



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2023

MARKS: 150

TIME: 3 hours

This question paper consists of 19 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.

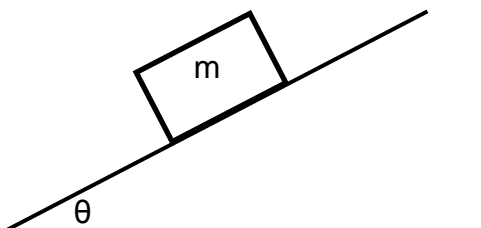
- 1.1 A constant net force is applied to a block. Which ONE of the following statements is CORRECT?

The block will move with a ...

- A constant velocity.
- B constant acceleration.
- C constantly increasing acceleration.
- D constantly decreasing acceleration.

(2)

- 1.2 A crate of mass m is stationary on a plane inclined at an angle θ with the horizontal.



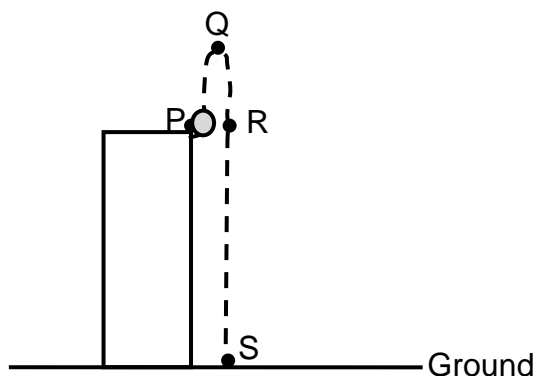
Which ONE of the following statements regarding the magnitude of the frictional force acting on the crate is CORRECT?

The magnitude of the frictional force acting on the crate is ...

- A equal to the component of the weight of the crate which is parallel to the plane.
- B larger than the component of the weight of the crate which is parallel to the plane.
- C equal to the component of the weight of the crate which is perpendicular to the plane.
- D larger than the component of the weight of the crate which is perpendicular to the plane.

(2)

- 1.3 A ball is projected vertically upwards from the top edge of a building. Points P, Q, R and S represent different positions during the motion of the ball, as shown in the diagram below.



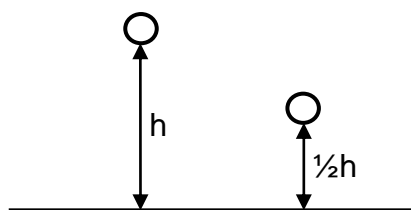
Ignore the effects of air friction.

Between which two points will the ball undergo the greatest change in kinetic energy?

- A P and S
- B P and R
- C R and S
- D Q and S

(2)

- 1.4 A ball is dropped from height h and strikes the floor with momentum p . The ball is then dropped from height $\frac{1}{2}h$.



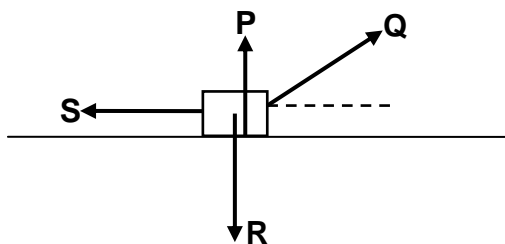
Ignore the effects of air friction.

Which ONE of the following represents the momentum of the ball when it strikes the floor after being dropped from height $\frac{1}{2}h$?

- A p
- B $\frac{1}{\sqrt{2}}p$
- C $\frac{1}{2}p$
- D $2p$

(2)

- 1.5 A box moves on a horizontal surface. The diagram below shows all the forces acting on the box.



Which ONE of the following combinations of forces do work on the box?

- A **P** and **R** only
- B **Q** and **S** only
- C **Q**, **R** and **S** only
- D **P**, **Q**, **R** and **S** (2)

- 1.6 A train moving at a constant velocity towards a stationary listener emits sound waves of constant frequency.

Which ONE the following statements about the sound waves observed by the listener is CORRECT?

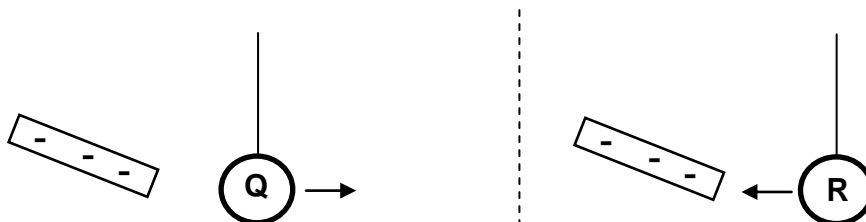
The observed ...

- A frequency is higher than the emitted frequency.
- B wavelength is longer than the emitted wavelength.
- C frequency is lower than the emitted frequency.
- D wavelength is equal to the emitted wavelength. (2)

1.7 Refer to the diagram below.

Q and **R** are small spheres suspended by light insulated strings.

When a negatively charged rod is brought close to sphere **Q**, sphere **Q** is repelled. When the negatively charged rod is brought close to sphere **R**, sphere **R** is attracted.

