basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2023

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. 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, etc. 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. 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 Which ONE of the following quantities is the tendency of an object to resist a change to its state of motion?

A Inertia

B Impulse

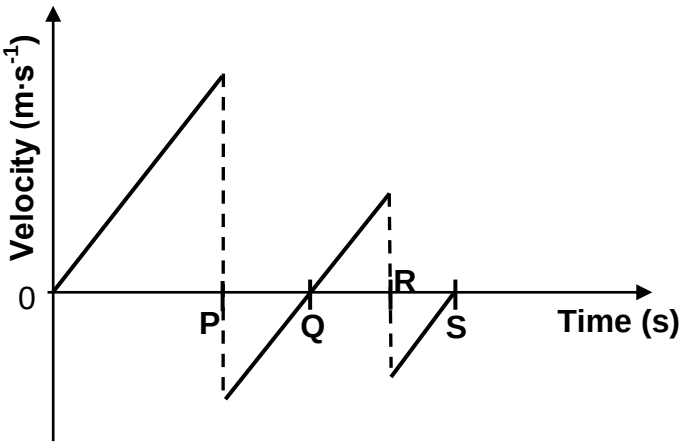
C Momentum

D Acceleration (2)

1.2 A ball is dropped from rest at a height above a concrete floor. The ball strikes the floor and bounces vertically up and down on the same spot on the floor.

The velocity-time graph for the bouncing ball is shown below, with points **P**, **Q**, **R** and **S** representing different times during the motion.

Ignore the effects of air resistance.



At which time does the ball reach its maximum height after the first upward bounce?

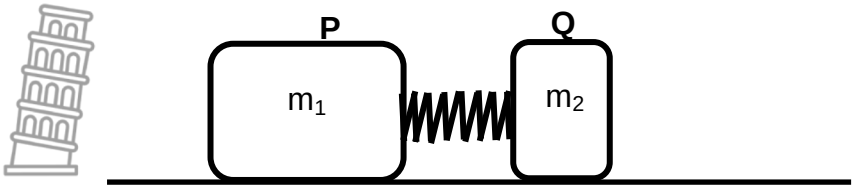
A **P**

B **Q**

C **R**

D **S** (2)

1.3 Two blocks, **P** and **Q**, of masses m_1 and m_2 respectively, are held at rest on a frictionless horizontal floor with a compressed spring between them, as shown below.



When the blocks are released and the spring drops to the floor, block **Q** moves to the right with velocity **v**.

Which ONE of the following represents the momentum of block **P** after the blocks are released?

A m_1**v** to the right

B m_2**v** to the right

C m_1**v** to the left

D m_2**v** to the left (2)

1.4 The magnitude of the gravitational force that spheres **X** and **Y** exert on each other is **F**.

The mass of sphere **X** is now doubled while the mass of sphere **Y** and the distance between the centres of the spheres remain the same.

Which ONE of the following combinations is CORRECT for the magnitude of the forces that the spheres now exert on each other?

	FORCE THAT X EXERTS ON Y	**FORCE THAT Y EXERTS ON X**
A	**F**	**F**
B	**F**	2**F**
C	2**F**	**F**
D	2**F**	2**F**

(2)

1.5 A hot-air balloon is moving vertically downwards at a CONSTANT SPEED. Assume that the mass of the hot-air balloon remains constant.

Which ONE of the following physical quantities associated with the hot-air balloon changes during the motion?

A Weight

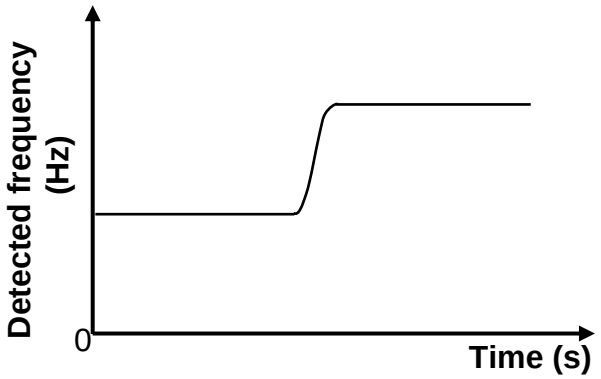
B Momentum

C Kinetic energy

D Potential energy (2)

1.6 A learner standing at a roadside records the frequency of sound waves produced by the siren of an ambulance. The ambulance is moving at constant velocity along a straight horizontal road.

The frequency-time graph for the detected sound is shown below.



Which ONE of the following statements concerning the motion of the ambulance is CORRECT?

The ambulance …

A approaches the learner and then passes the learner.

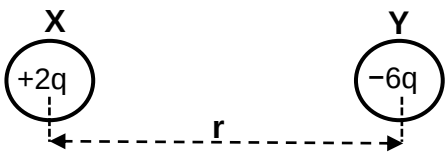
B moves away from the learner, then turns and approaches the learner.

C approaches the learner, then turns and moves away from the learner.

D moves away from the learner and then stops. (2)

1.7 Two identically charged spheres, **X** and **Y**, carry charges of +2q and −6q respectively.

Sphere **X** experiences an electrostatic force **F** to the right when the distance between their centres is **r**.



The spheres are brought into contact and are then returned to their original positions.

Which ONE of the following represents the magnitude of the electrostatic force that sphere **X** experiences now?

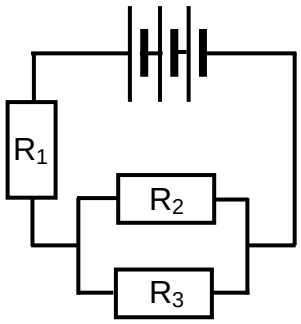
A $\frac{1}{4}$ **F**

B $\frac{1}{3}$ **F**

C 4 **F**

D 12 **F** (2)

1.8 In the circuit diagram below, R_1, R_2 and R_3 are identical resistors. The battery has negligible internal resistance.



The power dissipated by R_1 is **P**.

Which ONE of the following is the power dissipated by R_2?

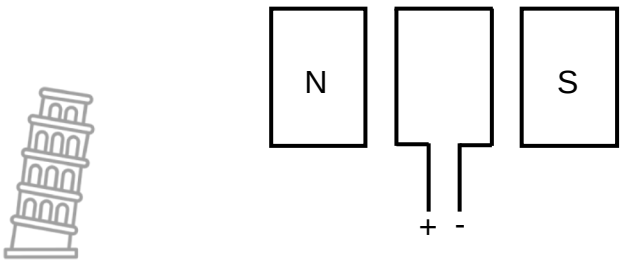
A $\frac{1}{4}$ **P**

B $\frac{1}{2}$ **P**

C 2 **P**

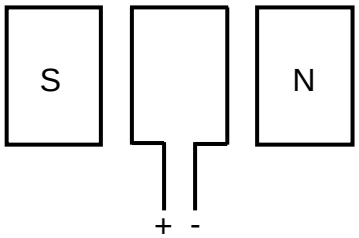
D 4 **P** (2)

1.9 The simplified diagram below represents a DC motor.

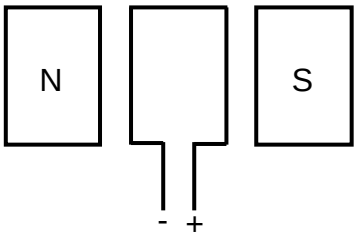


The diagrams below indicate some changes made to the above motor.

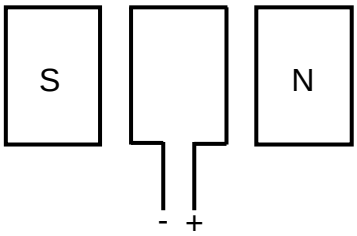
(i)



(ii)



(iii)



Which of the changes to the motor above will change the original direction of rotation of the coil?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (iii) only (2)

1.10 An atom has a ground state energy of **x**. When the atom moves to a higher energy state **y**, a line spectrum is observed.

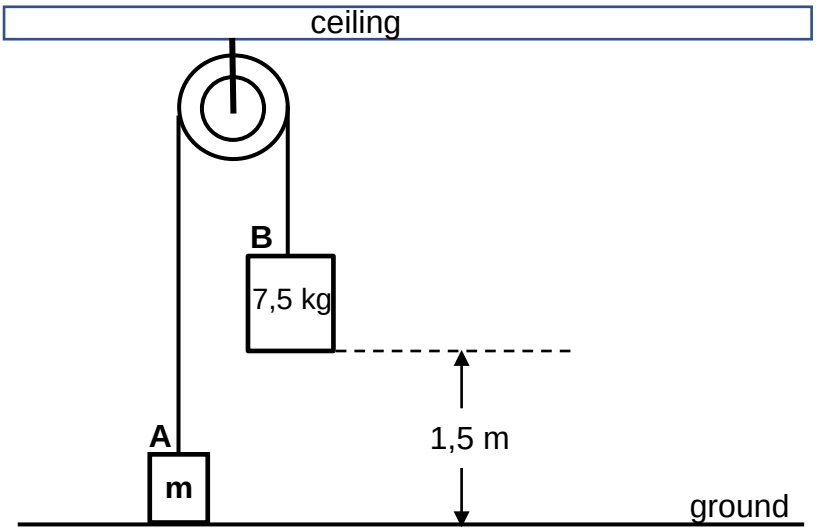
Which ONE of the following combinations is CORRECT for the ENERGY CHANGE of the atom and the TYPE OF LINE SPECTRUM observed during the transition?

	ENERGY CHANGE	TYPE OF LINE SPECTRUM
A	**y – x**	Emission
B	**x – y**	Emission
C	**x – y**	Absorption
D	**y – x**	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Block **A** of mass **m** is connected to block **B** of mass 7,5 kg by a light inextensible rope passing over a frictionless pulley. Block **B** is initially held at a height of 1,5 m above the ground, while block **A** is initially stationary on the ground, as shown in the diagram below.



When block **B** is released, it moves vertically downwards and strikes the ground with a velocity of 3,41 $m \cdot s^{-1}$.

Ignore the effects of friction.

