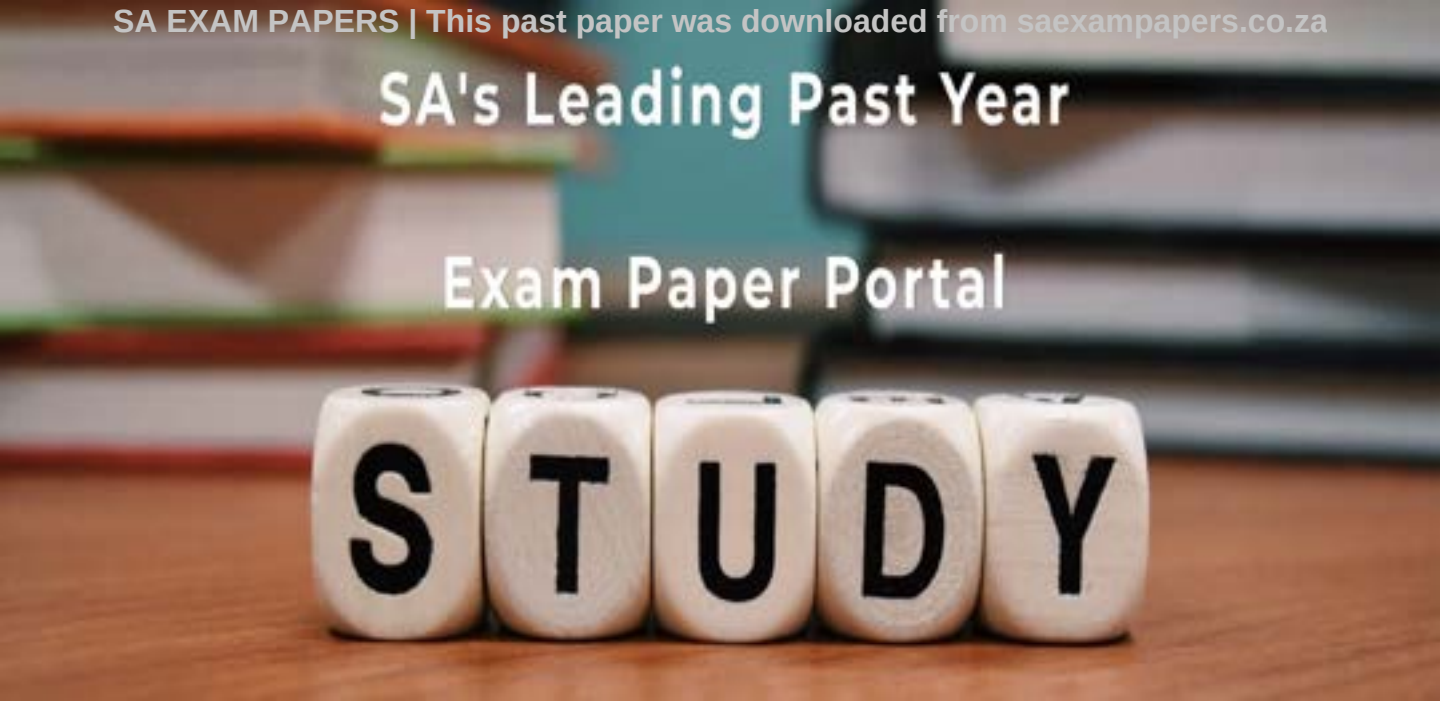


Western Cape Government
Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2024

MARKS: **150**

TIME: **3 hours**

DATE: **Wednesday 04 SEPTEMBER 2024**

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your Name and Surname on the first page of your ANSWER BOOK.
2. This question paper consists of 9 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW PAGE of your RULED A4 PAPER. Use BOTH sides of the page in order to avoid wasting paper.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, 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**. In multi-step calculations, intermediate steps, round off to four 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) on your RULED A4 PAPER, for example 1.11 D.

1.1 A wooden block is pulled up a rough, inclined surface using a rope. The wooden block moves at a constant velocity. This means that:

A There are no forces acting on the block.