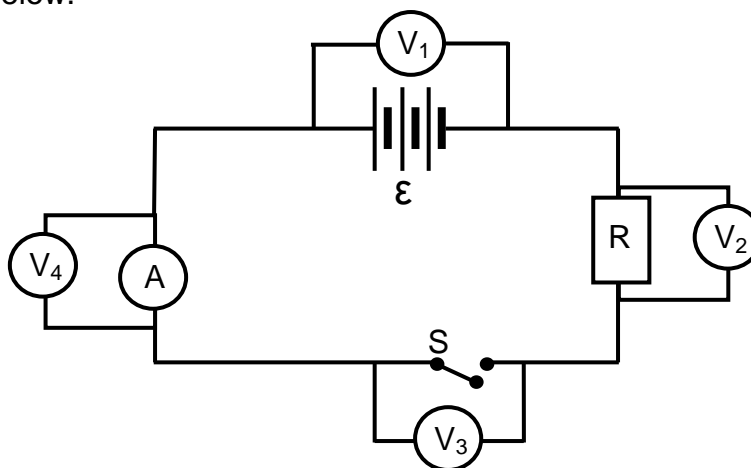


Which ONE of the combinations below can be possible for the nature of the charges on spheres **Q** and **R**?

	NATURE OF CHARGE ON SPHERE Q	NATURE OF CHARGE ON SPHERE R
A	Negative	Negative
B	Positive	Neutral
C	Neutral	Positive
D	Negative	Neutral

(2)

1.8 Four voltmeters, V_1 , V_2 , V_3 and V_4 , are connected in a circuit, as shown in the diagram below.



Which voltmeter(s) will have the same reading as voltmeter V_1 when the switch is open?

- A V_2 only
- B V_3 only
- C V_4 only
- D V_2 and V_4

(2)

- 1.9 A split-ring commutator connects the coil of a generator to an external circuit.

Which ONE of the combinations below is CORRECT for the magnitude and direction of the induced current in the external circuit?

	MAGNITUDE OF INDUCED CURRENT	DIRECTION OF INDUCED CURRENT
A	Constant	Constant
B	Constant	Changes
C	Changes	Constant
D	Changes	Changes

(2)

- 1.10 Light of a suitable frequency is shone on the surface of a metal and electrons are ejected from the metal.

Which ONE of the following is equal to the ratio of the work function to the threshold frequency of the metal?

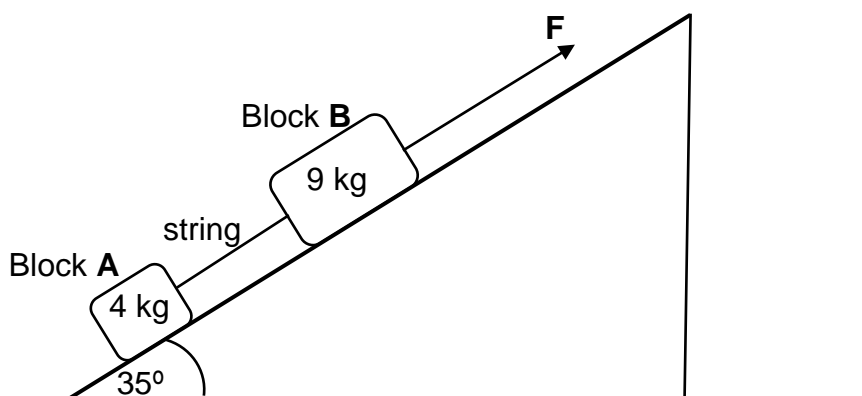
- A Planck's constant
- B The inverse of Planck's constant
- C The energy of the incident photons
- D The maximum kinetic energy of the ejected electrons

(2)
[20]

QUESTION 2 (Start on a new page.)

Two blocks, **A**, of mass 4 kg, and **B**, of mass 9 kg, are connected by a light inextensible string. The blocks are held at rest on a plane which is inclined at an angle of 35° with the horizontal.

A constant force, **F**, acting parallel to the plane, is applied to block **B**, as shown in the diagram below. The blocks now accelerate up the plane at $2 \text{ m}\cdot\text{s}^{-2}$.



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

The kinetic frictional forces acting on blocks **A** and **B** are 5,88 N and 13,23 N respectively.

2.2 Draw a labelled free-body diagram showing all the forces acting on block **A**. (4)

2.3 Calculate the magnitude of:

2.3.1 The tension in the string (4)

2.3.2 Force **F** (3)

2.4 The angle that the plane makes with the horizontal is now decreased.

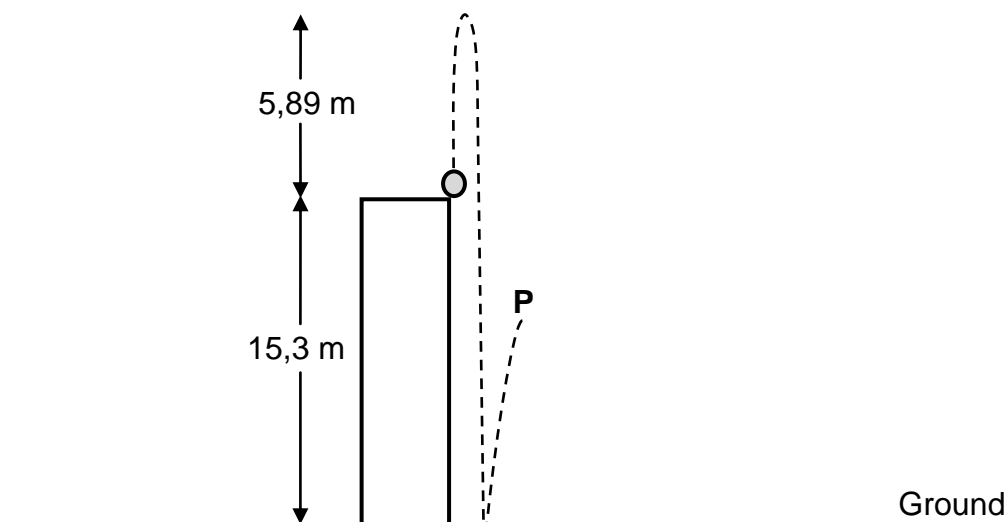
2.4.1 How will this change the kinetic frictional force acting on block **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

2.4.2 Explain the answer to QUESTION 2.4.1. (2)

[16]

QUESTION 3 (Start on a new page.)