2.1 Show, by means of a calculation, that the magnitude of the acceleration of block **B** was 3,88 $m \cdot s^{-2}$ while the block was moving vertically downwards. (3)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on block **B** immediately after it was released. (2)

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

2.4 Calculate the value of **m** by applying Newton's Second Law to EACH BLOCK while they are in motion. (5)

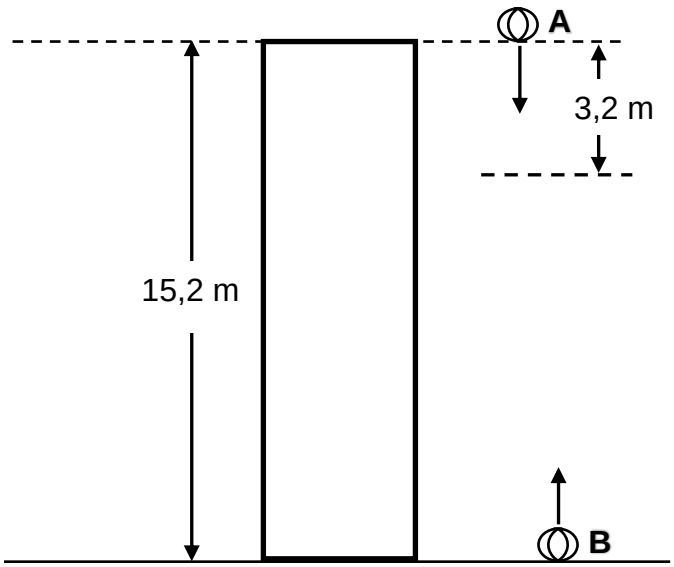
2.5 Calculate the maximum height above the ground reached by block **A**. (5)
[17]

QUESTION 3 (Start on a new page.)

Ball **A** is dropped from rest from the top of a building 15,2 m high.

After ball **A** has fallen 3,2 m, a second ball **B** is projected vertically upwards from the ground. After a while, the two balls strike the ground at the SAME time.

Ignore the effects of air resistance.



3.1 Define the term *free fall.* (2)

3.2 Calculate the:

3.2.1 Time taken for ball **A** to strike the ground (3)

3.2.2 Magnitude of the velocity with which ball **B** was projected from the ground (5)

3.3 On the same system of axes, draw position-time graphs to show the motions of both ball **A** and ball **B** from the instant ball **A** is dropped until the time it reaches the ground.

Take the ground as the zero position.

Label the graphs **A** and **B**.

Clearly indicate the following on the graphs:

- The starting time for each ball
- The initial position of each ball
- The time when the balls strike the ground (5)

[15]

QUESTION 4 (Start on a new page.)

Trolley **A** of mass 7,2 kg moves to the right at 0,4 m·s^{-1} in a straight line on a horizontal floor. It collides with a stationary trolley **B** of mass 5,3 kg.

After the collision, the trolleys lock together and move to the right, as shown in the diagram below.

Ignore any frictional effects.

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

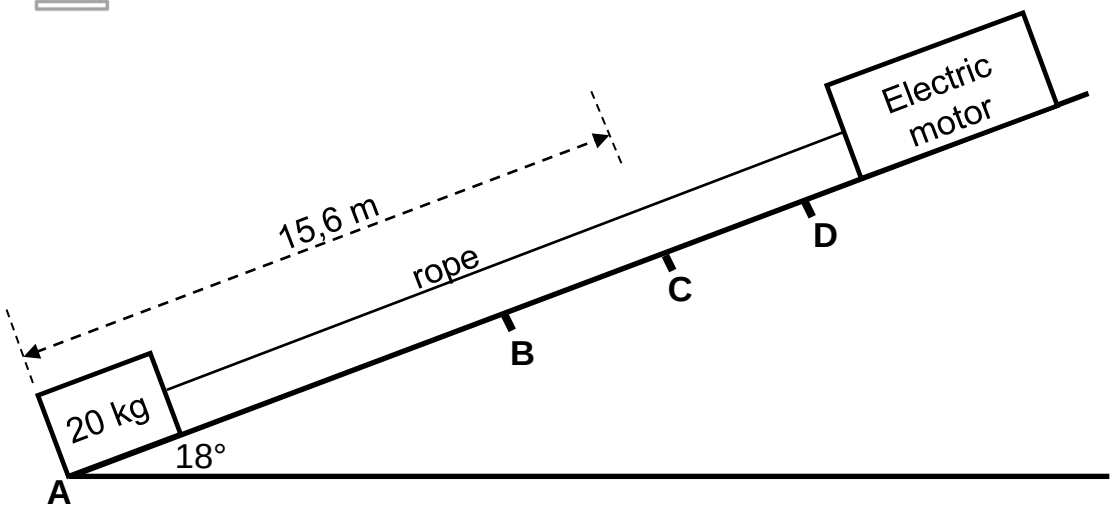
4.2 Calculate the magnitude of the:

4.2.1 Velocity of the trolleys immediately after the collision (3)

4.2.2 Average net force exerted by trolley **A** on trolley **B** during the collision, if the collision time is 0,02 s (3)
[8]

QUESTION 5 (Start on a new page.)

An electric motor pulls a 20 kg crate from rest at point **A** up an inclined plane by means of a light inextensible rope. The inclined plane makes an angle of 18° with the horizontal. **B**, **C** and **D** are points on the inclined plane and the distance between points **A** and **C** is 15,6 m, as shown in the diagram below.



The motor exerts a constant force of 96,8 N parallel to the inclined plane on the rope.

A constant frictional force of 13,5 N acts on the crate as it is moves on the inclined plane.

5.1 Define a *non-conservative force*. (2)

5.2 Use ENERGY PRINCIPLES to calculate the speed of the crate when it reaches point **C**. (5)

5.3 Calculate the minimum average power dissipated by the electric motor to pull the crate from point **A** to point **C**. (3)

When the crate reaches point **C**, the rope breaks. The crate continues moving up the inclined plane, comes to a stop at point **D**, and then slides down the plane past point **B**.

5.4 Draw a labelled free-body diagram for the crate as it slides down the plane past point **B**. (3)

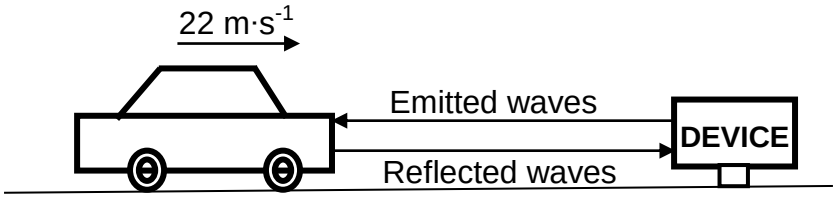
5.5 Draw a velocity-time graph for the entire motion of the crate starting from point **A** until it passes point **B** again on its motion down the inclined plane. (4)

[17]

QUESTION 6 (Start on a new page.)

6.1 A car moves at a constant velocity of 22 m·s^{-1} on a straight horizontal road TOWARDS a stationary device, which can both emit and detect sound waves.

The device emits sound waves with a frequency of 24 000 Hz. These sound waves are reflected off the car and the reflected sound waves are then detected by the device, as shown in the diagram below.



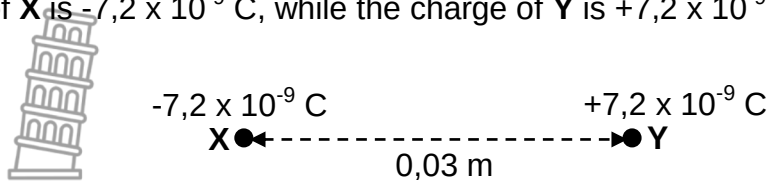
6.1.1 State the *Doppler effect* in words. (2)

6.1.2 If the speed of sound in air is 340 m·s^{-1}, calculate the frequency of the reflected sound waves detected by the device. (6)

6.2 The spectral lines observed for a distant star show that the star is moving away from Earth. Explain, by referring to frequency, how one can deduce that the star is moving away from Earth. (2)
[10]

QUESTION 7 (Start on a new page.)

Two point charges, **X** and **Y**, are held 0,03 m apart, as shown in the diagram below. The charge of **X** is $-7,2 \times 10^{-9}$ C, while the charge of **Y** is $+7,2 \times 10^{-9}$ C.

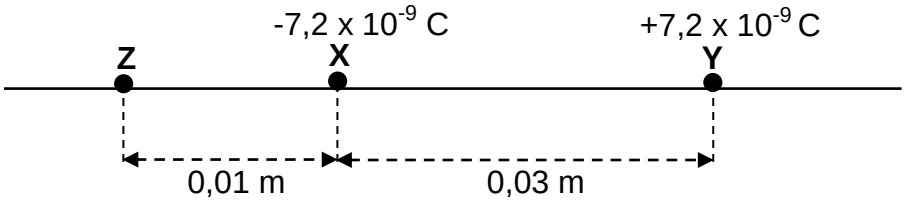


7.1 State Coulomb's law in words. (2)

7.2 Draw the net electric field pattern due to the two point charges. (3)

7.3 Calculate the magnitude of the electrostatic force that **Y** exerts on **X**. (3)

A third point charge, **Z**, of unknown positive charge, is positioned 0,01 m to the left of point charge **X** on the line joining point charges **X** and **Y**, as shown in the diagram below.



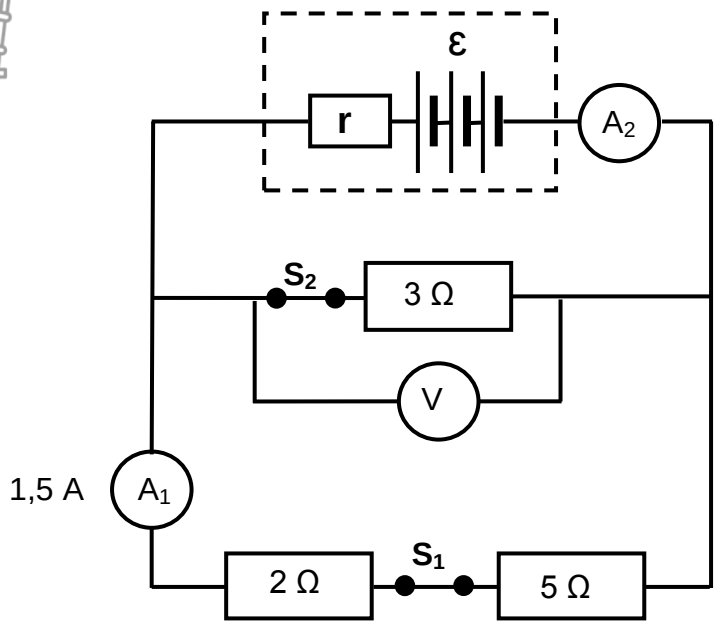
7.4 Draw a labelled vector diagram to show the directions of the electric fields at the point where **X** is positioned. (2)

7.5 The magnitude of the resultant electric field at the point where **X** is positioned is $4,91 \times 10^{5}$ N·C^{-1}.

Calculate the magnitude of charge **Z**. (5)
[15]

QUESTION 8 (Start on a new page.)