B There are no vertical forces acting on the block.

C Only gravitational force acts on the block.

D. The vector sum of all forces acting on the block is equal to zero. (2)

1.2 The MASS of an object on Earth is represented by $\frac{x}{g}$.

Which ONE of the following represents the MASS of the object on a planet, that has TWICE the mass of earth and HALF the radius of the Earth?

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

B $\frac{x}{g}$

C $\frac{x}{2g}$

D $\frac{x}{8g}$ (2)

1.3 Ball **A** of mass **m** is projected vertically upwards from the ground with an initial velocity **v**. Ball **A** rises to a maximum height **h** above the ground. Ball **B** of mass ½**m** is now projected vertically upwards with an initial velocity of **2v**. Ignore the effects of air friction.

In terms of **h**, to what maximum height does ball **B** rise above the ground?

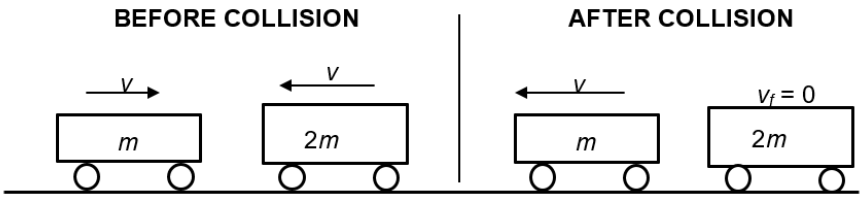
A **h**

B $\sqrt{2}h$

C 2**h**

D 4**h** (2)

1.4 An object of mass **m** moving at velocity **v** collides head-on with an object of mass **2m** moving in the opposite direction at velocity **v**. Immediately after the collision, the smaller mass moves at velocity **v** in the opposite direction and the larger mass is brought to rest. Ignore the effects of friction. Refer to the diagram below.

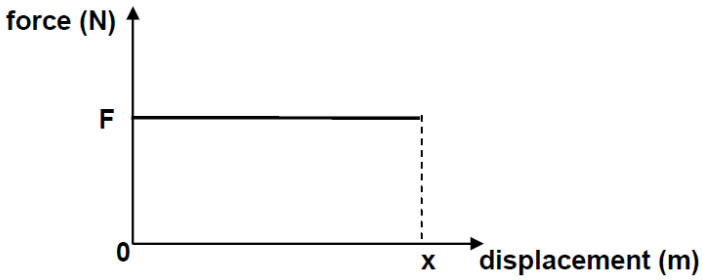


Which ONE of the following regarding the MOMENTUM and KINETIC ENERGY of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Conserved	Conserved
B	Not conserved	Conserved
C	Conserved	Not conserved
D	Not conserved	Not conserved

(2)

1.5 The graph below represents a constant force **F** acting on an object over a displacement **x**. The force and displacement are in the same direction.



Which ONE of the following statements can be deduced from the graph?

A The gradient of the graph represents the work done by the force.

B The gradient of the graph represents the change in kinetic energy of the object.

C The area under the graph represents the net work done by the force.

D The area under the graph represents the power dissipated by the force. (2)

1.6 A car travels at constant velocity along a horizontal road. A constant frictional force acts on the car during its motion. Which ONE of the following statements about the power dissipated by the engine of the car during the motion is CORRECT? The power …

A is zero.

B increases.

C decreases.

D remains constant. (2)

1.7 Light reaching the Earth from a galaxy moving away from it is shifted towards …

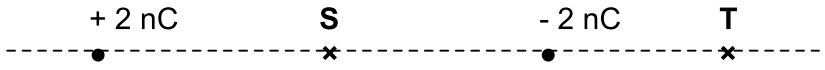
A Greater velocity.

B Higher frequency.

C Longer wavelength.

D Shorter wavelength. (2)

1.8 Two charges of +2 nC and -2 nC are located on a straight line. **S** and **T** are two points that lie on the same straight line as shown in the diagram below.