A ball of mass 0,5 kg is thrown vertically upwards from the top edge of a building which is 15,3 m high. The ball reaches a maximum height of 5,89 m above the top of the building. The ball strikes the ground and bounces vertically upwards, reaching a maximum height at point **P**, as shown in the diagram below.



Ignore the effects of air friction.

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

3.2 Using only EQUATIONS OF MOTION, calculate the speed at which the ball was projected upwards. (3)

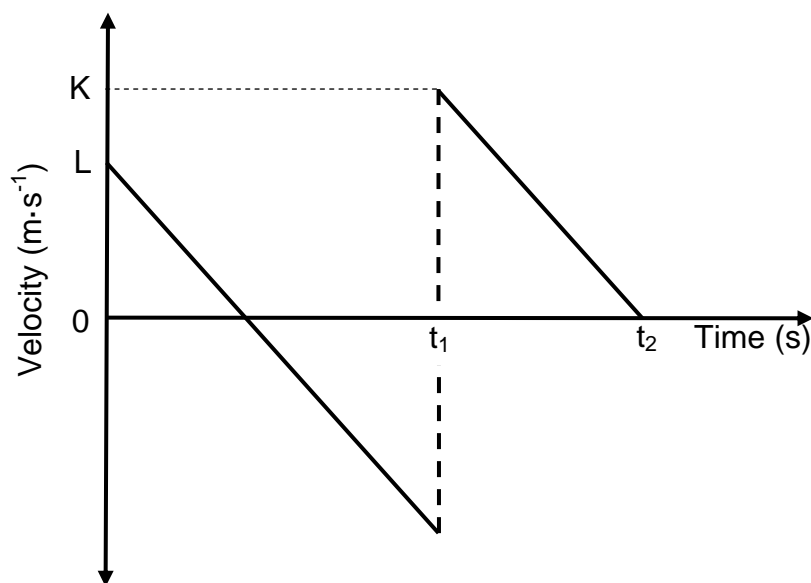
3.3 After the collision with the ground, the ball leaves the ground with a speed of $11,92 \text{ m}\cdot\text{s}^{-1}$.

Calculate the:

3.3.1 Amount of kinetic energy lost by the ball during the collision with the ground (5)

3.3.2 Time taken for the ball to reach point **P** after leaving the ground (3)

- 3.4 The velocity-time graph for the motion of the ball from the instant it is projected upwards from the top edge of the building until the time it reaches point **P** is shown below.



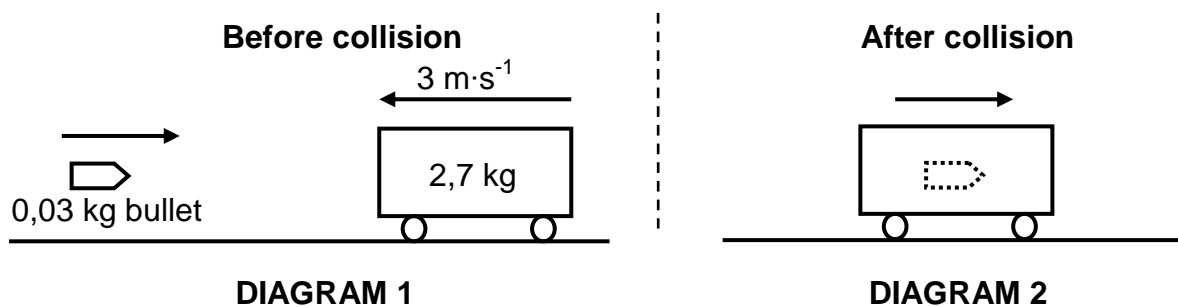
Write down the numerical values indicated by EACH of the following:

- | | | |
|-------|-------------|-----|
| 3.4.1 | K | (1) |
| 3.4.2 | L | (1) |
| 3.4.3 | $t_2 - t_1$ | (1) |
- [16]**

QUESTION 4 (Start on a new page.)

A wooden trolley of mass 2,7 kg moves to the left with a constant velocity of $3 \text{ m}\cdot\text{s}^{-1}$. A bullet of mass 0,03 kg is fired horizontally from the left towards the trolley. (See DIAGRAM 1.)

The bullet strikes the trolley and comes to rest inside the trolley in 0,02 s. The average net force exerted by the trolley on the bullet during this time is 591 N. The bullet-trolley combination now moves to the right. (See DIAGRAM 2.)