A battery with unknown emf (**ε**) and unknown internal resistance (**r**) is connected to three resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



8.1 State Ohm's law in words. (2)

Both switch **S_1** and switch **S_2** are CLOSED. The reading on ammeter **A_1** is 1,5 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Reading on ammeter **A_2** (4)

8.2.3 Power dissipated in the 3 Ω resistor (3)

Switch **S_1** is now OPENED, while switch **S_2** remains CLOSED. The reading on ammeter **A_2** is now 3,64 A.

8.3 Calculate the emf of the battery. (5)

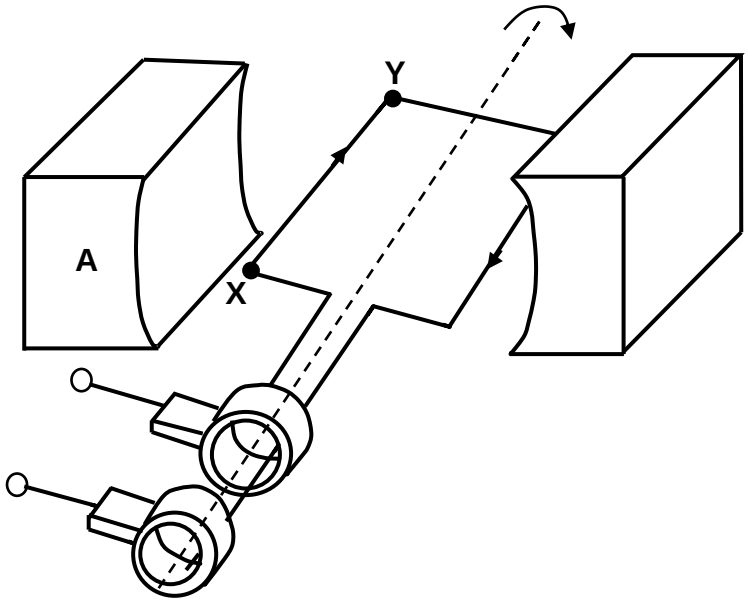
Switch **S_2** is now OPENED, while switch **S_1** is CLOSED.

8.4 How does the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer. (4)
[21]

QUESTION 9 (Start on a new page.)

9.1 The simplified sketch below represents an AC generator with the coil initially horizontal between the poles of a magnet. **X** and **Y** are two points on the coil, while **A** is one of the poles of the magnet.



When the coil of the generator rotates clockwise between the two poles of the magnet, the direction of the induced current is from **X** to **Y**, as shown above.

9.1.1 Is **A** the NORTH POLE or the SOUTH POLE of the magnet? (1)

9.1.2 The coil is now rotated through 180°.

Will the direction of the current be from **X** to **Y** or from **Y** to **X**? (1)

9.1.3 Sketch an emf-time graph for TWO complete rotations of the coil, starting from the position of the coil as shown in the diagram above. (3)

9.2 An electrical device is connected to an AC generator. The rms potential difference across the device is 200 V and the maximum current passing through the device is 6 A.

Calculate the:

9.2.1 Resistance of the device (4)

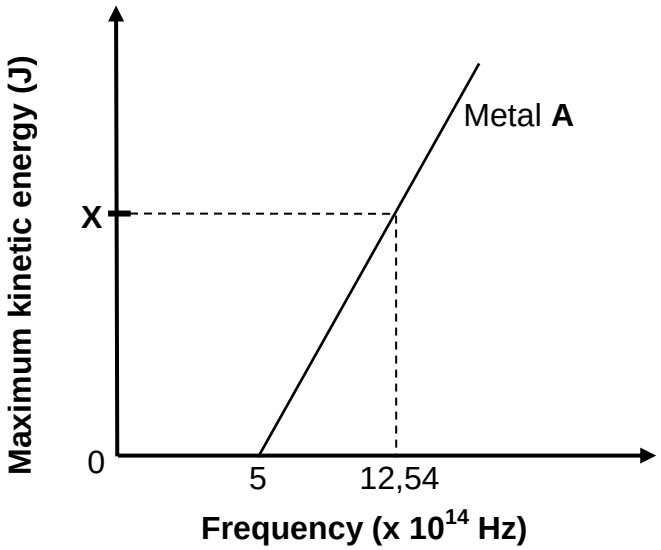
9.2.2 Energy consumed by the device in two hours (4)

[13]

QUESTION 10 (Start on a new page.)

In a photoelectric investigation, light of different frequencies was radiated on each of two metals, **A** and **B**. The graph of maximum kinetic energy of the ejected electrons from metal **A** and the frequency of the incident photons is shown below.

Point **X** on the graph represents an unknown maximum kinetic energy.



10.1 Write down the numerical value of the gradient of the graph. (1)

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

10.3 Calculate the:

10.3.1 Work function of metal **A** (3)

10.3.2 Value of **X** shown on the graph (4)

10.4 How will EACH of the following be affected if light of frequency 12,54 x 10^{14} Hz, but of higher intensity, is used?

Choose from INCREASES, DECREASES or NO EFFECT.

10.4.1 The value of **X** (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

Metal **B** has a larger work function than metal **A**.

10.5 Redraw the graph above in your ANSWER BOOK. (Do NOT include values on the axes.) Label this graph as **A**.

On the SAME set of axes, sketch the graph for metal **B**. Label this graph as **B**. (2)

[14]

TOTAL: 150

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	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or/*of* $E = W_0 + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or $K_{max} = \frac{1}{2}mv_{max}^2$	
$E = W_0 + E_{k(maks)}$ *of* $E = W_0 + K_{maks}$ *waar* $E = hf$ *en* $W_0 = hf_0$ *en* $E_{k(maks)} = \frac{1}{2}mv_{maks}^2$ *of* $K_{maks} = \frac{1}{2}mv_{maks}^2$	

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*

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 30 pages./
Hierdie nasienriglyne bestaan uit 30 bladsye.

GENERAL MARKING GUIDELINES PAPER 1
ALGEMENE NASIEN RIGLYNE VRAESTEL 1

1. CALCULATIONS/*BEREKENINGE*

1.1 **Marks will be awarded for**: correct formula, correct substitution, correct answer with unit.
***Punte sal toegeken word vir**: korrekte formule, korrekte substitusie, korrekte antwoord met eenheid.*

1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
***Geen punte** sal toegeken word waar 'n **verkeerde of ontoepaslike formule gebruik word** nie, selfs al is daar relevante simbole en relevante substitusies.*

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
*Wanneer 'n fout gedurende **substitusie in 'n korrekte formule** begaan word, sal 'n punt vir die korrekte formule en vir die korrekte substitusies toegeken word, maar **geen verdere punte** sal toegeken word nie.*

1.4 If **no formula** is given, but all **substitutions are correct**, a candidate will **forfeit one mark.**
*Indien **geen formule** gegee is nie, **maar al die substitusies is korrek, verloor** die kandidaat **een punt**.*

1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly.**
Geen penalisering** indien **nulwaardes nie getoon** word nie in berekeninge waar die **formule/beginsel korrek gegee is nie

1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
Wiskundige manipulasies en verandering van onderwerp van toepaslike formules tel geen punte nie, maar indien 'n kandidaat met die korrekte formule begin en dan die onderwerp van die formule verkeerd verander, sal punte vir die formule en korrekte substitusies toegeken word. Die punt vir die verkeerde numeriese antwoord word verbeur

1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
*Punte word slegs vir 'n formule toegeken indien 'n **poging tot 'n berekening aangewend is**, d.w.s. substitusies is gedoen of 'n numeriese antwoord is gegee.*

1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
Punte kan slegs toegeken word vir substitusies wanneer waardes in formules ingestel is en nie vir waardes wat voor 'n berekening gelys is nie.

1.9 All calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
Alle berekenings, wanneer dit nie in die vraag gespesifiseer word nie, moet tot 'n minimum van TWEE desimale plekke afgerond word.

1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
Indien 'n finale antwoord van 'n berekening korrek is, sal volpunte nie outomaties toegeken word nie. Nasieners sal altyd verseker dat die korrekte/toepaslike formule gebruik word en dat bewerkings, insluitende substitusies, korrek is

1.11 Questions where a series of calculations do not necessarily always have to follow the same order (as in circuit calculations), full marks will be awarded provided that it is a valid solution to the problem.
Vrae waar 'n reeks berekeninge nie noodwendig altyd in dieselfde volgorde hoef te wees nie (soos in stroombaanberekeninge) sal volpunte toegeken word op voorwaarde dat dit 'n geldige oplossing vir die probleem is.

1.12 Any calculation that will not bring the candidate closer to the answer than the original solution, will not count any marks.
Enige berekening wat nie die kandidaat nader aan die antwoord as die oorspronklike oplossing bring nie, sal geen punte tel nie.

2. Units/*Eenhede*

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
*Kandidate sal slegs een keer gepenaliseer word vir die herhaaldelike gebruik van 'n verkeerde **eenheid in 'n vraag**.*

2.2 Units are only required in the final answer to a calculation.
Eenhede word slegs in die finale antwoord op 'n berekening verlang.

2.3 Marks are only awarded for an answer, and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

Punte word slegs vir 'n antwoord en nie vir 'n eenheid op sigself toegeken nie. Kandidate sal dus die punt wat toegeken is vir die antwoord in elk van die volgende gevalle verbeur:
- Korrekte antwoord + verkeerde eenheid
- Verkeerde antwoord + korrekte eenheid
- Korrekte antwoord + geen eenheid

2.4 SI units must be used, except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this.
SI-eenhede moet gebruik word, behalwe in sekere gevalle, bv. $V \cdot m^{-1}$ in plaas van $N \cdot C^{-1}$, en $cm \cdot s^{-1}$ of $km \cdot h^{-1}$ in plaas van $m \cdot s^{-1}$ waar die vraag dit regverdig.

3 General/*Algemeen*

3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.

3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.
Vir nasiendoeleindes sal alternatiewe simbole (s, u, t, ens.) ook aanvaar word.

3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $m \cdot s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted.
Skei saamgestelde eenhede met 'n vermenigvuldigpunt, nie met 'n punt nie, bv. $m \cdot s^{-1}$. Vir nasiendoeleindes sal $m.s^{-1}$ en m/s ook aanvaar word.

