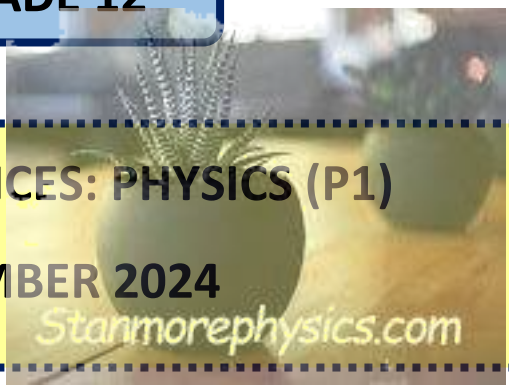
Western Cape Government
Education

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?

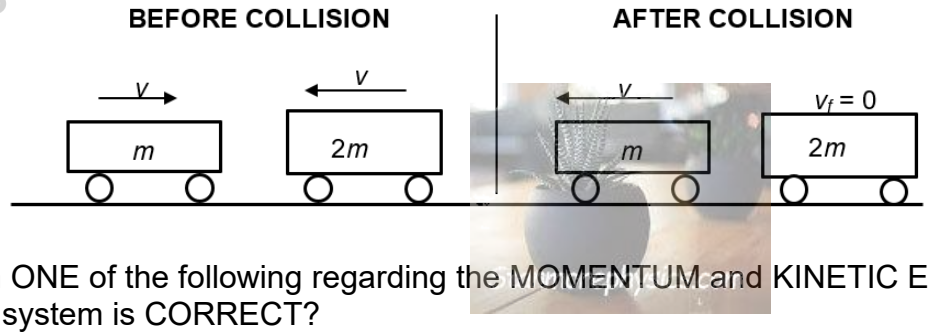
A **h**

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.

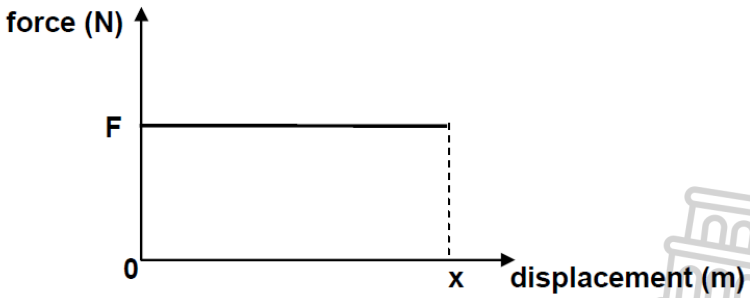


Which ONE of the following regarding the MOMENTUM and KINETIC ENERGY of the system is CORRECT?

	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 …

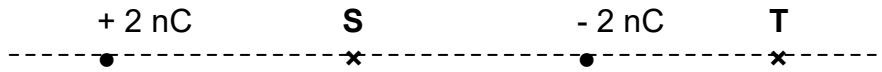
A Greater velocity.

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.

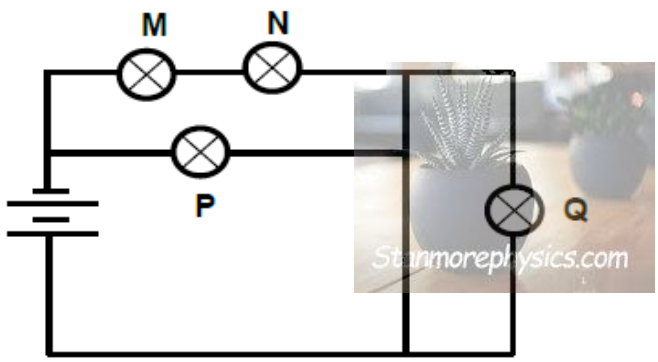


Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

	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 …

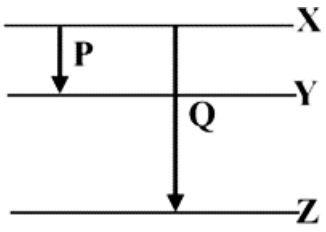
A 0 W

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

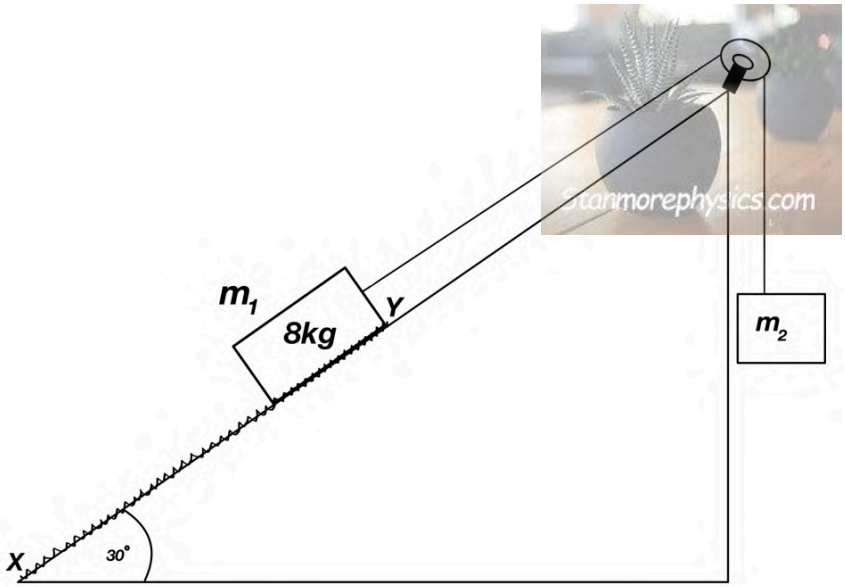
C $\frac{1}{2}\lambda$

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 $4,5 \times 10^9$ m. Mars has a mass of $6,417 \times 10^{23}$ kg and a diameter of 6 779 km.

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

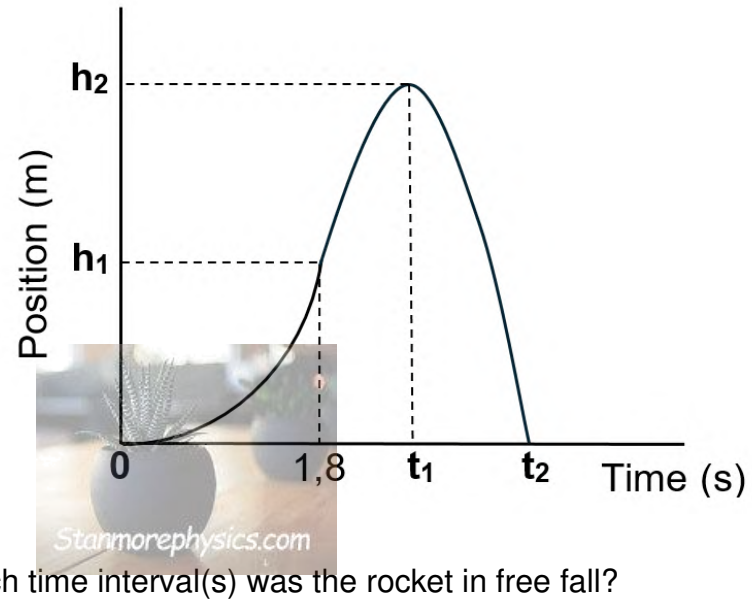
2.2.2 Calculate the magnitude of the gravitational force Earth exerts on Mars. (4)

[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 $\mathbf{h_2}$ (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 $\mathbf{t_2}$. (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:

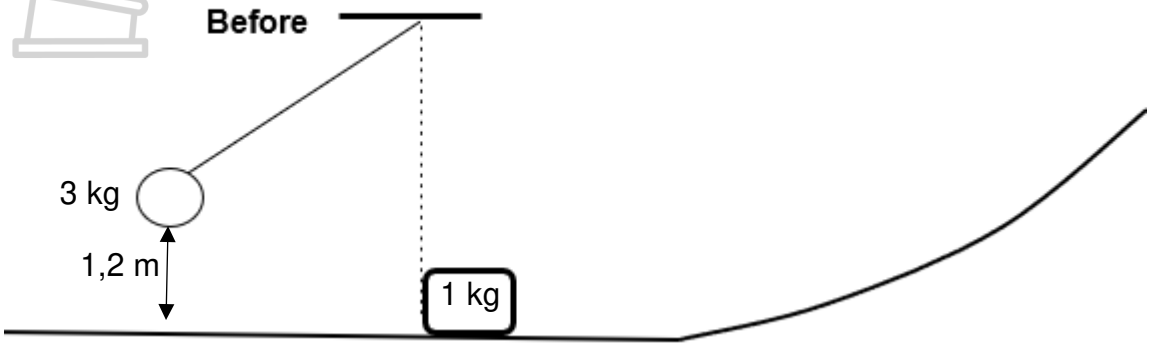
- The velocity of the rocket when the fuel runs out
- The value of time $\mathbf{t_2}$ when the rocket crashes on the ground (4)

[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.