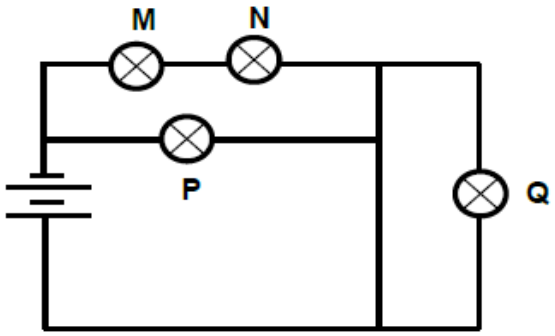


Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S	**DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T**
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

1.9 The circuit diagram below shows four identical bulbs **M**, **N**, **P** and **Q** connected to a battery. The power dissipated in bulb **M** is 60 W. The resistance of the connecting wires and the battery may be ignored.



The power dissipated in bulb **Q** is …

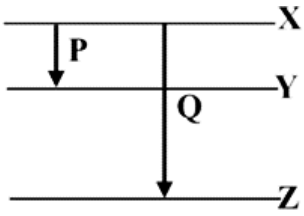
A 0 W

B 15 W

C 60 W

D 120 W (2)

1.10 The diagram represents 3 energy levels, **X**, **Y** and **Z**, in a certain atom. The energy difference between levels **Y** and **Z** is twice the energy difference between levels **X** and **Y**.



If the wavelength of a photon emitted as a result of transition P, from level **X** to **Y**, is λ, then the wavelength of the photon emitted during transition Q, from level **X** to **Z** is …

A 2λ

B 3λ

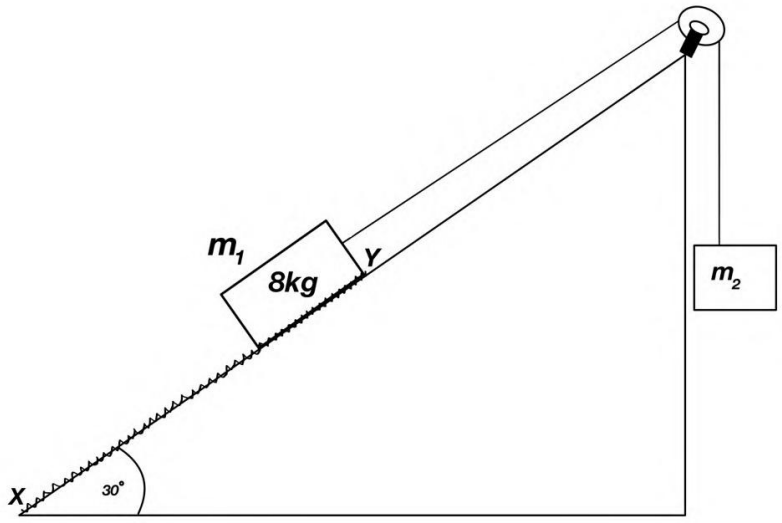
C $\frac{1}{2}\lambda$

D $\frac{1}{3}\lambda$ (2)

[20]

QUESTION 2 (Start on a new page)

2.1 Block m_1 of mass 8 kg, placed at point **X**, is connected to block m_2 by a light inextensible string passing over a frictionless pulley. Block m_1 is on a plane inclined at an angle of 30° to the horizontal and experiences a frictional force between points **X** and **Y** only. Block m_2 has an unknown mass and moves vertically downwards as shown in the diagram below.



Block m_1 is released at point **X** and moves at constant velocity to point **Y**. The coefficient of kinetic friction acting on the 8 kg block between points **X** and **Y** is 0,2.

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

Consider the motion of block m_1 between **X** and **Y:**

2.1.2 Draw a labelled free body diagram indicating all the forces acting on m_1. (4)

2.1.3 Calculate the magnitude of the frictional force acting on m_1. (3)

2.1.4 Calculate the mass of m_2. (5)

The 8 kg block continues to move past point **Y** and up the incline.

2.1.5 How will the magnitude of the acceleration be affected?
Write down INCREASES, DECREASES or REMAINS THE SAME.
Give a reason for the answer. (2)

2.2 On a particular day, the distance between the surface of Earth and the surface of Mars was 4,5 x 10^9 m. Mars has a mass of 6,417 x 10^{23} kg and a diameter of 6 779 km.