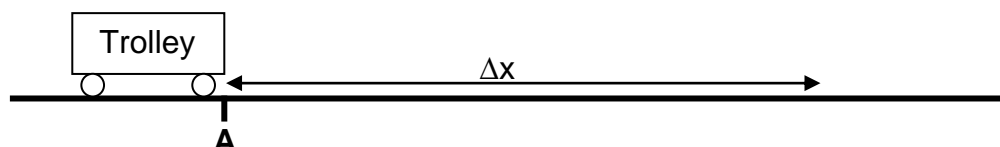


Ignore all frictional and rotational effects.

- 4.1 Write down the magnitude and direction of the average net force that the bullet exerts on the trolley. (1)
 - 4.2 Calculate the magnitude of the velocity with which the bullet strikes the trolley. (4)
 - 4.3 State the principle of conservation of linear momentum in words. (2)
 - 4.4 Calculate the magnitude of the velocity of the bullet-trolley combination after the collision. (4)
- [11]**

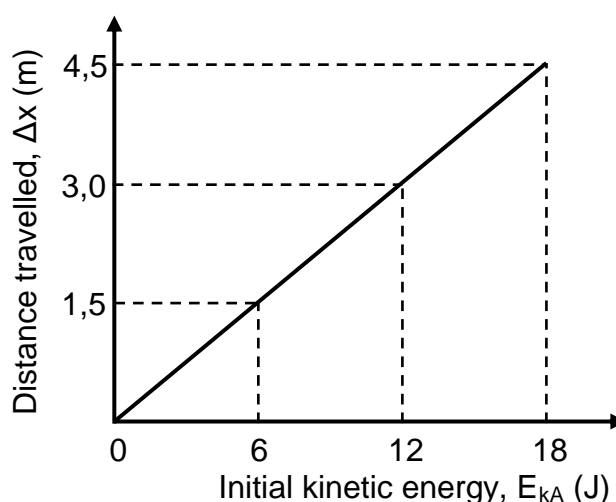
QUESTION 5 (Start on a new page.)

Learners conduct an experiment to determine how the initial kinetic energy given to a trolley affects the distance the trolley moves on a rough horizontal surface. A learner pushes a trolley of unknown mass until it reaches point **A** with kinetic energy E_{kA} . The horizontal distance (Δx) travelled by the trolley before it comes to rest is then measured. See the diagram below.



The experiment is repeated with the trolley moving on the same rough horizontal surface but with different initial kinetic energies at point **A**.

The results obtained are shown in the graph below.



Ignore the rotational effects of the wheels of the trolley.

- 5.1 Draw a labelled free-body diagram showing all the forces acting on the trolley during its motion after passing point **A**. (3)
- 5.2 Name the independent variable in this experiment. (1)
- 5.3 State the work-energy theorem in words. (2)
- 5.4 Calculate the mass of the trolley if the coefficient of kinetic friction between the wheels of the trolley and the rough horizontal surface is 0,18. (6)
- [12]**

QUESTION 6 (Start on a new page.)

- 6.1 An ambulance is moving away from a stationary listener with a constant velocity of $25 \text{ m}\cdot\text{s}^{-1}$. The siren of the ambulance emits sound waves at a frequency of 550 Hz. The listener detects the frequency of these sound waves to be 512,64 Hz.

Ignore the effects of wind.

6.1.1 State the Doppler effect in words. (2)

6.1.2 Use the given information to calculate the speed of sound in air. (5)

6.1.3 If the ambulance moves away from the stationary listener with a constant velocity which is greater than $25 \text{ m}\cdot\text{s}^{-1}$, how will EACH of the following change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

(a) The speed of sound in air (1)

(b) The frequency of the sound waves emitted by the siren (1)

(c) The frequency of the sound waves detected by the listener (1)

6.2 The spectrum of a distant star when viewed from the Earth is red shifted.

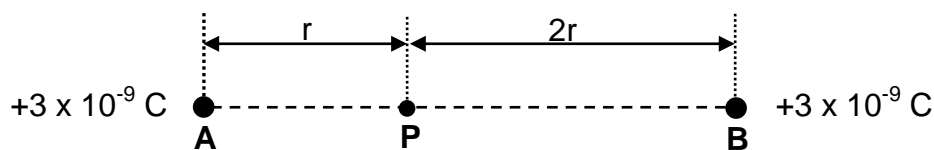
6.2.1 Is the star moving AWAY FROM or TOWARDS the Earth? (1)

6.2.2 Use the Doppler effect to explain the answer to QUESTION 6.2.1. (2)

[13]

QUESTION 7 (Start on a new page.)

Two point charges, **A** and **B**, each with a charge of $+3 \times 10^{-9} \text{ C}$, are stationary on a horizontal surface. Point **P** is r metres from charge **A** and $2r$ metres from charge **B**, as shown in the diagram below.



7.1 Describe an *electric field*. (2)

7.2 Draw the resultant electric field pattern due to charges **A** and **B**. (3)

The magnitude of the net electric field at point **P** is $27 \text{ N}\cdot\text{C}^{-1}$.