4. Positive marking/*Positiewe nasien*

Positive marking regarding calculations will be followed in the following cases:
Positiewe nasien met betrekking tot berekenings sal in die volgende gevalle geld:

4.1 **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), **full marks** are to be awarded for the subsequent subquestions.
Subvraag na subvraag: *Wanneer 'n sekere veranderlike in een subvraag (bv. 3.1) bereken word en dan in 'n ander vervang moet word (3.2 of 3.3), word* ***volpunte*** *vir die daaropvolgende subvrae toegeken.*

4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.
'n Vraag met veelvuldige stappe in 'n subvraag: *Indien 'n kandidaat, byvoorbeeld, die stroom verkeerd bereken in die eerste stap as gevolg van 'n substitusiefout, verbeur die kandidaat die punt vir die substitusie sowel as die finale antwoord.*

5. Negative marking/*Negatiewe nasien*

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for, for example, QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should be considered.
'n Verkeerde antwoord, indien dit op 'n konsepsuele fout gebaseer is, kan nie korrek gemotiveer word nie. Indien die kandidaat dus gevra word om in VRAAG 3.2 die antwoord op VRAAG 3.1 te motiveer en VRAAG 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op, byvoorbeeld, VRAAG 3.1 egter op 'n berekening gebaseer is, moet die motivering vir die verkeerde antwoord in VRAAG 3.2 oorweeg word.

QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 B ✓✓ (accept Q/*aanvaar Q*) (2)

1.3 D ✓✓ (2)

1.4 D ✓✓ (2)

1.5 D ✓✓ (2)

1.6 B **OR/*OF*** D ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 A ✓✓ (2)

1.10 D ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

2.1

Marking criteria/*Nasienkriteria*

- Formula to calculate a./*Formule om a te bereken.* ✓
- Correct substitution to calculate a./*Korrekte vervanging om a te bereken.* ✓✓

OPTION 1/*OPSIE 1*

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{(3,41)^2}$ ✓$= \underline{(0)^2 + (2)a(1,5)}$ ✓

$a = 3,88\ m\cdot s^{-2}$

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{(-3,41)^2}$ ✓$= \underline{(0)^2 + (2)a(-1,5)}$ ✓

$a = -3,88$

$a = 3,88\ m\cdot s^{-2}$

OPTION 2/*OPSIE 2*

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$1,5 = \left(\frac{0 + 3,41}{2}\right)\Delta t$

$\Delta t = 0,88\ s$

$v_f = v_i + a\Delta t$ ✓

$\underline{-3,41}$ ✓$= \underline{(0) + a(0,88)}$ ✓

$a = -3,88$

$a = 3,88\ m\cdot s^{-2}$

OR/*OF*

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

$\underline{-1,5}$ ✓$= \underline{(0)(0,88) + \frac{1}{2}a(0,88)^2}$ ✓

$a = -3,88$

$a = 3,88\ m\cdot s^{-2}$

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$-1,5 = \left(\frac{0 - 3,41}{2}\right)\Delta t$

$\Delta t = 0,88\ s$

$v_f = v_i + a\Delta t$ ✓

$\underline{3,41}$ ✓$= \underline{(0) + a(0,88)}$ ✓

$a = 3,88\ m\cdot s^{-2}$

OR/*OF*

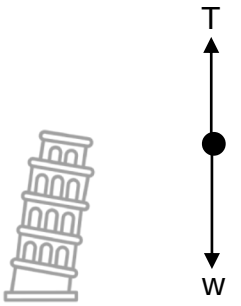
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\underline{1,5}$ ✓$= \underline{(0)(0,88) + \frac{1}{2}a(0,88)^2}$ ✓

$a = 3,88\ m\cdot s^{-2}$

(3)

2.2



ACCEPT/*AANVAAR*

	Accepted symbols/*Aanvaarde simbole*
w ✓	F_g/F_w/weight/*gewig*/mg/gravitational force/*gravitasiekrag*/$F_{Earth\ on\ block}$/ $F_{Aarde\ op\ blok}$/*73,5N*
T ✓	Tension/*Spanning*/$F_{Tension}$/$F_{Spanning}$/F_{rope}/F_{tou}/F_T/*F*

Notes/*Aantekeninge:*

- Mark awarded for label and arrow./*Punt toegeken vir byskrif en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max*/*Maks* $\frac{1}{2}$

(2)

2.3

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.*

When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp is.

OR/*OF*
The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force.
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwwerp in dieselfde rigting as die resulterende/netto krag.

(2)

2.4

Marking criteria/*Nasienkriteria*

- Any correct formula./*Enige korrekte formule.* ✓
- Correct substitution to calculate tension./*Korrekte vervanging om spanning te bereken.*✓✓
- Correct substitution to calculate mass of block A./*Korrekte vervanging om massa van blok A te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord*: 3,25 kg ✓

Calculation of tension (Block B) 3 marks: ***Berekening van spanning (Blok B)3 punte:***	**Calculation of mass (Block A) 2 marks:** ***Berekening van massa (Blok A) 2 punte:***
DOWNWARDS POSITIVE/*AFWAARTS POSITIEF*	**UPWARDS POSITIVE** ***OPWAARTS POSITIEF***
$F_{net} = ma$ $F_g + T = ma$ $mg - T = ma$ ✓Any one/ *Enige een* $7{,}5(9{,}8) - T$ ✓$= 7{,}5(3{,}88)$ ✓ $T = 44{,}40$ N	$F_{net} = ma$ $T - F_g = ma$ $T - mg = ma$ $44{,}40 - m(9{,}8) = m(3{,}88)$✓ $m = 3{,}25$ kg✓
UPWARDS POSITIVE/*OPWAARTS POSITIEF*	**DOWN POSITIVE** ***AF POSITIEF***
$F_{net} = ma$ $T - F_g = ma$ $T - mg = ma$ ✓Any one/ *Enige een* $T - 7{,}5(9{,}8)$ ✓$= 7{,}5(-3{,}88)$ ✓ $T = 44{,}40$ N	$F_{net} = ma$ $F_g - T = ma$ $mg - T = ma$ $m(9{,}8) - 44{,}40 = m(-3{,}88)$✓ $m = 3{,}25$ kg ✓

(5)

2.5

Marking criteria/*Nasienkriteria*

- Any correct formula./*Enige korrekte formule.* ✓
- Correct substitution of v_i and v_f ./*Korrekte vervanging van v_i en v_f.* ✓
- Correct substitution of 9,8 m·s^{-2}./Korrekte vervanging van 9,8 m·s^{-2}. ✓
- Adding 1,5 m to calculated Δy. /*Tel 1,5 m by berekende Δy*. ✓
- Correct final answer/*Korrekte finale antwoord*: 2,09 m ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(0^2) = (3,41)^2$ ✓ + $(2)(-9,8)\Delta y$ ✓

$\Delta y = 0,59$ m

Maximum height = 0,59 + 1,5 ✓

= 2,09 m ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(0^2) = (-3,41)^2$ ✓ + $(2)(9,8)\Delta y$ ✓

$\Delta y = -0,59$

$\Delta y = 0,59$ m

Maximum height = 0,59 + 1,5 ✓

= 2,09 m ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$

$0 = 3,41 + (-9,8)\Delta t$

$\Delta t = 0,35$ s

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

$= (3,41)(0,35)$ ✓ + $\frac{1}{2}(-9,8)(0,35)^2$ ✓

$= 0,59$ m

Maximum height = 0,59 + 1,5 ✓

= 2,09 m ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$

$0 = -3,41 + (9,8)\Delta t$

$\Delta t = 0,35$ s

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

$= (-3,41)(0,35)$ ✓ + $\frac{1}{2}(9,8)(0,35)^2$ ✓

$= -0,59$

$\Delta y = 0,59$ m

Maximum height = 0,59 + 1,5 ✓

= 2,09 m ✓

OPTION 3/*OPSIE 3* **UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ $0 = 3{,}41 + (-9{,}8)\Delta t$ $\Delta t = 0{,}35$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{3{,}41 + 0}{2}\right)$ ✓ (0,35) ✓ $= 0{,}59$ m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓	$v_f = v_i + a\Delta t$ $0 = -3{,}41 + (9{,}8)\Delta t$ $\Delta t = 0{,}35$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{-3{,}41 + 0}{2}\right)$ ✓ (0,35) ✓ $= -0{,}59$ m Maximum height = 0,59 + 1,5 ✓ = 2,09 m ✓

Note/*Aantekening*:
OPTION 4 TO 5/*OPSIE 4 TOT 5*
Substitution of incorrect mass/*Vervanging van verkeerde massa:*
max/maks: $^3/_5$

OPTION 4/*OPSIE 4*

$(E_{mech})_{top} = (E_{mech})_{bottom}$
$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$
$(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$
✓Any one/*Enige een*

$(9{,}8)(h) + (0)$ ✓ $= (0) + \frac{1}{2}(3{,}41)^2$ ✓
$h = 0{,}59$ m

Maximum height = 0,59 + 1,5 ✓
= 2,09 m ✓

OPTION 5/*OPSIE 5*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
✓Any one/*Enige een*

$(0) = (0) - \frac{1}{2}(3{,}41)^2$ ✓ $+ (9{,}8)(h)$ ✓
$h = 0{,}59$ m

Maximum height = 0,59 + 1,5 ✓
= 2,09 m ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓Any one/*Enige een*

$(9{,}8)(\Delta y)\cos 180°$ ✓ $= 0 - \frac{1}{2}(3{,}41)^2$ ✓
$\Delta y = 0{,}59$ m

Maximum height = 0,59 + 1,5 ✓
= 2,09 m ✓

(5)
[17]

QUESTION 3/*VRAAG 3*

3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasie/gewig/gravitasiekrag.
(2 or/of 0)

OR/*OF*
Motion in which the only force acting is the gravitational force.
Beweging waar die enigste krag wat inwerk gravitasiekrag is. (2)

3.2.1

Marking criteria/*Nasienkriteria*
- Formula to calculate Δt./*Formule om Δt te bereken.* ✓
- Correct substitution to calculate Δt./Korrekte v*ervanging om Δt te bereken.* ✓
- Final answer/*Finale antwoord*: 1,76 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-15,2 = (0) + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 1,76$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$15,2 = (0) + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 1,76$ s ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(-9,8)(-15,2)$
$v_f = -17,26\ m\cdot s^{-1}$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(9,8)(15,2)$
$v_f = 17,26\ m\cdot s^{-1}$

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$-17,26 = (0) + (-9,8)\Delta t$ ✓
$\Delta t = 1,76$ s ✓

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15,2 = \left(\frac{0 - 17,26}{2}\right)\Delta t$ ✓
$\Delta t = 1,76$ s ✓

OPTION 3/*OPSIE 3*
$(E_{mech})_{top} = (E_{mech})_{bottom}$
$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$
$(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$
$(9,8)(15,2) + 0 = 0 + (\frac{1}{2})(v_f)^2$
$v_f = 17,26\ m\cdot s^{-1}$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$17,26 = (0) + (9,8)\Delta t$ ✓
$\Delta t = 1,76$ s ✓

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$15,2 = \left(\frac{0 + 17,26}{2}\right)\Delta t$ ✓
$\Delta t = 1,76$ s ✓

OPTION 4/*OPSIE 4*
$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
$0 = \frac{1}{2}(v_f^2 - 0) + (9,8)(15,2)$
$v_f = 17,26\ m\cdot s^{-1}$

OPTION 5/*OPSIE 5*
$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(9,8)(15,2)\cos 180° = 0 - \frac{1}{2}(v_f)^2$
$v_f = 17,26\ m\cdot s^{-1}$

OPTION 6/*OPSIE 6*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	
$F_{net}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $-9,8\Delta t = -17,26 - (0)$ ✓ $\Delta t = 1,76$ s ✓	$F_{net}\Delta t = \Delta p = m(v_f - v_i)$ $mg\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $9,8\Delta t = 17,26 - (0)$ ✓ $\Delta t = 1,76$ s ✓

(3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1.**
POSITIEWE NASIEN VANAF VRAAG 3.2.1.