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

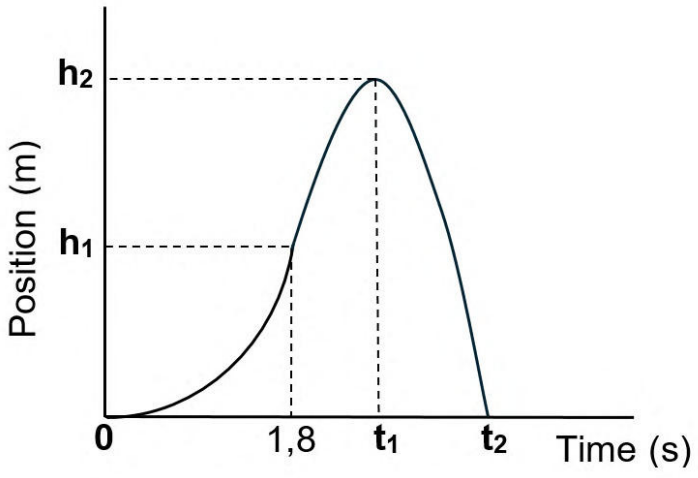
2.2.2 Calculate the magnitude of the gravitational force Earth exerts on Mars. (4)

[22]

QUESTION 3 (Start on a new page)

Learners in a Grade 12 class launched a model rocket from rest, vertically upwards from the ground. Assume the rocket experiences a constant acceleration for 1,8 s to reach a maximum velocity of 29,7 $m \cdot s^{-1}$, at which point it runs out of fuel. Ignore the effects of air resistance.

The sketch graph below (not drawn to scale) represents the position of the rocket relative to the ground from the moment it was launched until it crashes back on the ground.
Upward direction is taken as positive.



3.1. During which time interval(s) was the rocket in free fall? (1)

3.2. Calculate the constant acceleration the rocket experiences between 0 and 1,8 s (3)

3.3. Calculate the maximum height h_2 (above the ground) reached by the rocket, as indicated on the graph. (5)

3.4. Calculate how long the rocket was in free fall and hence the value of t_2. (4)

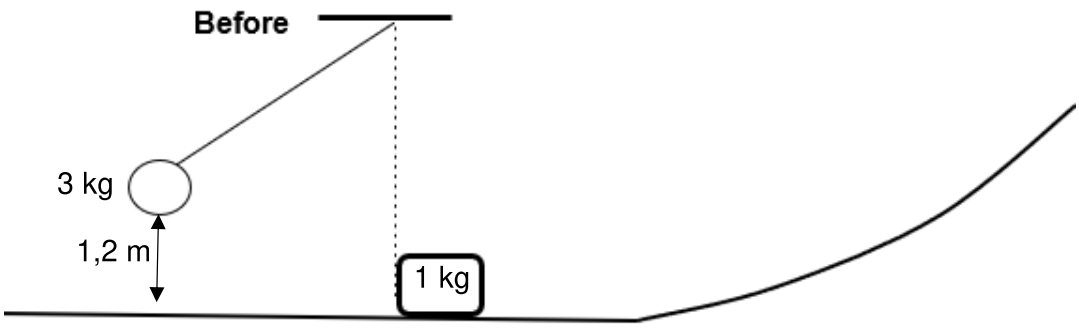
3.5. Sketch a velocity-time graph in your ANSWER BOOK for the motion of the rocket from the moment it is fired until it hits the ground. Clearly indicate the following on your graph:
- The velocity of the rocket when the fuel runs out
- The value of time t_2 when the rocket crashes on the ground (4)

[17]

QUESTION 4 (Start on a new page)

A pendulum with a bob of mass 3 kg is kept stationary at a height of 1,2 m above a surface. It is released and at its lowest point it collides with a block, mass 1 kg, which is at rest on a frictionless surface as shown in the diagram below. Ignore all effects of friction.