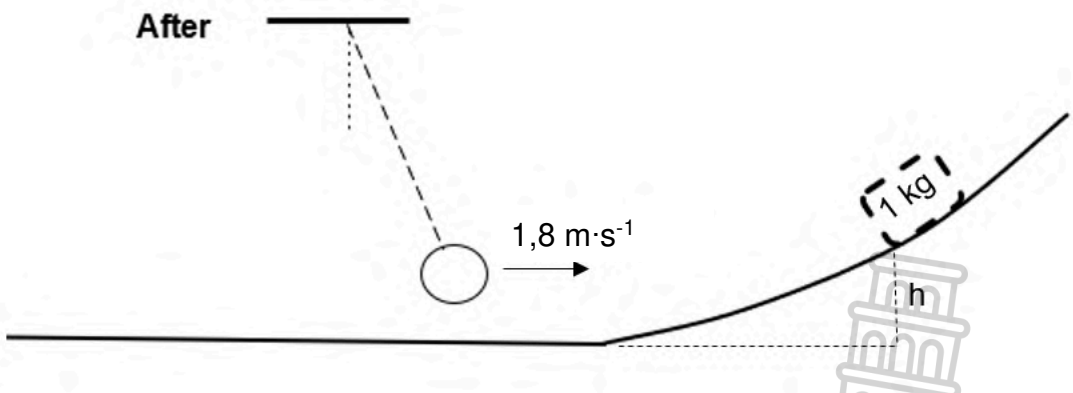
The diagrams below are NOT drawn to scale.



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)

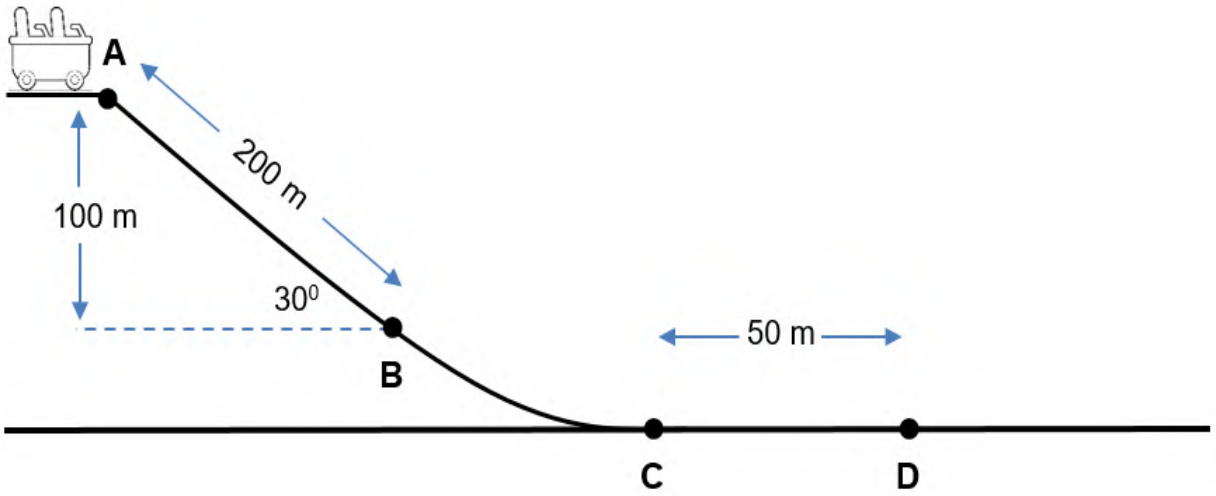
4.5 Calculate the vertical height, **h**, reached by the block. (3)

[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)

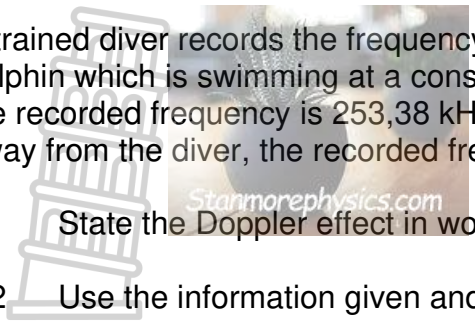
5.3 Calculate the net work done on the roller-coaster as it moves from **A** to **B**. (5)

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)

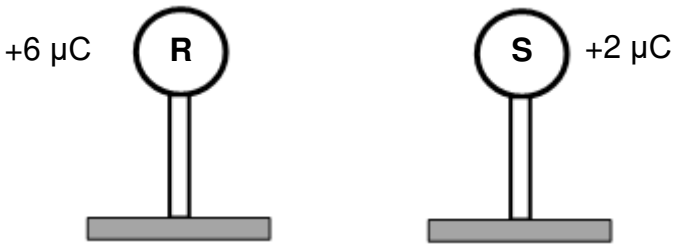
6.2 Use the information given and calculate the speed of sound in sea water. (6)

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.

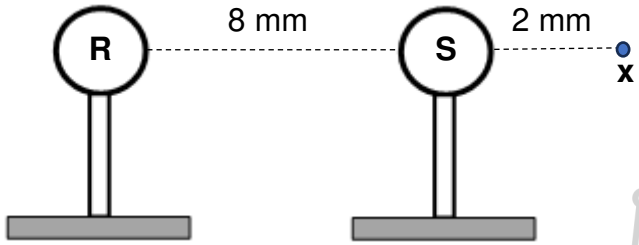
7.1 Which sphere loses electrons? Write down **R** or **S**. (1)

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.



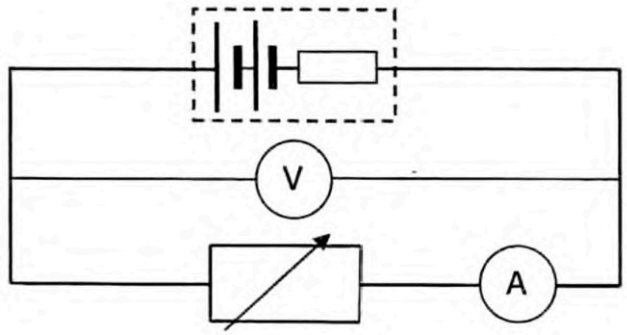
7.5.1 Define the term *electric field at a point* in words. (2)

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)

