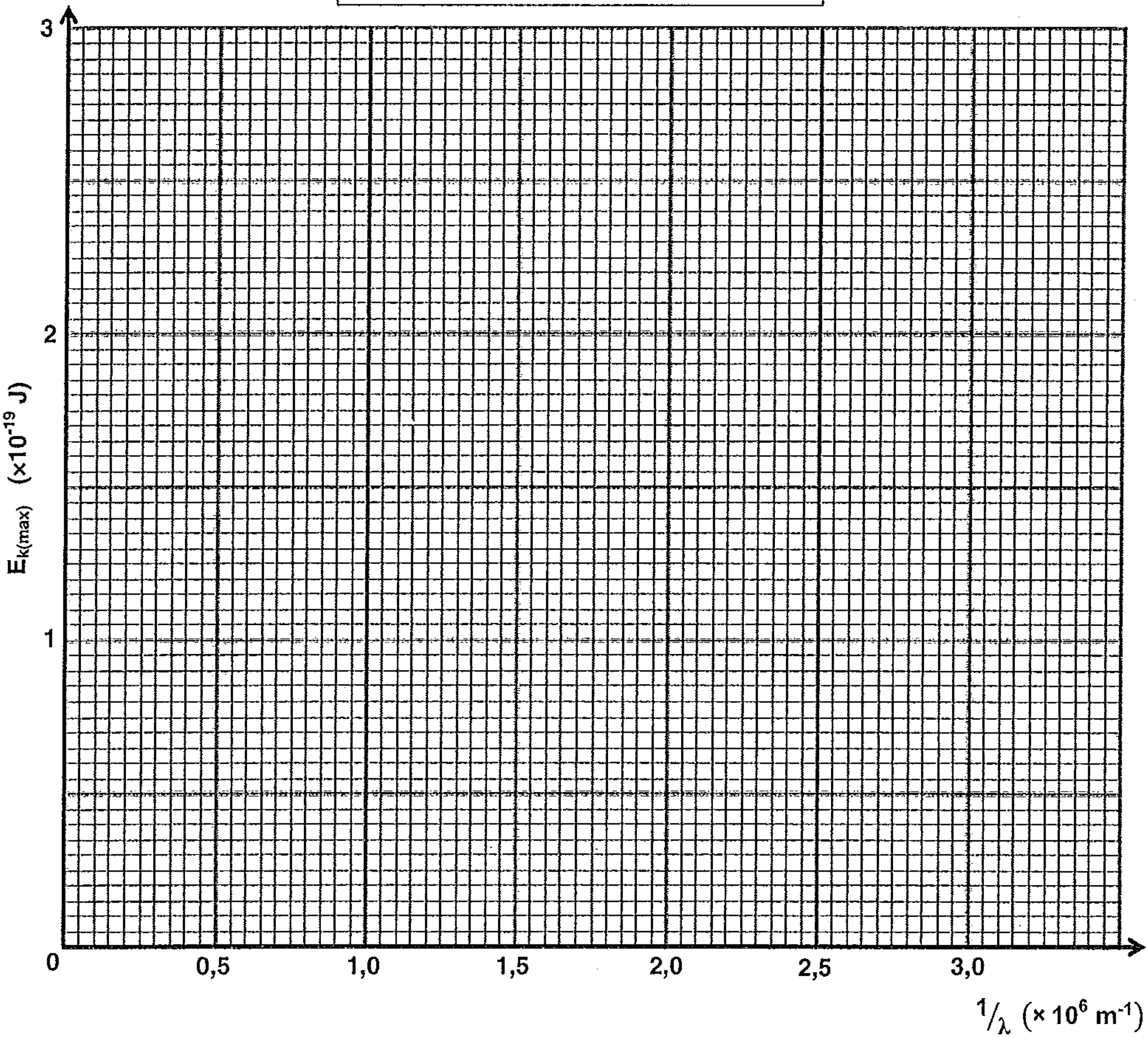
The same experiment is repeated using another metal **X** instead of caesium. The results are plotted on the same axis as in QUESTION 11.2.

11.4 How will the gradient of metal **X**'s graph compare to that of the graph for caesium metal?

Choose from: INCREASES, DECREASES or REMAINS THE SAME (1)
[12]

TOTAL: 150

GRAPH OF $E_{k(max)}$ VERSUS $^1/_\lambda$



DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

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

NAME / NAAM	SYMBOL / SIMBOOL	VALUE / WAARDE
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9\ N\cdot m^2\cdot C^{-2}$
Charge on electron *Lading op elektron*	e^-	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE / *TABEL 2: FORMULES*

MOTION / *BEWEGING*

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

FORCE / *KRAG*

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

WORK, ENERGY AND POWER / *ARBEID, ENERGIE EN DRYWING*

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

WAVES, SOUND AND LIGHT / *GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_o = hf_o$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS / ELEKTROSTATIKA

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

ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

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

ALTERNATING CURRENT / WISSELSTROOM

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$ / $I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$ $V_{rms}=\frac{V_{max}}{\sqrt{2}}$ / $V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$	$P_{ave}=V_{rms}I_{rms}$ / $P_{gemiddeld}=V_{wgk}I_{wgk}$ $P_{ave}=I_{rms}^2R$ / $P_{gemiddeld}=I_{wgk}^2R$ $P_{ave}=\frac{V_{rms}^2}{R}$ / $P_{gemiddeld}=\frac{V_{wgk}^2}{R}$