Marking criteria/*Nasienkriteria*

- Correct substitution to calculate Δt for ball A./*Korrekte vervanging om Δt te bereken vir bal A.* ✓
- Subtraction 1,76 – 0,81./*Aftrekking 1,76 – 0,81.* ✓
- Correct formula to calculate v_i for ball B./*Korrekte formule om v_i te bereken vir bal B.* ✓
- Correct substitution to calculate v_i for ball B./*Korrekte vervanging om v_i te bereken vir bal B.* ✓
- Final answer/*Finale antwoord:* 4,66 $m\cdot s^{-1}$ ✓ (4,66 to/*tot* 4,7)

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $(0) = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $v_f = v_i + a\Delta t$ $-v_i = v_i + (-9,8)(0,95)$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓
DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $v_f = v_i + a\Delta t$ $v_i = -v_i + (9,8)(0,95)$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓

Calculate/*Bereken*:
$v_f = 7,92\ m\cdot s^{-1}$

OPTION 3/*OPSIE 3*
UPWARDS +/
***OPWAARTS* +**
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(-9,8)(-3,2)$
$v_f = -7,92\ m\cdot s^{-1}$ →

DOWNWARDS +/
***AFWAARTS* +**
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (0)^2 + (2)(9,8)(3,2)$
$v_f = 7,92\ m\cdot s^{-1}$ →

OPTION 4/*OPSIE 4*
$(E_{mech})_{top} = (E_{mech})_{bot}$
$(E_p + E_k)_{top} = (E_p + E_k)_{bot}$
$(mgh+½mv_i^2)_{top} = (mgh+½mv_f^2)_{bot}$
$(9,8)(3,2) + 0 = 0 + (½)(v_f)^2$
$v_f = 7,92\ m\cdot s^{-1}$ →

OPTION 5/*OPSIE 5*
$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$
$0 = ½(v_f^2 - 0) + (9,8)(3,2)$
$v_f = 7,92\ m\cdot s^{-1}$ →

OPTION 6/*OPSIE 6*
$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$
$(9,8)(3,2)\cos 0° = ½v_f^2 - 0$
$v_f = 7,92\ m\cdot s^{-1}$ →

Calculate/*Bereken*:
$\Delta t(B) = 0,95\ s$

UPWARDS +/
***OPWAARTS* +**
$v_f = v_i + a\Delta t$
$-7,92 = (0) + (-9,8)\Delta t$ ✓
$\Delta t = 0,81\ s$

$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95\ s$ →

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$-3,2 = \left(\frac{0 - 7,92}{2}\right)\Delta t$ ✓
$\Delta t = 0,81\ s$

$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95\ s$ →

OR/*OF*
$\Delta y = v_i\Delta t + ½a\Delta t^2$
-12 ✓ $= -7,92\Delta t + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 0,95\ s$ →

DOWNWARDS +/
***AFWAARTS* +**
$v_f = v_i + a\Delta t$
$7,92 = (0) + (9,8)\Delta t$ ✓
$\Delta t = 0,81\ s$

$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95\ s$ →

OR/*OF*
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$3,2 = \left(\frac{0 + 7,92}{2}\right)\Delta t$ ✓
$\Delta t = 0,81\ s$

$\Delta t(B) = 1,76 - 0,81$ ✓
$\Delta t(B) = 0,95\ s$ →

OR/*OF*
$\Delta y = v_i\Delta t + ½a\Delta t^2$
12 ✓ $= 7,92\Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 0,95\ s$ →

Calculate/*Bereken*:
$v_i = 4,66\ m\cdot s^{-1}$

UPWARDS +/
***OPWAARTS* +**
$(\Delta t_{up\ and\ down} = 0,95\ s)$
$v_f = v_i + a\Delta t$ ✓
$-v_i = v_i + (-9,8)(0,95)$ ✓
$v_i = 4,66\ m\cdot s^{-1}$ ✓

OR/*OF*
$(\Delta t_{up} = 0,475\ s)$
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(0,475)$ ✓
$v_i = 4,66\ m\cdot s^{-1}$ ✓

OR/*OF*
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$0 = v_i(0,95) + ½(-9,8)(0,95)^2$ ✓
$v_i = 4,66\ m\cdot s^{-1}$ ✓

DOWNWARDS +/
***AFWAARTS* +**
$v_f = v_i + a\Delta t$ ✓
$v_i = v_i + (9,8)(0,95)$ ✓
$= -4,66$
$v_i = 4,66\ m\cdot s^{-1}$ ✓

OR/*OF*
$(\Delta t_{up} = 0,475\ s)$
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(0,475)$ ✓
$= -4,66$
$v_i = 4,66\ m\cdot s^{-1}$ ✓

OR/*OF*
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$0 = -v_i(0,95) + ½(9,8)(0,95)^2$ ✓
$v_i = 4,66\ m\cdot s^{-1}$ ✓

OPTION 7/*OPSIE 7*	
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF***
$F_{net}\Delta t = \Delta p$ $= m(v_f - v_i)$ } ✓Any one /*Enige een*	$F_{net}\Delta t = \Delta p$ $= m(v_f - v_i)$ } ✓Any one /*Enige een*
$\underline{(-9,8)(0,95)}$ ✓ $= \underline{-2v_i}$ ✓✓	$\underline{(9,8)(0,95)}$ ✓ $= \underline{2v_i}$ ✓✓
$v_i = 4,66\ m\cdot s^{-1}$ ✓ $(4,655\ m\cdot s^{-1})$	$v_i = 4,66\ m\cdot s^{-1}$ $(4,655\ m\cdot s^{-1})$ ✓

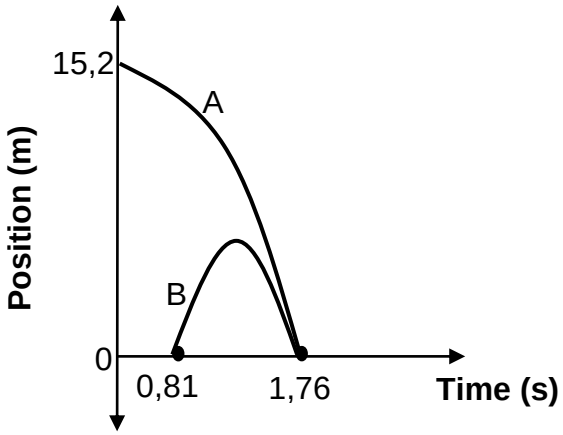
(5)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.1/**
POSITIEWE NASIEN VANAF VRAAG 3.2.1

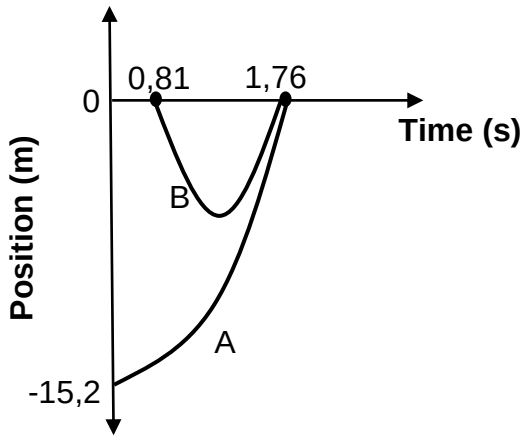
Marking criteria/*Nasienkriteria:*

- Initial position of ball A = 15,2 m and B = 0 m./*Oorspronklike posisie van A = 15,2 m en B = 0 m.* ✓
- Starting times for A = 0 s and B = 0,81 s./*Begintye van A = 0 s en B = 0,81 s.* ✓
- Both balls strike the ground at t = 1,76 s./*Albei balle tref die grond op t = 1,76 s.* ✓
- Shape of graph for ball A./*Vorm van grafiek vir bal A.* ✓
- Shape of graph for ball B./*Vorm van grafiek vir bal B.* ✓
- If graphs are drawn on seperate axis/*Indien grafieke op apparte asse geteken word:*
  max/*maks*: $^4/_5$

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF* (CHANGED GRAPH)



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



(5)
[15]

QUESTION 4 /*VRAAG 4*

4.1

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.*

In an isolated system the total (linear) momentum is conserved/remains constant. ✓✓ (accept closed system)
In 'n geïsoleerde sisteem bly die totale (lineêre) momentum behoue/ konstant. ✓✓ (aanvaar geslote sisteem)

ACCEPT FOR 1 MARK/*AANVAAR VIR 1 PUNT*
The total (linear) momentum before collision is equal to the total (linear) momentum after collision provided the system is isolated/the net external force on the system is zero.
Die totale (lineêre) momentum voor 'n botsing is gelyk aan die totale (lineêre) momentum na botsing mits die stelsel geïsoleer is/die netto eksterne krag op die stelsel is nul.