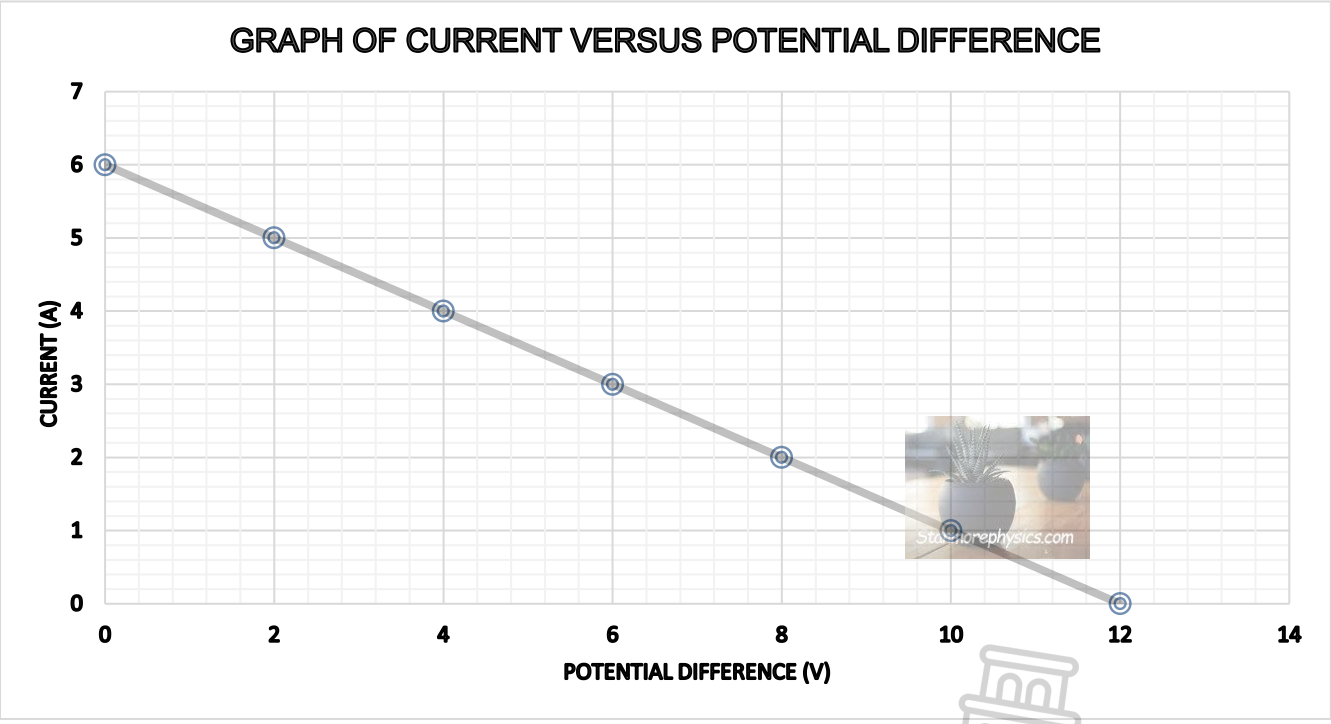
[16]

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.



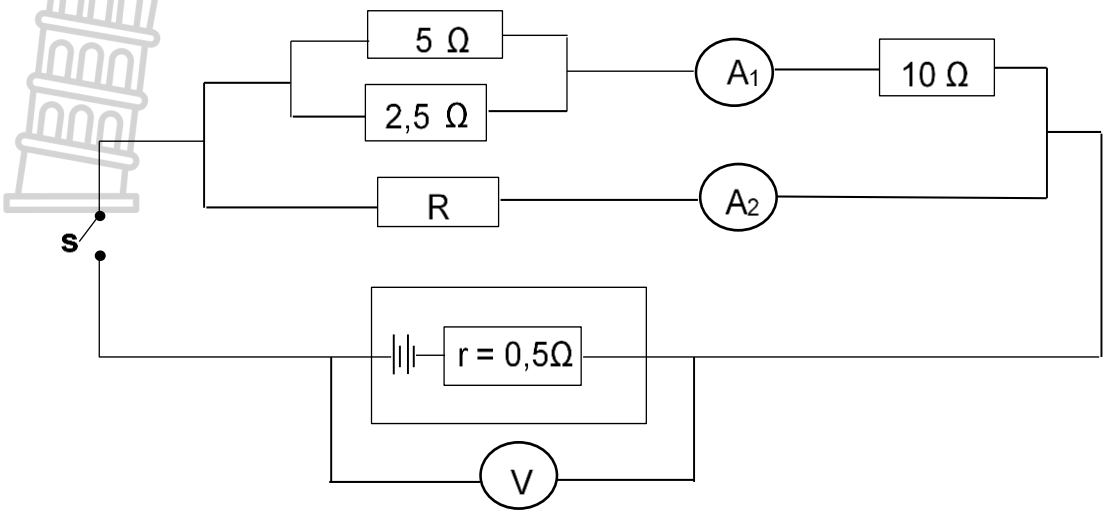
Use the graph to determine the value of the following:

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)

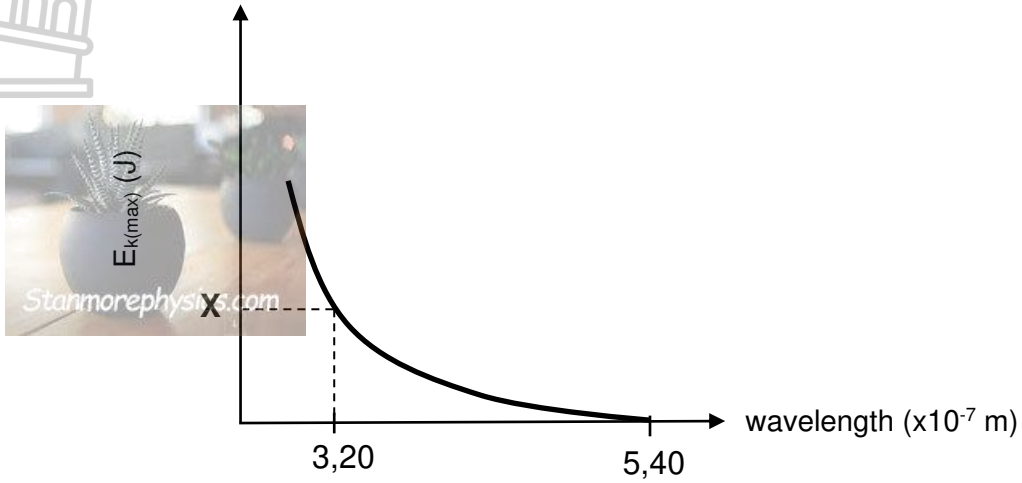
The unknown resistor **R** is now replaced by a conducting wire of negligible resistance.

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} $J \cdot s$
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*

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

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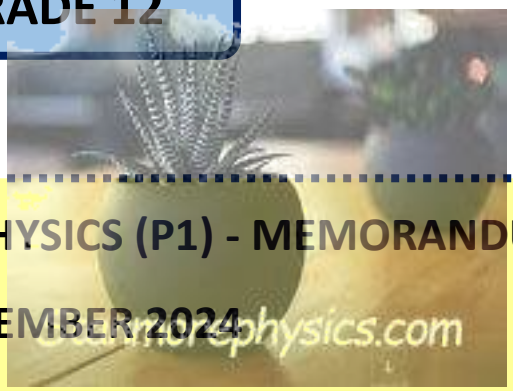
METRO CENTRAL EDUCATION DISTRICT

GRADE 12



PHYSICAL SCIENCES: PHYSICS (P1) - MEMORANDUM

SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

GRADE 12 **MARKING GUIDELINE** **SEPTEMBER 2024**

QUESTION 1

1.1 D ✓✓

1.2 B ✓✓

1.3 D ✓✓

1.4 C ✓✓

1.5 C ✓✓

1.6 D ✓✓

1.7 C ✓✓

1.8 A ✓✓

1.9 A ✓✓

1.10 D ✓✓

[20]

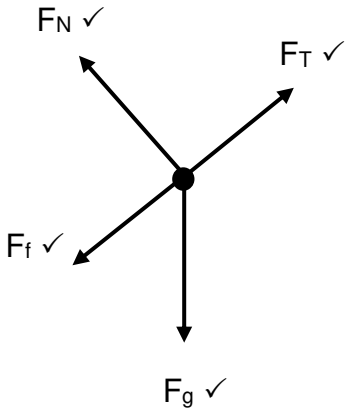
QUESTION 2

2.1.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. */Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

A body will remain in(its state of)rest or motion at constant velocity unless a non-zero resultant/net force/unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.
OR/*OF*
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net /unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto/ongebalanseerde krag daarop inwerk. (2)

2.1.2



Accepted Labels:

w	F_g / F_w / weight / mg / gravitational force/ force of gravity
T	F_T / Tension / F_{string}
f_k	$F_{friction}$ / F_f / Friction
N	F_{Normal} / Normal / F_N

Notes:

Mark awarded for label and arrow
Do not penalise for length of arrows since drawing is not to scale.
Any other additional force(s) → Max 3/4
If force(s) do not make contact with body → Max 3/4
NO MARK awarded for drawing F_g components .