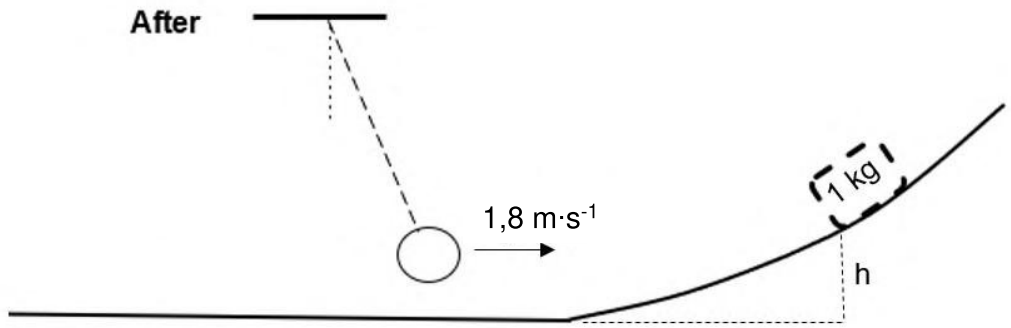
The diagrams below are NOT drawn to scale.



4.1 State the *principle of conservation of mechanical energy*, in words. (2)

4.2 Using energy principles only, calculate the speed of the pendulum-bob just before it collides with the block. (4)

After the collision the pendulum bob has a velocity of 1,8 $m \cdot s^{-1}$ and the block moves up the frictionless curved ramp until it reaches a maximum height ***h***, as shown below. Assume that no loss of mechanical energy occurs during the collision.



4.3 State the *principle of conservation of linear momentum*, in words. (2)

4.4 Calculate the magnitude of the velocity of the block just after the collision. (4)

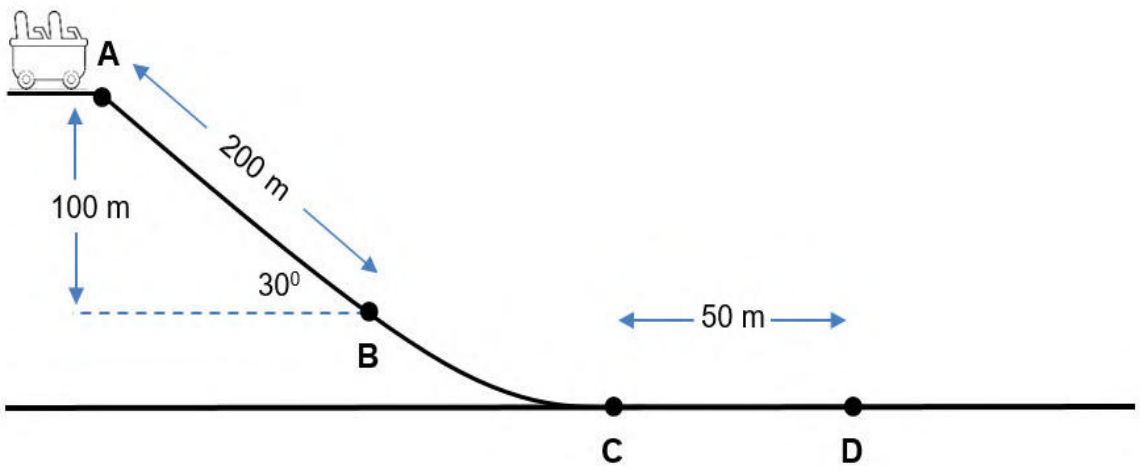
4.5 Calculate the vertical height, **h**, reached by the block. (3)

[15]

QUESTION 5 (Start on a new page.)

A 850 kg roller-coaster is released from rest at point **A** on the track shown in the figure below. It travels along the straight decline section **A** to **B** and continues along the curved section **B** to **C** where the brakes are then applied from point **C**. The roller-coaster comes to a stop at **D**, 50 m from **C**. The coefficient of kinetic friction of the track is 0,42.

Ignore the rotational effects of the roller coaster's wheels.