(2)

4.2.1

OPTION 1/*OPSIE 1*
RIGHT AS POSITIVE/*REGS AS POSITIEF:*

$$\sum p_i = \sum p_f$$
$$m_Av_{Ai} + m_Bv_{Bi} = m_Av_{Af} + m_Bv_{Bf}$$
$$m_Av_{Ai} + m_Bv_{Bi} = (m_A + m_B)v_f$$

✓Any one/*Enige een*

$(7,2)(0,4) + (0) = (7,2 + 5,3)v_f$ ✓
$v_f = 0,23\ m\cdot s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF:*

$$\sum p_i = \sum p_f$$
$$m_Av_{Ai} + m_Bv_{Bi} = m_Av_{Af} + m_Bv_{Bf}$$
$$m_Av_{Ai} + m_Bv_{Bi} = (m_A + m_B)v_f$$

✓Any one/*Enige een*

$(7,2)(-0,4) + (0) = (7,2 + 5,3)v_f$ ✓
$v_f = -0,23$
$\therefore v_f = 0,23\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*
RIGHT AS POSITIVE/*REGS AS POSITIEF*

$$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$$
$$m_A(v_{Af} - v_{Ai}) = -m_B(v_{Bf} - v_{Bi})$$

✓Any one/*Enige een*

$(7,2)(v_f - 0,4) = -(5,3)(v_f - 0)$ ✓
$v_f = 0,23\ m\cdot s^{-1}$ ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$$\Delta p_{trolley\ A} = -\Delta p_{trolley\ B}$$
$$m_A(v_{Af} - v_{Ai}) = -m_B(v_{Bf} - v_{Bi})$$

✓Any one/*Enige een*

$(7,2)(v_f + 0,4) = -(5,3)(v_f - 0)$ ✓
$v_f = -0,23$
$\therefore v_f = 0,23\ m\cdot s^{-1}$ ✓

(3)

4.2.2 **POSITIVE MARKING FROM QUESTIONS 4.2.1.**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 7,2(0,23 - 0,4)$ ✓ $F_{net} = -61,2$ ∴ $F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS NEGATIEF:*** **Force of B on A/*Krag van B op A:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 7,2(-0,23 + 0,4)$ ✓ $F_{net} = 61,2$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 2/*OPSIE 2* **RIGHT AS POSITIVE/** **REGS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 5,3(0,23 - 0)$ ✓ $F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)	**LEFT AS POSITIVE/** **LINKS *AS POSITIEF:*** **Force of A on B/*Krag van A op B:*** $F_{net}\Delta t = \Delta p$ } ✓Any one/ $F_{net}\Delta t = m(v_f - v_i)$ } *Enige een* $F_{net}(0,02) = 5,3(-0,23 - 0)$ ✓ $F_{net} = -60,95$ ∴ $F_{net} = 60,95$ N ✓ (60,95 N to/*tot* 61,2 N)
OPTION 3/*OPSIE 3* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $0,23 = 0,4 + a(0,02)$ $a = -8,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(-8,5)$ ✓ $= -61,20$ $F_{net} = 61,20$ N ✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **A:** $v_f = v_i + a\Delta t$ $-0,23 = -0,4 + a(0,02)$ $a = 8,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (7,2)(8,5)$ ✓ $= 61,20$ N $F_{net} = 61,20$ N✓
OPTION 4/*OPSIE 4* **RIGHT AS POSITIVE/*REGS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $0,23 = 0 + a(0,02)$ $a = 11,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(11,5)$ ✓ $= 60,95$ N $F_{net} = 60,95$ N✓	**LEFT AS POSITIVE/*LINKS AS POSITIEF*** **B:** $v_f = v_i + a\Delta t$ $-0,23 = 0 + a(0,02)$ $a = -11,5\ m{\cdot}s^{-2}$ $F_{net} = ma$ ✓ $= (5,3)(-11,5)$ ✓ $= -60,95$ N $F_{net} = 60,95$ N✓

(3)
[8]

QUESTION 5/*VRAAG 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.*

A force is non-conservative if the work it does/done on an object which is moving between two points depends on the path taken. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen op 'n voorwerp wat tussen twee punte beweeg afhanklik is van die pad gevolg.

OR/*OF*
A force is non-conservative if the work it does/done in moving an object around a closed path is non-zero. ✓✓
'n Krag is nie-konserwatief indien die arbeid wat dit verrig/doen om 'n voorwerp op 'n geslote pad te beweeg, nie nul is nie. (2)

Note/*Aantekening*:
If the word 'work' is omitted, 0/2.
Indien die woord 'arbeid' weggelaat is, 0/2.

5.2

Marking criteria/*Nasienkriteria*
- Any one of the correct equations./*Enige een van die korrekte vergelykings.* ✓
- Correct substitution for work done by gravity or ΔU. ✓
  Korrekte vervanging vir arbeid verrig deur gravitasie of ΔU.
- Correct substitution for work done by motor and friction./*Korrekte vervanging aan van arbeid verrig deur motor en wrywing.* ✓
- Correct substitution for ΔK./*Korrekte vervanging vir* ΔK.✓
- Correct final answer/*Korrekte finale antwoord:* 5,96 $m\cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*

$$W_{net} = \Delta K$$
$$W_w + W_f + W_F = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$mg\sin\theta\Delta x\cos\theta + W_f + W_F = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

✓Any one/*Enige een*

$(20)(9,8)(\sin 18°)(15,6)\cos 180°$✓ $+(13,5)(15,6)\cos 180° + (96,8)(15,6)\cos 0°$✓ $= \tfrac{1}{2}(20)(v_f^2 - 0^2)$✓

$$v_f = 5,96\ m\cdot s^{-1}\ ✓$$

OPTION 2/*OPSIE 2*

$$W_{nc} = \Delta K + \Delta U$$
$$W_f + W_F = \Delta K + mg(h_f - h_i)$$
$$f\Delta x\cos\theta + F\Delta x\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 + mgh_f - mgh_i$$

✓Any one/*Enige een*

$13,5(15,6)\cos 180° + 96,8(15,6)\cos 0°$✓ $= \tfrac{1}{2}(20)(v_f^2 - 0^2)$✓ $+(20)(9,8)(15,6\sin 18° - 0)$✓

$$v_f = 5,96\ m\cdot s^{-1}\ ✓$$

OPTION 3/*OPSIE 3*

$$W_{net} = \Delta K$$
$$W_w + W_f + W_F = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$-\Delta E_p + W_f + W_F = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

✓Any one/*Enige*

$-(20)(9,8)(15,6\sin 18°)$✓ $+(13,5)(15,6)\cos 180° + (96,8)(15,6)\cos 0°$✓ $= \tfrac{1}{2}(20)(v_f^2 - 0^2)$ ✓

$$v_f = 5,96\ m\cdot s^{-1}\ ✓$$

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$W_w + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$mg\Delta x\cos\theta + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\underline{(20)(9,8)(15,6)\cos 108°}$ ✓ + $\underline{(13,5)(15,6)\cos 180° + (96,8)(15,6)\cos 0°}$ ✓ = $\underline{\frac{1}{2}(20)(v_f^2 - 0^2)}$ ✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓

OPTION 5/*OPSIE 5*

$F_{net} = ma$
$F_{net} = F - F_{w//} - f$
$= 96,8 - \underline{(20)(9,8)\sin 18°}$ ✓ – 13,5
$= 22,73\ N$

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$\underline{22,73(15,6)\cos 0°}$ ✓ = $\underline{\frac{1}{2}(20)(v_f^2 - 0^2)}$ ✓
$v_f = 5,96\ m\cdot s^{-1}$ ✓ (5)

5.3 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

Marking criteria/*Nasienkriteria*
- Correct equation for power/*Korrekte vergelyking vir drywing*. ✓
- Correct substitution into power equation./ ✓
  Korrekte vervanging in drywingvergelyking.
- Correct final answer/*Korrekte finale antwoord*: 288,46 W ✓
  Range: 286,46 W to/*na* 288,73 W

OPTION1/*OPSIE 1*

$P_{ave} = Fv_{ave}$ ✓
$= 96,8\left(\frac{(0) + 5,96}{2}\right)$ ✓
$= 288,46\ W$ ✓

OPTION2/*OPSIE 2*

$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$15,6 = \left(\frac{(0) + 5,96}{2}\right)\Delta t$
$\Delta t = 5,23\ s$ (5,24)

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta x$
$(5,96)^2 = 0^2 + 2a(15,6)$
$a = 1,14\ m\cdot s^{-2}$ (1,13)

$v_f = v_i + a\Delta t$
$\underline{5,96 = 0 + (1,14)\Delta t}$
$\Delta t = 5,23\ s$ (5,27)

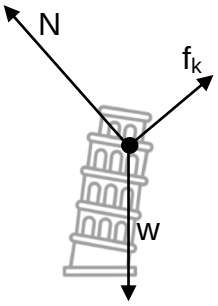
$P = \frac{W}{\Delta t}$
$P = \frac{F\Delta x\cos\Theta}{\Delta t}$ ✓Any one/*Enige een*
$P = \frac{96,8(15,6)\cos 0^\circ}{5,23}$ ✓
$P = 288,73\ W$ ✓

OR/*OF*

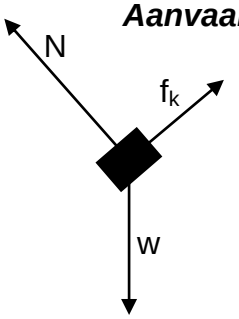
$v_{ave} = \frac{\Delta x}{\Delta t}$
$= \frac{15,6 - 0}{5,23 - 0}$
$= 2,98\ m\cdot s^{-1}$

$P_{ave} = Fv_{ave}$ ✓
$= 96,8(2,98)$ ✓
$= 288,46\ W$ ✓ (3)

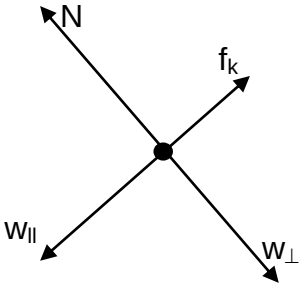
5.4



Accept force diagram/
Aanvaar kragte-diagram:



Accept/Aan*vaar:*



	Accepted symbols/*Aanvaarde simbole*
N ✓	F_N/196N/Normal/*Normaal*/F_{normal}/$F_{normaal}$
f ✓	(kinetic) friction/(kineties) wrywing/F_f/F_w/f_k/f_r
w ✓	F_g/F_w/weight/*gewig*/mg/gravitational force/*gravitasiekrag*/$F_{Earth\ on\ crate}$/ $F_{Aarde\ op\ krat}$

Notes/*Aantekeninge:*

- Accept correct numerical values for the forces./*Aanvaar korrekte numeriese waardes vir die kragte.*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max/Maks* $^2/_3$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $^2/_3$

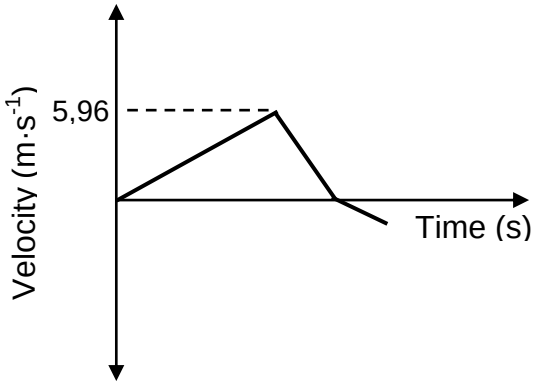
(3)

5.5 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VANAF VRAAG 5.2.