(4)

2.1.3 $f_k = \mu_k N$ ✓
$f_k = (0,2)(9,8 \times 8)\cos 30^\circ$ ✓
$f_k = 13,579$ (or 13,58) N ✓ (3)

2.1.4 **POSITIVE MARKING from 2.1.3.**

8 kg Block

$F_{net} = ma$ ✓

$T + f_k + F_{g//} = ma$

$T - 13,579 - (8 \times 9,8)\sin 30^o$ ✓ $= 0$

$T = 52,779$ N

✓ any one subst. of 0

m_2 Block

$F_{net} = ma$

$F_g - T = ma$

$9,8m_2 - 52,779$ ✓ $= 0$

$9,8m_2 = 52,78$

$m_2 = 5,386$ kg OR 5,39 kg ✓

Note: Accept using energy principles for full marks.
Note: if using the systems approach, max. 2 marks.[1 mark for formula and 1 mark for final answer only] (5)

2.1.5 INCREASE. ✓

From point Y onwards the 8 kg block is moving on a frictionless surface therefore force acting up the slope is greater / force acting down the slope is less.
OR
Net force increases since frictional force is absent.
OR
There is now an unbalanced force acting on the object.
OR
Acceleration is no longer zero. ✓ (2)

2.2.1 Every body in the universe attracts every other body with a force which is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres ✓ (2)

2.2.2

$$F = \frac{Gm_1m_2}{r^2} \quad ✓$$

$$Fg = \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(6,417 \times 10^{23}) ✓}{(6,38 \times 10^6 + 4,50 \times 10^9 + 3,3895 \times 10^6)^2 \ ✓}$$

$Fg = 1,2585 \times 10^{19}$ (or $1,26 \times 10^{19}$) N ✓ (4)

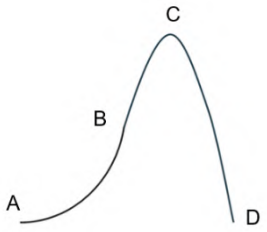
[22]

QUESTION 3

3.1 1,8 (s) – t_2 . ✓ (1)

3.2 **Marking criteria:**

- Correct formula for a ✓
- Correct substitution into formula ✓
- Final answer correct WITH direction ✓



- Accept gradient method for full marks.
- Accept using energy principles for full marks.

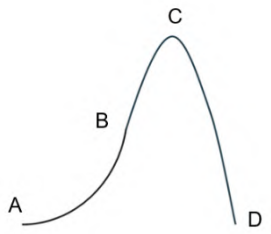
OPTION 1: (AB)	**OPTION 2: (AB)**
UPWARDS AS POSITIVE: $v_f = v_i + a\Delta t$ ✓ 29,7 = 0 + a(1,8) ✓ a = 16,50 m·s^{-2} up ✓ Do not penalise for a = 16,5 m·s^{-2} up	**DOWNWARDS AS POSITIVE:** $v_f = v_i + a\Delta t$ ✓ -29,7 = 0 + a(1,8) ✓ a = - 16,50 m·s^{-2} a = 16,50 m·s^{-2} up ✓
OPTION 3: $F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $ma = \frac{m(v_f - v_i)}{\Delta t}$ $a = \frac{(29,7-0)}{1,8}$ ✓ a = 16,50 m·s^{-2} , up ✓	

(3)

3.3 POSITIVE MARKING FROM 3.2

Marking criteria:

- Correct formula with Δy ✓
- Correct substitution into formula ✓
- Correct substitution into: $v_f^2 = v_i^2 + 2a\Delta y$ ✓
- Addition of displacements for max height ✓
- Final answer correct ✓



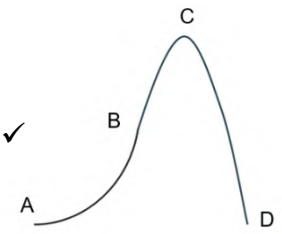
OPTION 1 **UPWARDS AS POSITIVE:**	**OPTION 2** **DOWNWARDS AS POSITIVE:**
Δy: (AB) $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(29,7)^2 = (0)^2 + 2(16,50)\Delta y$ ✓ $\Delta y = 26,73$ m, (upwards) **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 45,005$ m (upwards) Max height = 26,73 +✓ 45,0046 = 71,735 (or 71,73) m ✓	**Δy: (AB)** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-29,7)^2 = (0)^2 + 2(-16,50)\Delta y$ ✓ $\Delta y = -26,73$ m $\Delta y = 26,73$ m, upwards **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -45,0046$ m $\Delta y = 45,005$ m, upwards Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓
OPTION 3 **UPWARDS AS POSITIVE:**	**OPTION 4** **DOWNWARDS AS POSITIVE:**
Δy: (AB) $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (0)(1,8) + \frac{1}{2}(16,5)(1,8)^2$ ✓ $\Delta y = 26,73$ m **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 45,005$ m (upwards) Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓	**Δy: (AB)** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (0)(1,8) + \frac{1}{2}(-16,5)(1,8)^2$ ✓ $\Delta y = -26,73$ m $\Delta y = 26,73$ m, upwards **Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -45,0046$ m $\Delta y = 45,005$ m, upwards Max height = 26,73 + ✓45,0046 = 71,735 (or 71,73) m ✓

OPTION 5 **UPWARDS AS POSITIVE:**	**OPTION 6** **DOWNWARDS AS POSITIVE:**
Δy: (AB) $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(29,7)}{2}(1,8)$ ✓ Δy = 26,73 m	**Δy: (AB)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(-29,7)}{2}(1,8)$ ✓ Δy = - 26,73 m Δy = 26,73 m, upwards
Δy: (BC) $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (29,7)^2 + 2(-9,8)\Delta y$ ✓ Δy = 45,0046 m (upwards)	**Δy: (BC)** $v_f^2 = v_i^2 + 2a\Delta y$ $(0)^2 = (-29,7)^2 + 2(9,8)\Delta y$ ✓ Δy = - 45,0046 m Δy = 45,0046 m, upwards
Max height = 26,73 + ✓45,0046 = 71,7346 (or 71,73) m ✓	Max height = 26,73 +✓ 45,0046 = 71,7346 (or 71,73) m ✓

(5)

Marking criteria:

- Correct formula with Δy ✓
- Correct substitution into formula ✓
- Correct substitution of Δt into: $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓
- Addition for max height ✓
- Final answer correct ✓



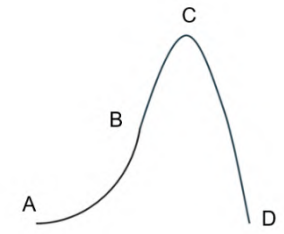
OPTION 7 **UPWARDS AS POSITIVE:**	**OPTION 8** **DOWNWARDS AS POSITIVE:**
Δy: (AB) $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(29,7)}{2}(1,8)$ ✓ Δy = 26,73 m **Δt: (BC)** $v_f = v_i + a\Delta t$ 0 = 29,7 + (-9,8) Δt Δt = 3,0306 s **Δy: (BC)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ $\Delta y = \frac{(29,7)+(0)}{2}(3,0306)$ ✓ Δy = 45,0044 m Max height = 26,73 + ✓ 45,0044 = 71,7344 (or 71,73) m ✓	**Δy: (AB)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓ $\Delta y = \frac{(0)+(-29,7)}{2}(1,8)$ ✓ Δy = - 26,73 m Δy = 26,73 m, upwards **Δt: (BC)** $v_f = v_i + a\Delta t$ 0 = (-29,7) + (9,8) Δt Δt = 3,0306 s **Δy: (BC)** $\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ $\Delta y = \frac{(-29,7)+(0)}{2}(3,0306)$ ✓ Δy = - 45,0044 m Δy = 45,0044 m, upwards Max height = 26,73 + ✓ 45,0046 = 71,7344 (or 71,73) m ✓