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

5.2 Draw a labelled free body diagram showing all the forces acting on the roller-coaster as it moves from **A** to **B**. (3)

5.3 Calculate the net work done on the roller-coaster as it moves from **A** to **B**. (5)

5.4 Along the curved section **BC**, the kinetic energy of the roller-coaster decreases by 108 950 J. The brakes are then applied at point **C.**

Calculate the magnitude of the average braking force required by the braking system to bring the roller-coaster to a stop at point **D**. Use ENERGY PRINCIPLES ONLY. (7)

[17]

QUESTION 6 (Start on a new page.)

A trained diver records the frequency of ultrasound waves emitted by a dolphin. When the dolphin which is swimming at a constant speed of 20 $m \cdot s^{-1}$ approaches the stationary diver, the recorded frequency is 253,38 kHz. The dolphin passes the diver, and when swimming away from the diver, the recorded frequency is 246,71 kHz.

6.1 State the Doppler effect in words. (2)

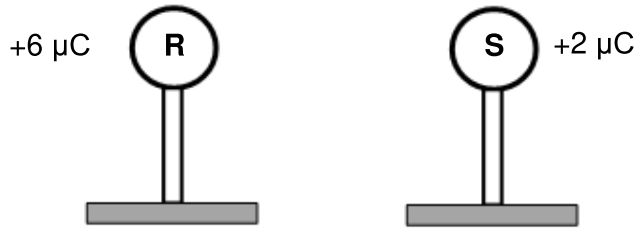
6.2 Use the information given and calculate the speed of sound in sea water. (6)

6.3 If the dolphin's constant speed increases to 25 $m \cdot s^{-1}$, how will the frequency of the ultrasound waves emitted by the dolphin compare to the waves emitted when swimming at 20 $m \cdot s^{-1}$? Write down only HIGHER, LOWER or REMAINS THE SAME. Give a reason for the answer. (2)

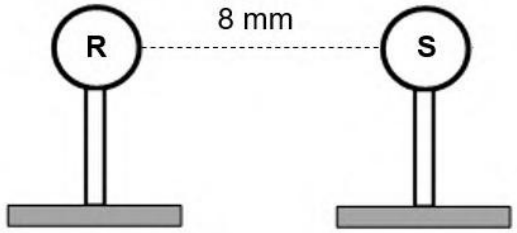
[10]

QUESTION 7 (Start on a new page.)

The diagram below shows two small identical metal spheres, **R** and **S**, each placed on a wooden stand, in a vacuum. Spheres **R** and **S** carry charges of +6 µC and +2 µC respectively.



Spheres **R** and **S** are brought into contact for a while and then separated by a distance of 8 mm between their centres.



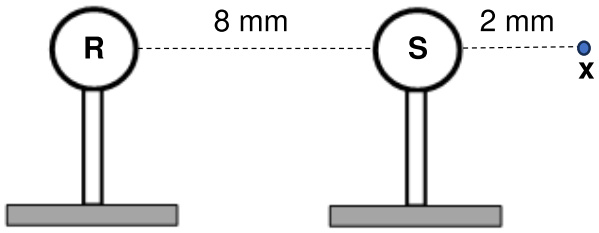
7.1 Which sphere loses electrons? Write down **R** or **S**. (1)

7.2 Draw the electric field patterns due to sphere **R** and **S**. (3)

7.3 Calculate the new charge on sphere **S**, after contact with **R**. (2)

7.4 Calculate the number of electrons transferred during contact. (3)

7.5 Point **x** is located 2 mm to the right of sphere S, as shown below.



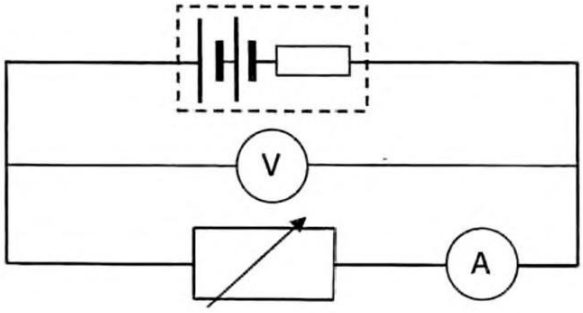
7.5.1 Define the term *electric field at a point* in words. (2)