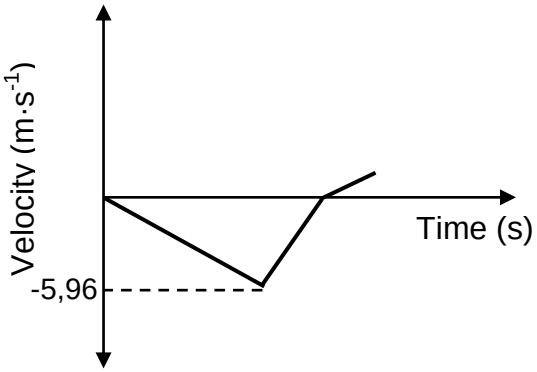
Marking criteria/*Nasienkriteria:*
- First straight line starting at zero with positive gradient, reaching a maximum velocity./*Eerste reguit lyn met 'n positiewe gradiënt begin by nul en bereik maksimum snelheid.* ✓
- Second straight line with negative gradient from maximum velocity to zero./ *Tweede reguit lyn met negatiewe gradiënt vanaf maksimum snelheid na zero.* ✓
- Third straight line continuing from second line at zero and extending below the x-axis./*Derde reguit lyn wat aangaan vanaf tweede lyn vanaf nul en verleng onder die x-as.* ✓
- Third line has a smaller negative gradient than the second line./*Derde reguit lyn het 'n kleiner negatiewe gradiënt as die tweede lyn* ✓

Note/Aantekening:
Direction of gradients opposite for graph 2./*Rigting van hellings teenoorgesteld vir grafiek 2.*
No marks given for values of velocities./*Geen punte toegeken vir waardes van snelhede nie.*

UPWARDS AS POSITIVE
OPWAARTS *AS POSITIEF:*



DOWNWARDS AS POSITIVE
AFWAARTS *AS POSITIEF:*



(4)
[17]

QUESTION 6/*VRAAG 6*

6.1.1 **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.*

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓
Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/*OF*
An (apparent) change in observed/detected frequency/pitch as a result of the relative motion between a source and an observer/listener.
'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$f_L = \frac{340 + 22}{340}$ ✓ $24\,000$ ✓

$f_L = 25\,552{,}94$ Hz

$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_S$

$f_L = \frac{340}{340 - 22}$ ✓ $25\,552{,}94$ ✓

$f_L = 27\,320{,}75$ Hz ✓ (6)

6.2 The frequencies of the spectral lines would have decreased./*Die frekwensies van die spektrale lyne sou verminder het.*✓✓

OR/*OF*
The spectral lines from the distant star are shifted towards lower frequency end of the spectrum./*Die spektrale lyne van die ver af ster sou verskuif na 'n laer frekwensie op die spektrum*. (2)
[10]

QUESTION 7/*VRAAG 7*

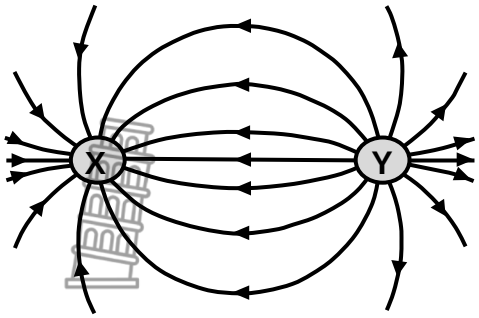
7.1

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.*
If any refrence is made to mass/*Indien enige verwysing gemaak is na massa*: $^0/_2$

The magnitude of the electrostatic force exerted by one (stationary) point charge ($\mathbf{Q_1}$) on another (stationary) point charge ($\mathbf{Q_2}$) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (**r**) between them.✓✓

*Die grootte van die elektrostatiese krag uitgeoefen deur een (stilstaande) puntlading ($\mathbf{Q_1}$) op 'n ander puntlading ($\mathbf{Q_2}$) is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (**r**) tussen hulle.* (2)

7.2



Criteria for graph/*Kriteria vir grafiek:*	
Correct shape/ *Korrekte vorm*	✓
Correct direction from **Y** to **X**. /*Korrekte rigting van **Y** na **X**.*	✓
Lines must not cross and must touch charges./ *Lyne mag nie kruis nie en moet die ladings raak.*	✓

Note/*Aantekening*:
- If the net electric field pattern is drawn for two like charges: $^{0}/_{3}$
  Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is: $^{0}/_{3}$
- Ignore labels for point charges/ *Ignoreer byskrifte vir puntladings.*

(3)

7.3 $F = \frac{kQ_YQ_X}{r^2}$ ✓

$F = \frac{(9 \times 10^{9})(7{,}2 \times 10^{-9})(7{,}2 \times 10^{-9})}{(0{,}03)^2}$ ✓

$= 5{,}18 \times 10^{-4}$ N ✓ (0,000518 N) (3)

7.4 E_Y✓ E_Z ✓ **accept/** ***aanvaar*** E_Z ✓ E_Y✓ **OR/*OF*** E_Z ✓ E_Y✓

Notes/*Aantekeninge:*
- 1 Mark for arrows in opposite directions./*1 Punt vir pyle in teenoorgestelde rigtings.*
- 1 Mark for correct labels./*1 Punt vir korrekte benoemings.*
- Do not penalise for length of arrow since drawing is not to scale./*Moenie penaliseer vir die lengte van die pyltjie nie aangesien tekening nie volgens skaal is nie.*
- Accept Y and Z as labels./*Aanvaar Y en Z as benoeming*.

(2)

7.5

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria*

- Formula for electric field./*Formule vir elektriese veld.* ✓
- Substitution of E_{net}./*Vervanging van* E_{net}. ✓
- Correct substitution into $\frac{kQ}{r^2}$ equation for charge Z or charge Y✓
  Korrekte vervanging in $\frac{kQ}{r^2}$*.vergelyking vir lading Z of lading Y*
- Subtraction of electric fields ($E_Z + E_Y$)/*Aftrek van elektriese velde* ($E_Z + E_Y$) ✓
- Correct final answer✓/*Korrekte finale antwoord*: 6,25 x 10^{-9}C
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

OPTION 1/*OPSIE 1*

$E_{net} = E_Z + E_Y$

$= E_Z - E_Y$

$E_{net} = \frac{kQ_z}{r^2}\checkmark + \frac{kQ_y}{r^2}$

$4,91 \times 10^5 \checkmark = \left(\frac{(9 \times 10^9)(Q_Z)}{0,01^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})}{0,03^2}\right)\checkmark$

$Q_Z = 6,25 \times 10^{-9}$ C ✓

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM QUESTION 7.3/
POSITIEWE NASIEN VANAF VRAAG 7.3

Marking criteria/*Nasienkriteria*

- Correct formula for electric field./*Korrekte formule vir elektriese veld.* ✓
- Substitution of F_{net}./*Vervanging van* F_{net}. ✓
- Correct substitution into $\left(\frac{kQ_zQ_x}{r^2}\right)$ for charge Z. ✓
  Korrekte vervanging in $\left(\frac{kQ_zQ_x}{r^2}\right)$ *vir lading Z*
- Subtraction of forces✓./*Aftrek van kragte.*
- Correct final answer/*Korrekte finale antwoord:* 6,26 x 10^{-9} C ✓
  Range/*Gebied*: 6,25 x 10^{-9} C to/*na* 6,26 x 10^{-9} C

$E = \frac{F}{Q}$ ✓

$4,91 \times 10^5 = \frac{F}{7,2 \times 10^{-9}}$

$F_{net} = 3,54 \times 10^{-3}$ N

$F_{net} = F_{Z \text{ on } X} + F_{Y \text{ on } X}$

$F_{net} = \left(\frac{kQ_zQ_x}{r^2}\right) + \left(\frac{kQ_YQ_x}{r^2}\right)$

$(3,54 \times 10^{-3})\checkmark = \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})Q_Z}{(0,01)^2}\right)\checkmark - (5,18 \times 10^{-4})$

$Q_Z = 6,26 \times 10^{-9}$ C ✓

(5)
[15]

QUESTION 8/*VRAAG 8*

8.1

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 potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided all other physical conditions remain constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits alle ander fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided all other physical conditions remain constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits alle fisiese toestande konstant bly). (2)

8.2.1

OPTION 1/*OPSIE 1*

$R = \frac{V}{I}$ ✓

$7 = \frac{V}{1,5}$ ✓

V = 10,5 V ✓

OPTION 2/*OPSIE 2*

$R = \frac{V}{I}$ ✓

$2 = \frac{V}{1,5}$

V = 3 V

$5 = \frac{V}{1,5}$

V = 7,5 V

$V_T = V_1 + V_2$
= 3 + 7,5 ✓ (addition of calculated values/*optel van berekende waardes*)
= 10,5 V ✓

OPTION 3/*OPSIE 3*

Ratio of R:
3 : 7
Ratio of I:
7 : 3

$I = 1,5 \times \frac{7}{3} = 3,5$ A

V = IR ✓
= (3,5)(3) ✓
= 10,5 V ✓

(3)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/*OPSIE 1*

$R = \frac{V}{I_3}$ ✓

$3 = \frac{10,5}{I_3}$ ✓

$I_3 = 3,5$ A ✓

$I_T = 1,5 + 3,5$ (addition of calculated values/*optel van berekende waardes*)
= 5 A ✓

OPTION 2/*OPSIE 2*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

OR/*OF*

$R_p = \frac{R_1 R_2}{R_{1+}R_2}$

$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$ ✓

$R_p = 2,1\ \Omega$

$R_p = \frac{(7)(3)}{7+3}$ ✓
$= 2,1\ \Omega$

$R = \frac{V}{I_T}$ ✓

$2,1 = \frac{10,5}{I_T}$ ✓

$I_T = 5$ A ✓

OPTION 3/*OPSIE 3*

$I_{3\Omega} = \frac{7}{3} \times 1,5$ ✓
= 3,5 A ✓

$I_{total} = 3,5 + 1,5$ ✓

= 5 A ✓

OPTION 4/*OPSIE 4*

$I_S = (\frac{R_{3\Omega}}{R_{3\Omega}+R_S}) \times I_{total}$ ✓

$1,5$ ✓ $= \frac{3}{3+7}$ ✓ $\times I_{total}$

$I_{total} = 5$ A ✓

(4)

8.2.3 **POSITIVE MARKING FROM QUESTION 8.2.1 AND/OR QUESTION 8.2.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1 EN/OF VRAAG 8.2.2.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$P = \frac{V^2}{R}$ ✓ $= \frac{10,5^2}{3}$ ✓ = 36,75 W ✓	$P = I^2R$ ✓ $= \underline{(3,5)^2(3)}$ ✓ = 36,75 W ✓
OPTION 3/*OPSIE 3*	
P = VI ✓ $= \underline{(10,5)(3,5)}$ ✓ = 36,75 W ✓	

(3)

8.3 **POSITIVE MARKING IF OPTION 2 IS USED IN QUESTION 8.2.2./**
POSITIEWE NASIEN INDIEN OPSIE 2 GEBRUIK IS IN VRAAG 8.2.2.