(5)

3.4 POSITIVE MARKING FROM 3.3

Marking criteria:

- Formula with Δt ✓
- Correct substitution into formula Δt ✓
- Addition of total time ✓
- Final answer correct ✓



OPTION 1:

UPWARDS POSITIVE

Δt: (BD)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$-26,73 = (29,7)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓

$\Delta t = 6,8568$ s

Value of t_2

$t_2 = 1,8 + 6,8568$ ✓

$= 8,6568$ (or 8,66) s ✓

OPTION 2:

DOWNWARDS POSITIVE

Δt: (BD)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$26,73 = (-29,7)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓

$\Delta t = 6,8568$ s

Value of t_2

$t_2 = 1,8 + 6,8568$ ✓

$= 8,6568$ (or 8,66) s ✓

OPTION 3:

UPWARDS POSITIVE

Δt: (CD)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$-71,7346 = (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓

$\Delta t = 3,82618$ s

Value of t_2

$t_2 = 1,8 + 3,0306 + 3,82618$ ✓

$= 8,65678$ (or 8,66) s ✓

OPTION 4:

DOWNWARDS POSITIVE

Δt: (CD)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$71,7346 = (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓

$\Delta t = 3,82618$ s

Value of t_2

$t_2 = 1,8 + 3,0306 + 3,82618$ ✓

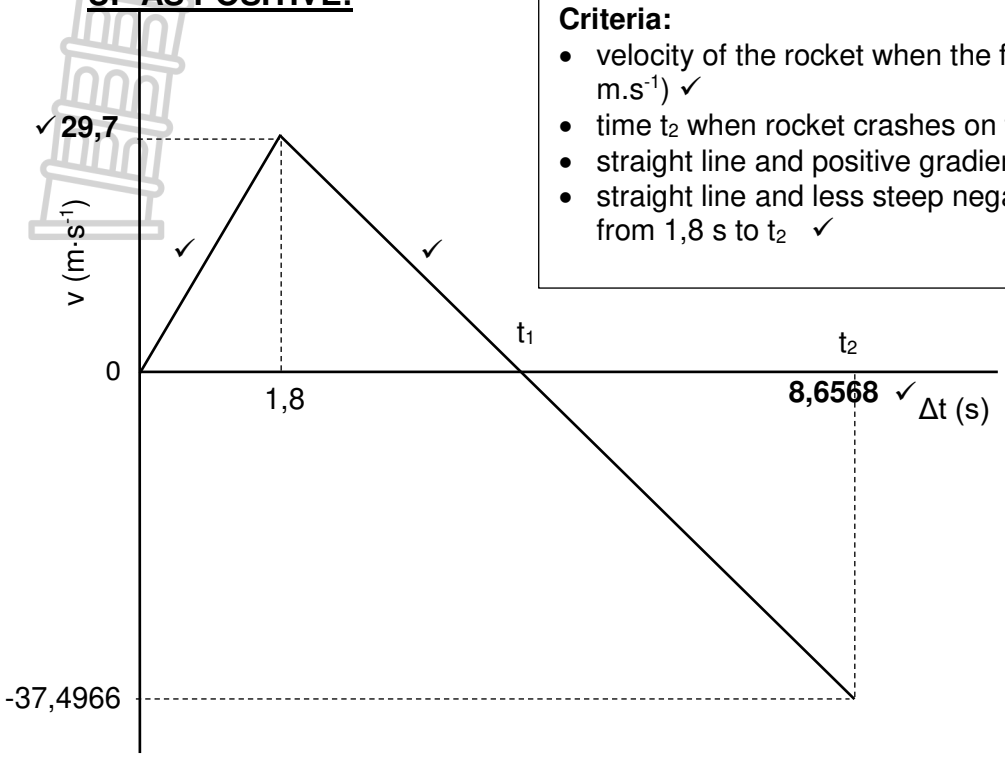
$= 8,65678$ (or 8,66) s ✓

OPTION 5 **UPWARDS AS POSITIVE:** **v_f: (BD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (29,7)^2 + 2(-9,8)(-26,73)$ $v_f = -37,4966\ m.s^{-1}$ **Δt: (BD)** $v_f = v_i + a\Delta t$ ✓ $(-37,4966) = (29,7) + (-9,8)\Delta t$ ✓ $\Delta t = 6,8568\ s\ s$ **Value of t_2** $t_2 = 1,8 + 6,8568$ ✓ $= 8,6568$ (or 8,66) s ✓	**OPTION 6** **DOWNWARDS AS POSITIVE:** **v_f: (BD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (-29,7)^2 + 2(9,8)(26,73)$ $v_f = 37,4966\ m.s^{-1}$ **Δt: (BD)** $v_f = v_i + a\Delta t$ ✓ $(37,4966) = (-29,7) + (9,8)\Delta t$ ✓ $\Delta t = 6,8568\ s\ s$ **Value of t_2** $t_2 = 1,8 + 6,8568$ ✓ $= 8,6568$ (or 8,66) s ✓
OPTION 7 **UPWARDS AS POSITIVE:** **v_f: (CD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (0)^2 + 2(-9,8)(-71,7346)$ $v_f = -37,4966\ m.s^{-1}$ **Δt: (CD)** $v_f = v_i + a\Delta t$ ✓ $(-37,4966) = (0) + (-9,8)\Delta t$ ✓ $\Delta t = 3,82618\ s$ **Value of t_2** $t_2 = 1,8 + 3,0306 + 3,82618$ ✓ $= 8,65678$ (or 8,66) s ✓	**OPTION 8** **DOWNWARDS AS POSITIVE:** **v_f: (CD)** $v_f^2 = v_i^2 + 2a\Delta y$ $v_f^2 = (-0)^2 + 2(9,8)(71,7346)$ $v_f = 37,4966\ m.s^{-1}$ **Δt: (CD)** $v_f = v_i + a\Delta t$ ✓ $(37,4966) = (-0) + (9,8)\Delta t$ ✓ $\Delta t = 3,82618\ s$ **Value of t_2** $t_2 = 1,8 + 3,0306 + 3,82618$ ✓ $= 8,65678$ (or 8,66) s ✓

(4)

3.5 **POSITIVE MARKING FROM 3.3 and 3.4**

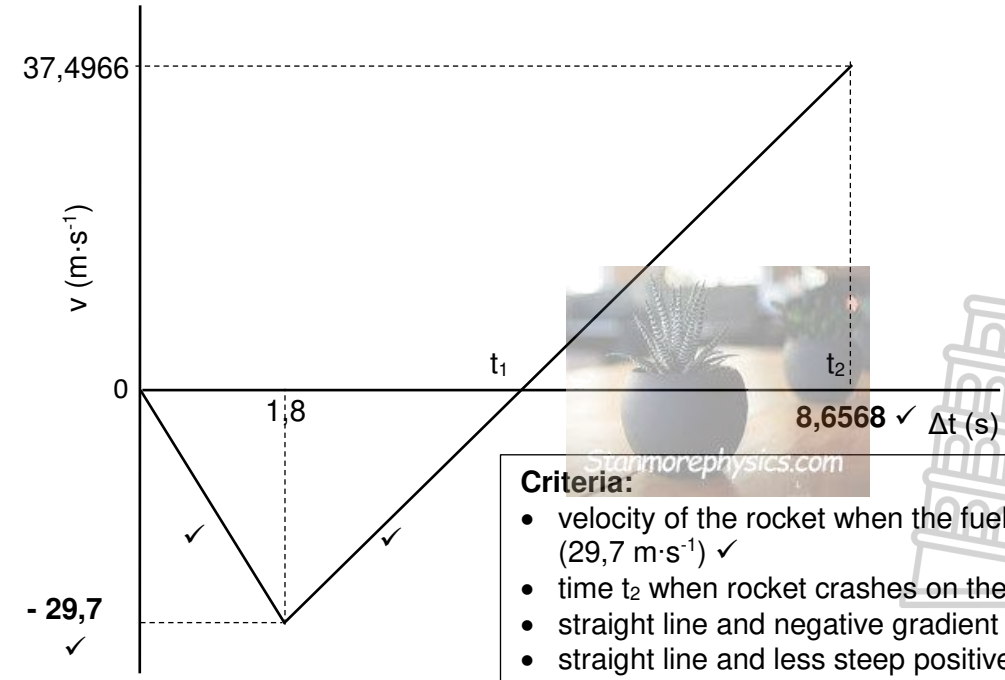
UP AS POSITIVE:



Criteria:
- velocity of the rocket when the fuel runs out (29,7 $m.s^{-1}$) ✓
- time t_2 when rocket crashes on the ground ✓
- straight line and positive gradient for first 1,8 s ✓
- straight line and less steep negative gradient from 1,8 s to t_2 ✓

(4)

DOWN AS POSITIVE:



Criteria:
- velocity of the rocket when the fuel runs out (29,7 $m·s^{-1}$) ✓
- time t_2 when rocket crashes on the ground ✓
- straight line and negative gradient for first 1,8 s ✓
- straight line and less steep positive gradient from 1,8 s to t_2 ✓

(4)
[17]

QUESTION 4

4.1 In an isolated system ✓ the total mechanical energy remains constant/is conserved ✓

OR

In an isolated system ✓The sum of gravitational potential energy and kinetic energy remains constant ✓ (2)

4.2

$$(E_p + E_k)_{Before} = (E_p + E_k)_{After}$$
$$(mgh + \tfrac{1}{2}mv^2)_{Before} = (mgh + \tfrac{1}{2}mv^2)_{After} \quad ✓$$
$$(3)(9,8)(1,2) ✓ + \tfrac{1}{2}(3)(0)^2 = (3)(9,8)(0) + \tfrac{1}{2}(3)v^2 \quad ✓$$
$$v = 4,8497 \text{ or } 4,85 \text{ m·s}^{-1} ✓$$

Accept W_{NC} for full marks. (4)

4.3 In an isolated system ✓ total linear momentum remains constant /is conserved. ✓

OR

In an isolated system the total linear momentum before collision equals the total momentum after collision. ✓ → [1 mark]

NOTE: NO marks to be awarded if **closed system** is used. (2)

4.4 **POSITIVE MARKING FROM 4.2**

Right +

$$\sum p_{before} = \sum p_{after} \quad ✓$$
$$m_p v_{pi} + m_b v_{bi} = m_p v_{pf} + m_p v_{bf}$$
$$(3)(4,8497) ✓ + (1)(0) = (3)(1,8) + (1)v_{bf} ✓$$
$$v_{bf} = 9,1491 (9,15) \text{ m·s}^{-1} ✓ \text{ (right)}$$

(4)

4.5 **POSITIVE MARKING FROM 4.4**

$$(E_p + E_k)_{Before} = (E_p + E_k)_{After}$$
$$(mgh + \tfrac{1}{2}mv^2)_{Before} = (mgh + \tfrac{1}{2}mv^2)_{After}$$
$$(1)(9,8)(0) + \tfrac{1}{2}(1)(9,1491)^2 ✓ = (1)(9,8)h ✓ + \tfrac{1}{2}(1)(0)^2$$
$$h = 4,27 \text{ m} ✓$$

Accept W_{NC} for full marks

Do NOT accept equations of motion. (3)

[15]

QUESTION 5

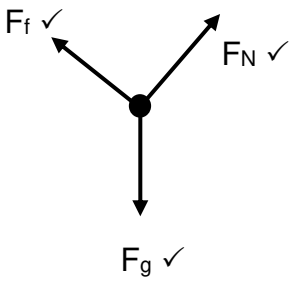
5.1

Marking criteria/*Nasienkriteria*

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The net work done on an object by a force is equal to the change in the object's kinetic energy. ✓✓ OR
The work done on an object by a resultant / net force is equal to the change in the object's kinetic energy. ✓✓ (2)

5.2



Accepted Labels:

w	F_g / F_w / weight / mg / gravitational force/ force of gravity
f_k	$F_{friction}$ / F_f / Friction
N	F_{Normal} / Normal / F_N

Notes:

Mark awarded for label and arrow
Do not penalise for length of arrows since drawing is not to scale.
Any other additional force(s) → Max 2/3
If force(s) do not make contact with body → Max 2/3

(3)

5.3

OPTION 1

$$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity} \checkmark$$

$$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$$

$$W_{net} = 0 + (0{,}42)(850)(9.8)(\cos 30°) \checkmark (200)(\cos 180°) \checkmark + (850)(9{,}8)(200)(\cos 60°) \checkmark$$

$$W_{net} = (-\ 605\ 975{,}2955) + 833\ 000$$

$$W_{net} = 227\ 024,7045 \text{ (or } 227\ 024,7) \text{ J} \checkmark$$

OR

$$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity} \checkmark$$

$$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$$

$$W_{net} = 0 + (0{,}42)(850)(9.8)(\cos 30°) \checkmark (200)(\cos 180°) \checkmark + (850)(9{,}8)\sin 30^0(200)(\cos 0°) \checkmark$$

$$W_{net} = (-\ 605\ 975{,}2955) + 833\ 000$$

$$W_{net} = 227\ 024,7045\ (227\ 024,7) \text{ J} \checkmark$$

(Check the range)

OPTION 2

$$W_{net} = \Delta E_K \checkmark$$

$$(W_{Fnormal}) + W_{friction} + W_{Fgravity} = \Delta E_K$$

$$(0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta = \Delta E_K$$

$$0 + \underline{(0,42)(850)(9.8)(\cos 30°)}\checkmark\underline{(200)(\cos 180°)}\checkmark + \underline{(850)(9,8)(200)(\cos 60°)} \checkmark = \Delta E_K$$

$$- 605\,975,2955 + 833\,000 = \Delta E_K$$

$$W_{net} = \Delta E_K = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

OPTION 3

$W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity}$ ✓

$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$

$W_{net} = (0) + \underline{(0,42)(850)(9.8)(\cos 30°)}$ ✓$\underline{(200)(\cos 180°)}$ ✓ + $\underline{(850)(9,8)(100)(\cos 0°)}$ ✓

$W_{net} = (- 605\,975,2955) + 833\,000$

$W_{net} = 227\,024,7045$ (or $227\,024,7$) J ✓

OPTION 4

$$W_{net} = \Delta E_K \checkmark$$

$$(W_{Fnormal}) + W_{friction} + W_{Fgravity} = \Delta E_K$$

$$(0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta = \Delta E_K$$

$$0 + \underline{(0,42)(850)(9.8)(\cos 30°)}\checkmark\underline{(200)(\cos 180°)}\checkmark + \underline{(850)(9,8)(100)(\cos 0°)} \checkmark = \Delta E_K$$

$$- 605\,975,2955 + 833\,000 = \Delta E_K$$

$$W_{net} = \Delta E_K = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

OPTION 5

$$F_{net} = F_{g\,//} - F_k$$

$$F_{net} = (850)(9,8)(\sin 30°) – (0,42)(850)(9,8)(\cos 30°) \checkmark$$

$$F_{net} = 1135,123522 \text{ N}$$

$$W_{net} = F_{net}.\Delta x.\cos\theta \checkmark$$

$$W_{net} = (1135,123522) \checkmark (200)(\cos 0°) \checkmark$$

$$W_{net} = 227\,024,7045 \text{ (or } 227\,024,7) \text{ J} \checkmark$$

(5)