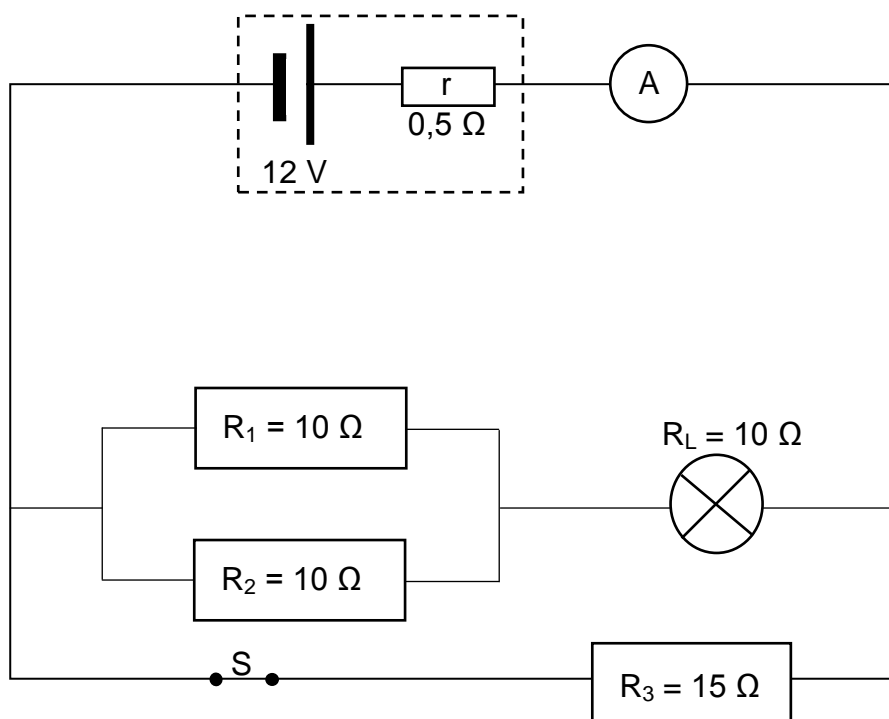
7.3 Calculate the value of r . (5)

7.4 Calculate the magnitude of the net electrostatic force that an electron would experience if placed at point **P**. (3)

[13]

QUESTION 8 (Start on a new page.)

The circuit diagram below shows a battery with an emf of 12 V and an internal resistance of $0,5 \, \Omega$ connected to three resistors, a light bulb, a switch, an ammeter and connecting wires. The ammeter and connecting wires have negligible resistance.



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

Switch S is initially CLOSED.

8.2 Calculate the:

8.2.1 Total external resistance of the circuit (5)

8.2.2 Reading on the ammeter (3)

8.2.3 Power dissipated by resistor R_3 (4)

8.3 Switch S is now OPENED.

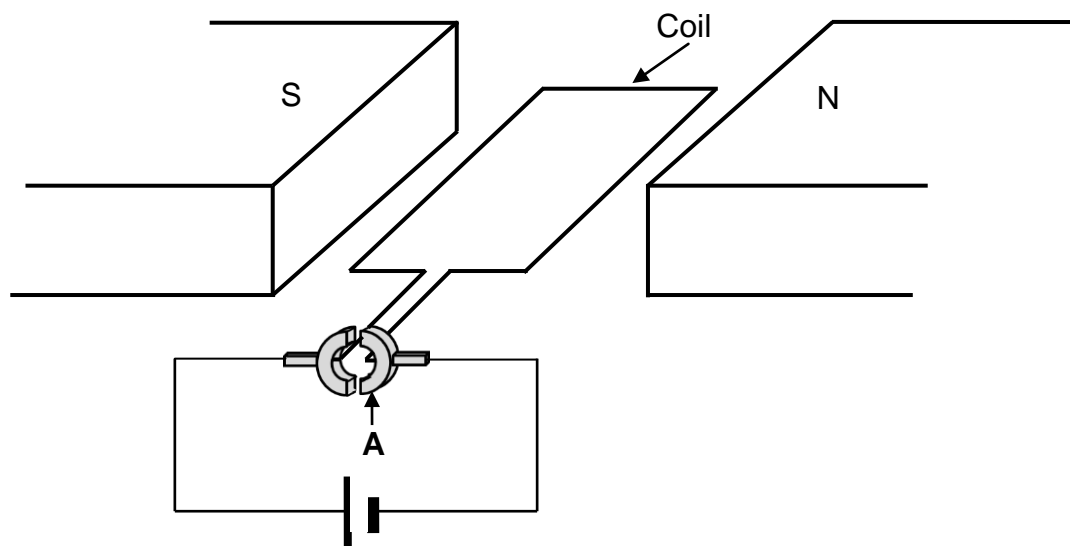
8.3.1 If the resistance of the light bulb remains constant, how will the brightness of the light bulb be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

8.3.2 Explain the answer to QUESTION 8.3.1. (3)

[18]

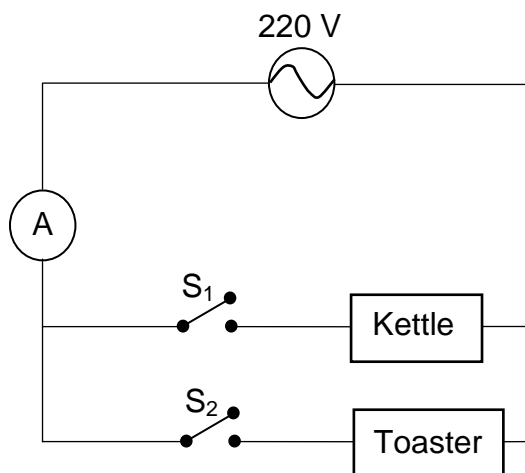
QUESTION 9 (Start on a new page.)