Marking criteria/*Nasienkriteria*
- Correct equation for emf./*Korrekte vergelyking vir emk.* ✓
- Correct substitution for S_2 closed. /*Korrekte vervanging vir S_2* gesluit. ✓
- Correct substitution for S_2 open./*Korrekte vervanging vir S_2 oop.* ✓
- Equating emf or internal resistance equations. ✓
  Gelykstelling van emk of interne weerstand vergelykings.
- Correct final answer/*Korrekte finale antwoord:* 12,05 V ✓
  Range/*Gebied*: 12,04 V to/*tot* 12,05 *V*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$

$R_p = 2,1\ \Omega$

For S_1 and S_2 closed:

$\varepsilon = I(R + r)$
$\varepsilon = IR + Ir$
$\varepsilon = V_{int} + V_{ext}$
✓ Any one/ *Enige een*

$= \underline{5(2,1 + r)}$ ✓…(1)

For S_2 open:

$\varepsilon = I(R+r)$
$= \underline{3,64(3 + r)}$ ✓…(2)

(1) = (2)
✓
$5(2,1 + r) = 3,64(3 + r)$
$r = 0,31\ \Omega$

$\varepsilon = 5(2,1 + 0,31)$
= 12,05 V ✓ (12,04)

OR/*OF*

$\varepsilon = 3,64(3 + 0,31)$
= 12,05 V ✓ (12,04)

(1) = (2):

$\frac{\varepsilon - 10,5}{5}$ ✓ $= \frac{\varepsilon - 10,92}{3,64}$

ε = 12,05 V ✓ (12,04)

(5)

8.4 Increases/*Toeneem* ✓
(Total) resistance increases./(*Totale) weerstand neem toe.* ✓
Current decreases./*Stroom neem af.* ✓
$V_{internal}$ /Internal volts decreases./V_{intern}/*Interne volts neem af.* ✓ (4)

Note/*Aantekening:*
Award marks if learner proved the statement using calulated numerical values./ *Ken punte toe indien leerder die stelling bewys deur berekende waardes te gebruik.*

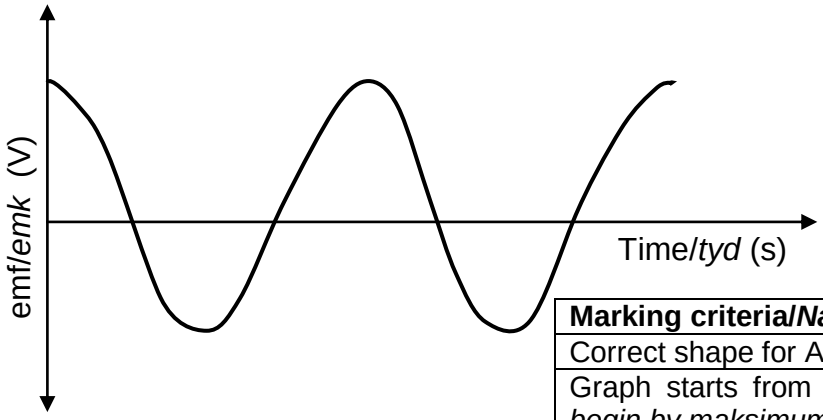
[21]

QUESTION 9/*VRAAG 9*

9.1.1 North pole/*Noord-pool* ✓ (1)

9.1.2 Y to X/*Y na X* ✓ (1)

9.1.3



Marking criteria/*Nasienkriteria*	
Correct shape for AC./*Korrekte vorm vir WS.*	✓
Graph starts from maximum value./*Grafiek begin by maksimum waarde.*	✓
Two complete waves/ *Twee volledige golwe*	✓
Note/*Aantekening:* Accept graph starting at negative max./*Aanvaar grafiek wat by negatiewe maks begin*.	

(3)

9.2.1

Marking criteria/*Nasienkriteria*:
- Formula to calculate V_{max} or I_{rms}./*Formule om V_{maks} of I_{wgk} te bereken.* ✓
- Correct substitution of V_{rms} or I_{max}./*Korrekte vervanging van V_{wgk} of I_{maks}.* ✓
- Correct substitution to calculate R./*Korrekte vervanging om R te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord*: 47,14 Ω to/*tot* 47,2 Ω ✓

OPTION 1/*OPSIE 1*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$200 = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = 282,84$ V

$R = \frac{V}{I}$

$= \frac{282,84}{6}$ ✓

R = 47,14 Ω ✓

OPTION 2/*OPSIE 2*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{6}{\sqrt{2}}$ ✓

$I_{rms} = 4,24$ A

$R = \frac{V}{I}$

$= \frac{200}{4,24}$ ✓

R = 47,17 Ω ✓

OPTION 3/*OPSIE 3*	
$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $I_{rms} = \frac{6}{\sqrt{2}}$ ✓ $I_{rms} = 4{,}24$ A $P_{ave} = V_{rms}I_{rms}$ $= (200)(4{,}24)$ $= 848$ W (848,53)	$P_{ave} = \frac{V^2_{rms}}{R}$ $848 = \frac{(200)^2}{R}$ ✓ $R = 47{,}17\ \Omega$ ✓ **OR/*OF*** $P_{ave} = I^2_{rms}R$ $848 = (4{,}24)^2R$ ✓ $R = 47{,}17\ \Omega$ ✓

(4)

9.2.2 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VANAF VRAAG 9.2.1.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$W = I^2R\Delta t$ ✓ $= \underline{(4{,}24)^2(47{,}17)}$ ✓(7200) ✓ $= 6{,}11 \times 10^6$ J ✓ ($6{,}10 \times 10^6$)	$W = VI\Delta t$ ✓ $= \underline{(200)(4{,}24)}$ ✓(7200) ✓ $= 6{,}11 \times 10^6$ J ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$W = \frac{V^2\Delta t}{R}$ ✓ $= \frac{(200^2)(7200)}{47{,}27}$ ✓ ✓ $= 6{,}11 \times 10^6$ J ✓ ($6{,}10 \times 10^6$)	$P = \frac{W}{\Delta t}$ ✓ ✓ $848 = \frac{W}{7200}$ ✓ $= 6{,}11 \times 10^6$ J ✓

(4)
[13]

QUESTION 10/*VRAAG 10*

10.1 $6{,}63 \times 10^{-34}$ ✓ (1)

10.2

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

The minimum energy needed to eject an electron from a (metal) surface. ✓✓
Die minimum energie benodig om 'n elektron uit 'n (metaal)oppervlak vry te stel. (2)

10.3.1 $W_o = hf_o$ ✓
$= \underline{(6{,}63 \times 10^{-34})(5 \times 10^{14})}$ ✓
$= 3{,}32 \times 10^{-19}$ J ✓ (3)

10.3.2 **POSITIVE MARKING FROM QUESTION 10.3.1./ *POSITIEWE NASIEN VANAF VRAAG 10.3.1.***

OPTION 1/*OPSIE 1*

$$\text{Gradient} = \frac{\Delta E_k}{\Delta f} \checkmark$$

$$6{,}63 \times 10^{-34} \checkmark = \frac{(X - 0)}{(12{,}54 \times 10^{14} - 5 \times 10^{14})} \checkmark$$

$$X = 5 \times 10^{-19}\ (J) \checkmark$$

OPTION 2/*OPSIE 2*

$E = W_o + E_{k(max)}$

$hf = hf_o + \frac{1}{2}mv^2_{max}$

$h\frac{c}{\lambda} = h\frac{c}{\lambda_o} + E_{k(max)}$

✓ Any one/*Enige een*

$$\underline{(6{,}63 \times 10^{-34})(12{,}54 \times 10^{14})} \checkmark = \underline{3{,}32 \times 10^{-19} + E_{k(max)}} \checkmark$$

$$E_{k(max)} = 5 \times 10^{-19}\ J \checkmark$$

$$X = 5 \times 10^{-19}\ (J)$$

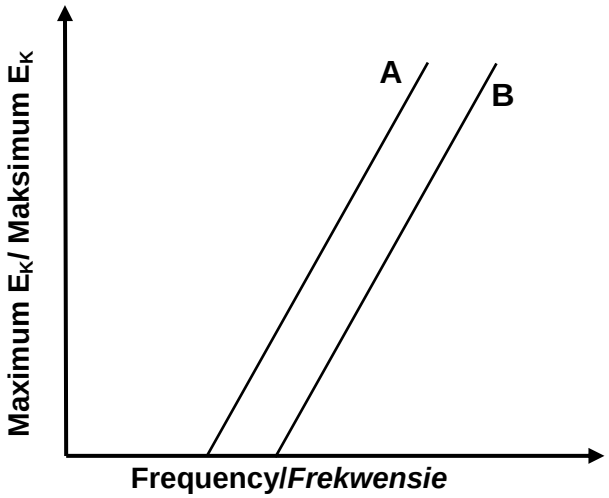
Note/*Aantekkening*:
Do not penalise learner again in 10.3.2 if ($\times 10^{14}$) is omitted in 10.3.1/*Moenie leerder weer penaliseer in 10.3.2 indien ($\times 10^{14}$) uitgelaat is in 10.3.1 nie.*

(4)

10.4.1 No effect/*Geen effek* ✓ (1)

10.4.2 Increases/*Toeneem* ✓ (1)

10.5



Marking criteria/*Nasienkriteria*	
Graph B to the right of graph A./ *Grafiek B aan regterkant van grafiek A.*	✓
Lines are parallel./*Lyne is parallel.*	✓
If both graphs are not labelled/*Indien beide grafieke nie benoem is nie*: 0/2	
If two seperate graphs are drawn/*Indien twee aparte grafieke geteken is* : 0/2	

(2)

[14]

TOTAL/*TOTAAL*: 150