5.4

$$\Delta E_{K \text{ from B to C}} = E_{Kf} - E_{Ki}$$

$$\underline{-108\,950 = E_{Kf} - 227\,024,7045} \checkmark$$

$$E_{Kf \text{ at C}} = 118\,074,7045$$

OPTION 1

$$W_{net} = \Delta E_K \checkmark$$

$$W_{Fnormal} + W_{Fgravity} + W_{friction} + W_{Fbrakes} = \Delta E_K$$

$$0 + 0 + \mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = E_{Kf \text{ at D}} - E_{Ki \text{ at C}}$$

$$0 + 0 + \underline{(0,42)(850)(9,8)} \checkmark \underline{(50)(\cos 180°)} \checkmark + \underline{F_{brakes}.(50)(\cos 180°)} \checkmark = \underline{0 - 118\,074,7045} \checkmark$$

$$F_{brakes} = -1137,106 \text{ N}$$

$$\therefore \text{ magnitude of } F_{brakes} = 1137,106 \text{ N} \checkmark$$

OPTION 2

$$W_{nc} = \Delta E_P + \Delta E_K \checkmark$$

$$W_{friction} + W_{Fbrakes} = (E_{P \text{ at D}} - E_{P \text{ at C}}) + (E_{Kf \text{ at D}} - E_{Ki \text{ at C}})$$

$$\mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = (mgh_D - mgh_C) + (E_{Kf \text{ at D}} - E_{Ki \text{ at C}})$$

$$\underline{(0,42)(850)(9,8)} \checkmark \underline{(50)(\cos 180°)} \checkmark + \underline{F_{brakes}.(50)(\cos 180°)} \checkmark = (0 - 0) + \underline{(0 - 118\,074,7045)} \checkmark$$

$$F_{brakes} = -1137,106 \text{ N}$$

$$\therefore \text{ magnitude of } F_{brakes} = 1137,106 \text{ N} \checkmark$$

OPTION 3 and 4

$\Delta E_{K \text{ from B to C}} = E_{Kf} - E_{Ki}$

$-108\,950 = E_{Kf} - 227\,024,7045$ ✓

$E_{Kf \text{ at C}} = 118\,074,7045$ J

$$E_{K \text{ at C}} = \frac{1}{2}mv^2$$

$$118\,074,7045 = \frac{1}{2}(850)v^2$$

$$v_{at\ C} = 16,6680 \text{ m·s}^{-1}$$

OPTION 3

$$W_{net} = \Delta E_K \checkmark$$

$$W_{Fnormal} + W_{Fgravity} + W_{friction} + W_{Fbrakes} = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$0 + 0 + \mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$$

$(0,42)(850)(9,8)$ ✓ $(50)(\cos 180°)$ ✓ $+ F_{brakes}.(50)(\cos 180°)$ ✓ $= \frac{1}{2}(850)(0^2 - 16,6680^2)$ ✓

$$F_{brakes} = -1137,106 \text{ N}$$

$$\therefore \text{ magnitude of } F_{brakes} = 1137,106 \text{ N} \checkmark$$

OPTION 4

$$W_{nc} = \Delta E_P + \Delta E_K \checkmark$$

$$W_{friction} + W_{Fbrakes} = (E_{P \text{ at D}} - E_{P \text{ at C}}) + \frac{1}{2}m(v_f^2 - v_i^2)$$

$$\mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = (mgh_D - mgh_C) + \frac{1}{2}m(v_f^2 - v_i^2)$$

$(0,42)(850)(9,8)$ ✓ $(50)(\cos 180°)$ ✓ $+ F_{brakes}.(50)(\cos 180°)$ ✓ $= (0 - 0) + \frac{1}{2}(850)(0^2 - 16,6680^2)$ ✓

$$F_{brakes} = -1137,106 \text{ N}$$

$$\therefore \text{ magnitude of } F_{brakes} = 1137,106 \text{ N} \checkmark$$

(7)
[17]

QUESTION 6

6.1 The change in frequency (or pitch) ✓ of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓ **OR**

The apparent change in frequency/pitch/wavelength ✓ of the sound detected by the listener due to the relative motion between listener and source. ✓ (2)

6.2

Moving Towards

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$253\,380 = \frac{v}{v-20} f_s$ ✓

$f_s = \frac{(253\,380)(v-20)}{v}$

✓ (Converting)

Moving Away

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$

$246\,710 = \frac{v}{v+20} f_s$ ✓

$f_s = \frac{(246\,710)(v+20)}{v}$

Equate

$\frac{(253\,380)(v-20)}{v} = ✓ \frac{(246\,710)(v+20)}{v}$

$v = 1\,499,52\ m \cdot s^{-1}$ ✓

(6)

6.3 REMAINS THE SAME ✓
Frequency emitted by the source does not depend on the speed of the source.

OR

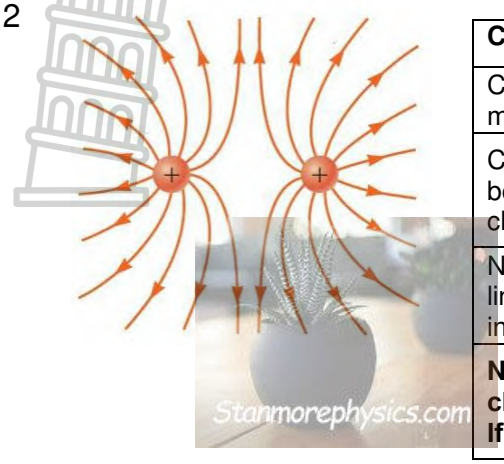
Frequency of the source is the same. ✓ (2)

[10]

QUESTION 7

7.1 S ✓ (1)

7.2



Criteria for sketch	Marks
Correct direction of field lines & minimum of 8 lines per charge	✓
Correct shape of the electric field lines between charges and on the outside of the charges.	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge.	✓
Note: If learner draws field pattern of two opposite charges: 0/3 **If only one charge is drawn, max: 1/3 for direction.**	

(3)

7.3

$$Q_{new} = \frac{Q_1 + Q_2}{2}$$

$$Q_{new} = \frac{6\times10^{-6} + 2\times10^{-6}}{2} \checkmark$$

$$\therefore Q_s = +4\times10^{-6}\ C \checkmark$$

$$Q_{new} = \frac{Q_1 + Q_2}{2}$$

$$Q_{new} = \frac{6 + 2}{2} \checkmark$$

$$\therefore Q_s = 4\ \mu C \checkmark$$

(2)

7.4 **Positive marking from 7.3.**

Charge S

(a) $\Delta Q = 4\times10^{-6} - 2\times10^{-6}$

$= +2\times10^{-6}\ C$

(b) $n = \frac{Q}{e}$ ✓

$n = \frac{2\times10^{-6}}{1,6\times10^{-19}}$ ✓

$n = 1,25\times10^{13}$ electrons ✓

Charge R

(a) $\Delta Q = 4\times10^{-6} - 6\times10^{-6}$

$= -2\times10^{-6}\ C$

(b) $n = \frac{Q}{e}$ ✓

$n = \frac{-2\times10^{-6}}{-1,6\times10^{-19}}$ ✓

$n = 1,25\times10^{13}$ electrons ✓

(3)

7.5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓ (2)

7.5.2 **POSITIVE MARKING FROM 7.3**

$E_{net} = E_{R\ on\ X} + E_{S\ on\ X}$

$E_{net} = \frac{kQ_R}{r^2} + \frac{kQ_S}{r^2}$ ✓ [Any formula]

$= \frac{(9x10^9)(4x10^{-6})}{(10x10^{-3})^2}$ ✓ + ✓ $\frac{(9x10^9)(4x10^{-6})}{(2x10^{-3})^2}$ ✓