9.1 A simplified diagram of a DC electric motor is shown below.



- 9.1.1 Write down the name of component **A**. (1)
- 9.1.2 State the energy conversion that takes place in the motor. (1)
- 9.1.3 In which direction will the coil rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)
- 9.1.4 State TWO changes that can be made to the motor for the coil to rotate faster. (2)

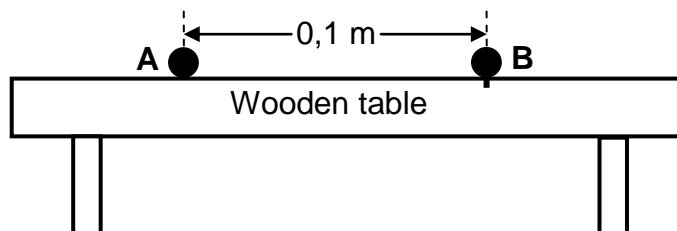
- 9.2 The circuit diagram below shows an electric kettle and a toaster connected to an AC source with an rms voltage of 220 V. The ammeter, connecting wires and switches S_1 and S_2 have negligible resistance.



- 9.2.1 Define the term *root mean square current*. (2)
- 9.2.2 When switch S_1 is CLOSED and switch S_2 is OPEN, the maximum current through the circuit is 3,6 A.
- Calculate the root mean square current in the circuit. (3)
- 9.2.3 When switch S_1 is OPEN and switch S_2 is CLOSED, the root mean square current in the circuit is 2,62 A.
- Calculate the energy consumed by the toaster in two minutes. (3)
- [14]**

QUESTION 10 (Start on a new page.)

- 10.1 Two small spheres, **A** and **B**, made of pure zinc are at rest 0,1 m apart on a wooden table. Sphere **A** is negatively charged and is free to move on the table, while sphere **B** is uncharged and fixed to the table, as shown in the diagram below.



High-intensity ultraviolet light of frequency $2,8 \times 10^{16}$ Hz is now shone continuously onto sphere **B**.

The work function of zinc is $6,63 \times 10^{-19}$ J.

- 10.1.1 Define the term *work function* of a metal. (2)

- 10.1.2 Explain, using a suitable calculation, why the ultraviolet light shone on sphere **B** will eject electrons from its surface. (4)

- 10.1.3 Sphere **A** carries a charge of $-5,4 \times 10^{-6}$ C and requires a minimum force of 0,027 N to move from rest.

Calculate the minimum number of photons of ultraviolet light that must strike sphere **B** which will cause sphere **A** to move from its rest position. (6)

- 10.2 A beam of white light is shone through a cold gas. The emerging light is dispersed and a line spectrum is observed on a screen.

10.2.1 Name the type of line spectrum observed. (1)

10.2.2 Describe the spectrum referred to in QUESTION 10.2.1. (2)

10.2.3 The diagrams below indicate some possible energy transitions made by atoms.

Which ONE of the diagrams could result in the type of spectrum observed in QUESTION 10.2.1? Choose from DIAGRAM A or DIAGRAM B.

DIAGRAM A

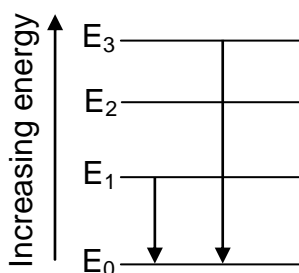
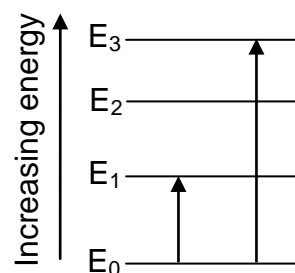


DIAGRAM B



(2)
[17]

TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE KONSTANTES

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

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

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ 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 $E_k = \frac{1}{2}mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

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

ELECTROSTATICS/ELEKTROSTATIKA

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

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad / \quad I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad / \quad V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}} \quad / \quad P_{\text{gemid}} = V_{\text{wgk}} I_{\text{wgk}}$ $P_{\text{ave}} = I_{\text{rms}}^2 R \quad / \quad P_{\text{gemid}} = I_{\text{wgk}}^2 R$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \quad / \quad P_{\text{gemid}} = \frac{V_{\text{wgk}}^2}{R}$
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**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

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

NOVEMBER 2023

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 28 pages.
*Hierdie nasienriglyne bestaan uit 28 bladsye.***

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | A ✓✓ | (2) |
| 1.3 | D ✓✓ | (2) |
| 1.4 | B ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | A ✓✓ | (2) |
| 1.7 | D ✓✓ | (2) |
| 1.8 | B ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | A ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

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.*

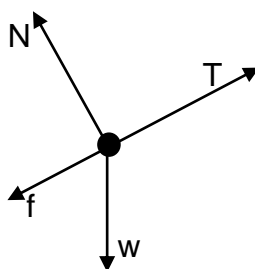
When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp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

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. (2 or 0)
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum in die rigting van die resulterende/netto krag. (2 of 0)

(2)