7.5.2 Calculate the net electric field strength at point **x** due to spheres **R** and **S**, after **R** and **S** have touched and separated. (5)

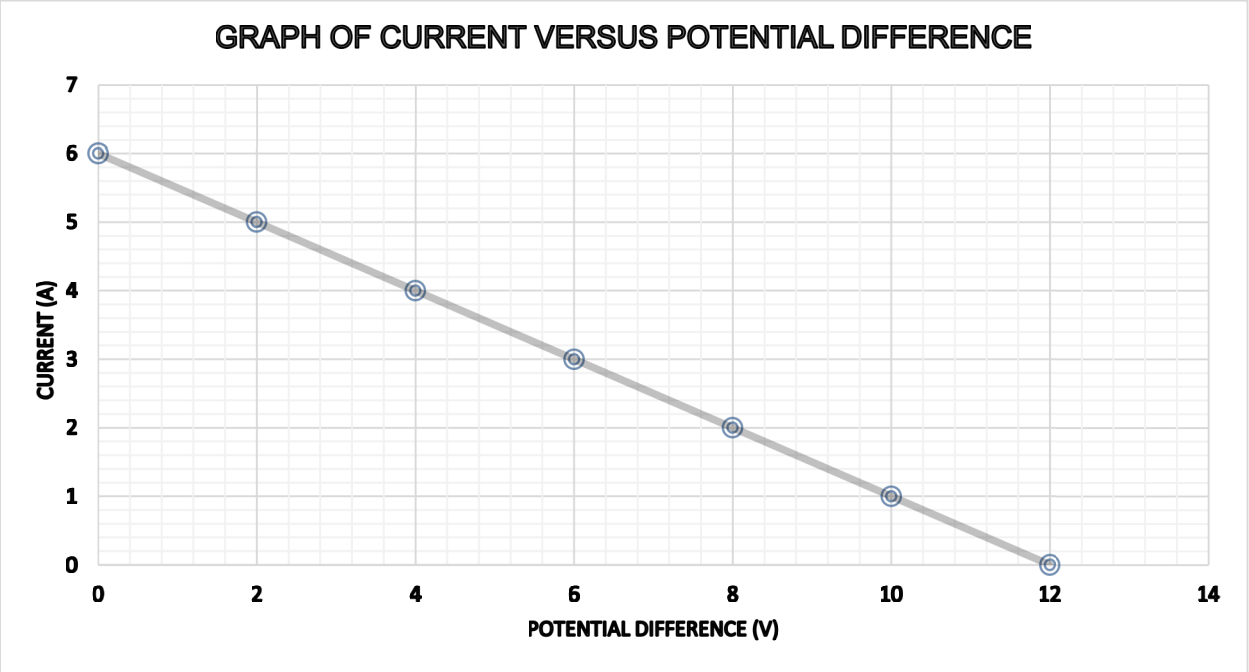
[16]

QUESTION 8 (Start on a new page.)

8.1 Grade 12 learners conduct an experiment to determine the internal resistance of a battery. They connect the battery to a rheostat, an ammeter and a voltmeter as shown in the diagram below.



The results obtained are shown in the graph below.