$= 3{,}6 \times 10^8 + 9 \times 10^9$

$E_{net} = 9{,}36 \times 10^9$ N·C^{-1} right ✓

Marking Criteria:
- ✓ Formula
- ✓ First Substitution
- ✓ Second Substitution
- ✓ Addition
- ✓ Final answer with direction

$E_{R\ on\ X} = \frac{kQ_R}{r^2}$ ✓ [Any formula]

$= \frac{(9x10^9)(4x10^{-6})}{(10x10^{-3})^2}$ ✓

$= 3{,}6 \times 10^8$ N·C^{-1}

$E_{S\ on\ X} = \frac{kQ_R}{r^2}$

$= \frac{(9x10^9)(4x10^{-6})}{(2x10^{-3})^2}$ ✓

$= 9 \times 10^9$ N·C^{-1}

$E_{net} = (3{,}6 \times 10^8) +$ ✓ (9×10^9)

$E_{net} = 9{,}36 \times 10^9$ N·C^{-1} right ✓

(5)

[16]

QUESTION 8

8.1.1 12 V ✓ (1)

8.1.2 12 – 8
= 4 V ✓ (1)

8.1.3

Option 1

gradient $= \frac{\Delta I}{\Delta V}$ ✓

$-\frac{1}{r}$ ✓ $= \frac{0-6}{12-0}$ ✓ [or any suitable co-ordinates]

$-\frac{1}{r} = -\frac{6}{12}$

r = 2 Ω ✓

Option 2

$r = -\frac{1}{\text{gradient}}$ ✓

$r = -\frac{1}{\frac{\Delta I}{\Delta V}}$ ✓

$r = -\frac{1}{\frac{0-6}{12-0}}$ ✓ [or any suitable co-ordinates]

r = 2 Ω ✓

Option 3

$V_{int} = Ir$ [lose formula mark]

4 ✓ $= 2r$ ✓ [or any suitable co-ordinates]

r = 2 Ω ✓ [max 3 marks] (4)

8.2.1 The maximum (total) energy ✓ provided by a battery per unit (positive) charge / per coulomb passing through it. ✓ OR

The maximum (total) work done ✓ by a battery per unit (positive) charge passing through it. ✓ (2)

8.2.2 19,125 V ✓ (1)

8.2.3

OPTION 1

$V_{int} = Ir$ ✓

$6,5 = I(0,5)$ ✓

$I_{circuit} = 13\ A$ ✓

OPTION 2

$\varepsilon = V_{ext} + Ir$ ✓

$19,125 = (19,125 - 6,5) + I(0,5)$ ✓

$I_{circuit} = 13\ A$ ✓

(3)

8.2.4

OPTION 1

(a) $\frac{1}{R_p} = \frac{1}{R1} + \frac{1}{R2}$ ✓

$= \frac{1}{5} + \frac{1}{2,5}$ ✓

$= 0,6\ \Omega$

$R_{A1} = 1,6667 + 10 = 11,6667\ \Omega$

(b) $V_p = 19,125 - 6,5$

$= 12,625\ V$

(c) $R = \frac{V_P}{I_{A1}}$

$11,6667 = \frac{12,625}{I_{A1}}$ ✓

$I_{A1} = 1,08\ A$ ✓

OPTION 2

(a) $\frac{1}{R_p} = \frac{1}{R1} + \frac{1}{R2}$ ✓

$= \frac{1}{5} + \frac{1}{2,5}$ ✓

$= 0,6\ \Omega$

$R_{A1} = 1,6667 + 10 = 11,6667\ \Omega$

(b) $V_p = 19,125 - 6,5$ ✓

$= 12,625\ V$

(c) $V_{10\Omega} = \frac{10}{11,6667} \times 12,625$

$= 10,8214\ V$

(d) $R_{10\Omega} = \frac{V_{10\Omega}}{I_{A1}}$

$10 = \frac{10,8214}{I_{A1}}$ ✓

$I_{A1} = 1,08\ A$ ✓

(4)

8.2.5 **POSITIVE MARKING FROM 8.2.3 AND 8.2.4**

OPTION 1

(a) $I_{circuit} = I_{A1} + I_{A2}$

$13 = 1,08 + I_{A2}$ ✓

$I_{A2} = 11,92$ A

(b) $R = \frac{V_P}{I_{A2}}$

$= \frac{12,625}{11,92}$ ✓

$R = 1,06\ \Omega$ ✓

OPTION 2

(a) $\varepsilon = I(R + r)$

$19,125 = 13(R + 0,5)$ ✓

$R_{ext} = 0,97115\ \Omega$

(b) $\frac{1}{R_{ext}} = \frac{1}{R1} + \frac{1}{R2}$

$\frac{1}{0,97115} = \frac{1}{11,6667} + \frac{1}{R}$ ✓

$R = 1,06\ \Omega$ ✓

OPTION 3

(a) $R_T = \frac{V_T}{I_T}$

$= \frac{19,125}{13}$ ✓

$R_T = 1,47115\ \Omega$

(b) $R_{ext} = R_T - r$

$R_{ext} = 1,47115 - 0,5$

$R_{ext} = 0,97115\ \Omega$

(c) $\frac{1}{R_{ext}} = \frac{1}{R1} + \frac{1}{R2}$

$\frac{1}{0,97115} = \frac{1}{11,6667} + \frac{1}{R}$ ✓

$R = 1,06\ \Omega$ ✓

(3)

8.2.6 Decrease ✓

- Total external resistance of the circuit decreases. ✓
- current in the circuit increases ✓
- V_{int} (= Ir) increases

From: emf = V_{ext} + V_{int}

- emf remains constant ✓

Therefore V (= V_{ext}) decreases (4)

[23]

QUESTION 9

9.1

Marking criteria

If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.

The process whereby electrons are emitted / ejected from a metal surface when light of suitable frequency is incident on that surface. (2)

9.2 $5,4 \times 10^{-7}$ ✓ (m) (1)

9.3 **POSITIVE MARKING FROM 9.2**

OPTION 1

$$E = W_o + Ek_{max} \quad ✓$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \tfrac{1}{2} m_e v^2$$

$$\frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(3,2 \times 10^{-7})} ✓ = \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(5,4 \times 10^{-7})} ✓ + \tfrac{1}{2}(9,11 \times 10^{-31})v^2 \ ✓$$

$$v^2 = 5,55937 \times 10^{11}$$

$$v = 745\,611,829 \text{ m·s}^{-1} / \ 7,4561 \times 10^{5} \text{ m·s}^{-1} \ ✓$$

OPTION 2 (a)

$$E = \frac{hc}{\lambda}$$

$$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(3,2 \times 10^{-7})} ✓$$

$$= 6,2156 \times 10^{-19} \text{ J}$$

(b)

$$W_0 = \frac{hc}{\lambda_0}$$

$$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(5,4 \times 10^{-7})} ✓$$

$$= 3,6833 \times 10^{-19} \text{ J}$$

(c)

$$E = W_o + Ek_{max} ✓$$

$$(6,2156 \times 10^{-19}) = (3,6833 \times 10^{-19}) + Ek_{max}$$

$$Ek_{max} = 2,5323 \times 10^{-19} \text{ J}$$

(c)

$$Ek_{max} = \tfrac{1}{2} mv^2$$

$$2,5323 \times 10^{-19} = \tfrac{1}{2}(9,11 \times 10^{-31})v^2 ✓$$

$$v = 745\,611,677 \text{ m·s}^{-1} / \ 7,456 \times 10^{5} \text{ m·s}^{-1} \ ✓$$

(5)

9.4 REMAIN THE SAME ✓
Intensity only affects number of photons incident onto the metal per second (and therefore the number of photoelectrons emitted from a metal surface per second)
OR
Intensity does not affect the kinetic energy of photoelectrons.
OR
Only frequency affects the kinetic energy of photoelectrons. ✓ (2)

TOTAL: 150