2.2



	Accepted labels/Aanvaarde benoemings
N	F_N /Normal/ F_{normal} / $F_{normaal}$ /Normaal
f	(kinetic) friction/5,88 N / F_f/f_k /(kinetiese) wrywing / F_w
w	F_g/F_w /weight/mg/39,2 N/gravitational force F_g/F_w /gewig/mg/39,2 N/gravitasiekrag
T	F_T/F_{string} /tension/spanning/ F_{tou}
Notes/Aantekeninge <ul style="list-style-type: none"> Mark is awarded for label <u>and</u> arrow./Punt word toegeken vir byskrif <u>en</u> pyltjie. Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie. If w is not shown but $w_{ }$ and w_{\perp} are shown, give 1 mark for both./Indien w nie getoon is nie maar $w_{ }$ en w_{\perp} is getoon, ken 1 punt toe vir beide. If arrows do not touch the dot/Indien pyle nie die kolletjie raak nie: Max/Maks $\frac{3}{4}$ Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks $\frac{3}{4}$ If everything correct, but no arrows/Indien alles korrek, maar geen pyltjies: Max/Maks $\frac{3}{4}$ 	

(4)

2.3.1

For block A/Vir blok A:

UP THE INCLINE AS POSITIVE/

TEEN DIE SKUINSTE OP AS POSITIEF

$$\begin{aligned} F_{\text{net}} &= ma \\ T - f_k - w_{\parallel} &= ma \\ T - f_k - mg\sin\theta &= ma \end{aligned} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one / Enige een}$$

$$\underline{T - 5,88 - 4(9,8)\sin 35^\circ} \checkmark = 4(2) \checkmark$$

$$T = 36,36 \text{ N} \checkmark$$

DOWN THE INCLINE AS POSITIVE/

TEEN DIE SKUINSTE AF AS POSITIEF

$$\begin{aligned} F_{\text{net}} &= ma \\ -T + f_k + w_{\parallel} &= ma \\ -T + f_k + mg\sin\theta &= ma \end{aligned} \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \checkmark \text{ Any one / Enige een}$$

$$\underline{-T + 5,88 + 4(9,8)\sin 35^\circ} \checkmark = 4(-2) \checkmark$$

$$T = 36,36 \text{ N} \checkmark$$

(4)

2.3.2

POSITIVE MARKING FROM QUESTION 2.3.1

POSITIEWE NASIEN VANAF VRAAG 2.3.1

NOTE: If systems approach is used, learner gets mark for the answer only.

NOTA: Indien sisteem benadering gebruik word, kry leerder slegs 'n punt vir die antwoord.

For block B/Vir blok B:

UP THE INCLINE AS POSITIVE/

TEEN DIE SKUINSTE OP AS POSITIEF

$$\begin{aligned} F_{\text{net}} &= ma \\ F - T - f_k - w_{\parallel} &= ma \\ F - T - f_k - mg\sin\theta &= ma \end{aligned}$$

$$\underline{F - 36,36 - 13,23 - 9(9,8)\sin 35^\circ} \checkmark = (9)(2) \checkmark$$

$$F = 118,18 \text{ N} \checkmark$$

DOWN THE INCLINE AS POSITIVE/

TEEN DIE SKUINSTE AF AS POSITIEF

$$\begin{aligned} F_{\text{net}} &= ma \\ -F + T + f_k + w_{\parallel} &= ma \\ -F + T + f_k + mg\sin\theta &= ma \end{aligned}$$

$$\underline{-F + 36,36 + 13,23 + 9(9,8)\sin 35^\circ} \checkmark = (9)(-2) \checkmark$$

$$F = 118,18 \text{ N} \checkmark$$

(3)

2.4.1

INCREASES/TOENEEM ✓

(1)

2.4.2

- Since μ_k and m are constant, as θ decreases, normal force/ w_{\perp} / $mg\cos\theta$ will increase. ✓

Aangesien μ_k en m konstant is, soos θ afneem sal

normaalkrag/ w_{\perp} / $mg\cos\theta$ toeneem.

OR/OF

$$N = mg\cos\theta$$

- Frictional force is directly proportional to normal force/ ✓
Wrywing is direk eweredig aan normaalkrag

$$\text{OR/OF } f \propto N \text{ / } f \propto w_{\perp} \text{ / } f \propto N \text{ / } f = \mu_k N$$

(2)

[16]

QUESTION 3/VRAAG 3

3.1 Motion under the influence of gravitational force only. ✓✓ Accept weight/gravity.

Beweging slegs onder die invloed van gravitasiekrag. Aanvaar swaartekrag/gewig/gravitasie.

(2 or/of 0)

OR/OF

Motion in which the only force acting is gravitational force. Accept weight/gravity.

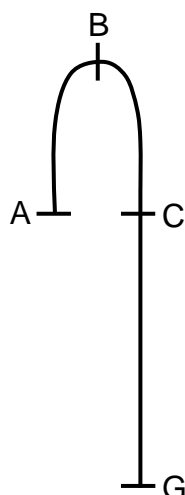
Beweging waar die enigste krag wat inwerk, gravitasiekrag is. Aanvaar swaartekrag/gewig/gravitasie. (2 or/of 0)

(2)

NOTE: If projectile is defined: 0/2

NOTA: Indien projektiel gedefinieer is: 0/2

3.2



Marking criteria/Nasienkriteria

- Correct formula for v_i . /Korrekte formule vir v_i . ✓
- Correct substitution into formula. /Korrekte vervanging in formule. ✓
- Correct final answer /Korrekte finale antwoord: $10,74 \text{ m} \cdot \text{s}^{-1}$ ✓

Note: If energy principles are used, max: $\frac{1}{3}$ for answer.

Nota: Indien energiebeginsels gebruik word, maks: $\frac{1}{3}$ vir antwoord.