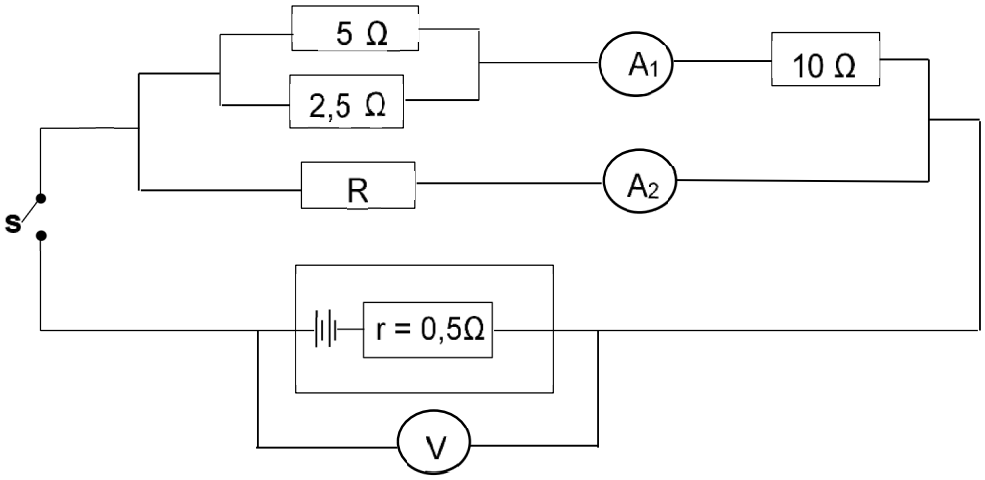
Use the graph to determine the value of the following:

8.1.1 Emf (Ɛ) of the battery. (1)

8.1.2 The lost voltage when the current is 2 A. (1)

8.1.3 Internal resistance of the battery, WITHOUT USING THE EQUATION Ɛ = I(R + r) IN YOUR CALCULATION(S). (4)

8.2 In the circuit below, the battery has an emf of 19,125 V and internal resistance of 0,5 Ω. Voltmeter **V** is connected across the battery. Ammeters **A_1** and **A_2**, and the connecting wires have negligible resistances.



8.2.1 Define the term *emf* in words. (2)

8.2.2 What is the reading on **V** while the switch is open? (1)

Switch **S** is now CLOSED. The reading on **V** decreases by 6,5 V.

Calculate the:

8.2.3 Current flowing through the battery. (3)

8.2.4 Reading on ammeter **A_1** (4)

8.2.5 The value of the unknown resistor **R** (3)

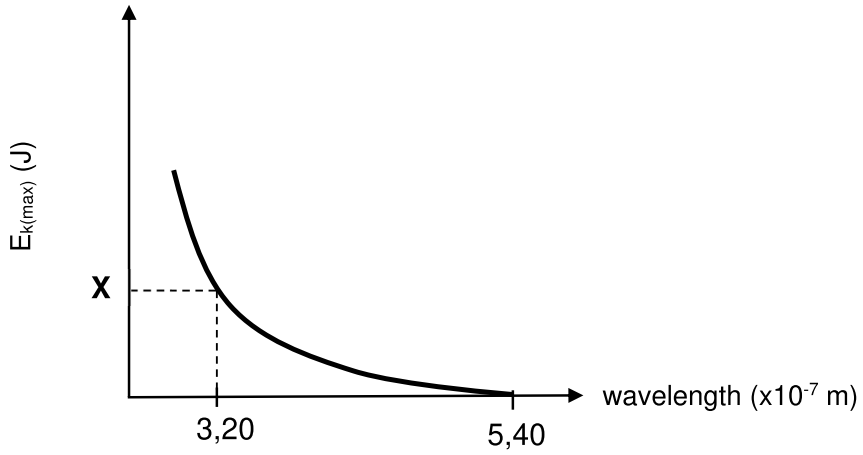
The unknown resistor **R** is now replaced by a conducting wire of negligible resistance.

8.2.6 How will the reading of voltmeter **V** be affected? Write down INCREASE, DECREASE or REMAINS THE SAME.
Explain the answer. (4)

[23]

QUESTION 9 (Start on a new page.)

An experiment is conducted to investigate the relationship between the wavelength of light incident on a metal and the maximum kinetic energy of the emitted electrons from the surface of the metal. The graphs below, NOT DRAWN TO SCALE, represents the results obtained.



9.1 Define the term *photoelectric effect*. (2)

9.2 Write down the value of threshold wavelength for the metal used. (1)

9.3 Calculate the maximum speed of the ejected photoelectrons when the kinetic energy is **X**. (5)

9.4 How would the maximum kinetic energy of the photoelectron be affected if light of a higher intensity is used? Write down only INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

[10]

TOTAL 150 MARKS

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 gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
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
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ 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)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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