OPTION 1/OPSIE 1

A-B:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0^2 = v_i^2 + 2(-9,8)(5,89) \quad \checkmark$$

$$v_i = 10,74 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$0^2 = v_i^2 + 2(9,8)(-5,89) \quad \checkmark$$

$$v_i = 10,74 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 2/OPSIE 2

B-C:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = 0 + 2(-9,8)(-5,89) \quad \checkmark$$

$$v_i = 10,74 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = 0 + 2(9,8)(5,89) \quad \checkmark$$

$$v_i = 10,74 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

(3)

3.3.1 **POSITIVE MARKING FROM QUESTION 3.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2

Marking criteria/Nasienkriteria

- Any one of the correct formulae leading to the velocity at which the ball strikes the ground./Enige een van die korrekte formules wat lei tot die snelheid waarmee die bal die grond tref. ✓
- Correct substitution leading to the velocity at which the ball strikes the ground (values of v_i and v_f can be swapped)./Korrekte vervanging wat lei tot die snelheid waarmee die bal die grond tref (waardes van v_i en v_f kan omgeruil word). ✓
- Correct formula for $\Delta E_k/E_k/E_{k \text{ lost}}$./Korrekte formule vir $\Delta E_k/E_k/E_{k \text{ verlore}}$. ✓
- Correct substitution into $\Delta E_k/E_k/E_{k \text{ lost}}$ formula (values of v_i and v_f can be swapped, ignore negative v_i or v_f values)./Korrekte vervanging in $\Delta E_k/E_k/E_{k \text{ verlore}}$ formule (waardes van v_i en v_f kan omgeruil word, ignoreer negatiewe v_i of v_f waardes). ✓
- Correct final answer/Korrekte finale antwoord: $\pm 68,31 \text{ J}$ ✓
Range/Gebied: (67,91 – 69,34J)

Note: Accept if downwards is taken as positive.

Nota: Aanvaar indien afwaarts as positief geneem is.

OPTION 1/OPSIE 1

A-G:

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (10,74)^2 + 2(-9,8)(-15,3) \quad \checkmark$$

$$v_f = -20,38 \text{ m}\cdot\text{s}^{-1}$$

OPTION 2/OPSIE 2

B-G:

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = 0^2 + 2(-9,8)(-21,19) \quad \checkmark$$

$$v_f = -20,38 \text{ m}\cdot\text{s}^{-1}$$

OPTION 3/OPSIE 3

C-G:

$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (-10,74)^2 + 2(-9,8)(-15,3) \quad \checkmark$$

$$v_f = -20,38 \text{ m}\cdot\text{s}^{-1}$$

OPTION 4/OPSIE 4

A-G:

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

$$-15,3 = (10,74)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$t = 3,18 \text{ s}$$

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

$$-15,3 = \left(\frac{10,74 + v_f}{2} \right) 3,18 \quad \checkmark$$

$$v_f = -20,38 \text{ m}\cdot\text{s}^{-1}$$

DURING COLLISION/
TYDENS BOTSING

$$\Delta E_k = E_{kf} - E_{ki}$$

$$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array} \right\}$$

$$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$$

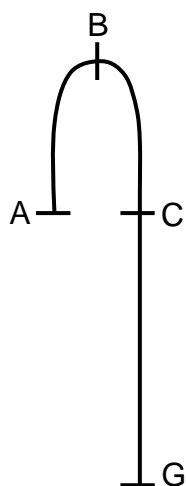
$$\Delta E_k = \frac{1}{2}(0,5)[(11,92)^2 - (20,38)^2] \quad \checkmark$$

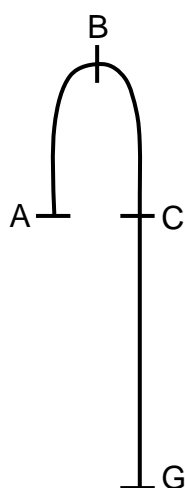
$$\Delta E_k/E_{k \text{ lost}} = -68,31 \text{ J} \quad \checkmark$$

OR/OF

$$\Delta E_k = \frac{1}{2}(0,5)[(20,38)^2 - (11,92)^2] \quad \checkmark$$

$$\Delta E_k/E_{k \text{ lost}} = 68,31 \text{ J} \quad \checkmark$$





OPTION 5/OPSIE 5

B-G:

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

$$-21,19 = (0) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$t = 2,08 \text{ s}$$

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

$$-21,19 = \left(\frac{0 + v_f}{2} \right) 2,08 \checkmark$$

$$v_f = -20,38 \text{ m} \cdot \text{s}^{-1}$$

OPTION 6/OPSIE 6

C-G:

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

$$-15,3 = (-10,74) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$t = 0,98 \text{ s}$$

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

$$-15,3 = \left(\frac{-10,74 + v_f}{2} \right) 0,98 \checkmark$$

$$v_f = -20,48 \text{ m} \cdot \text{s}^{-1}$$

OPTION 7/OPSIE 7

A-G:

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

$$-15,3 = (10,74) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$t = 3,18 \text{ s}$$

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = 10,74 + (-9,8)(3,18) \checkmark$$

$$v_f = -20,42 \text{ m} \cdot \text{s}^{-1}$$

OPTION 8/OPSIE 8

B-G:

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

$$-21,19 = (0) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$t = 2,08 \text{ s}$$

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = 0 + (-9,8)(2,08) \checkmark$$

$$v_f = -20,38 \text{ m} \cdot \text{s}^{-1}$$

OPTION 9/OPSIE 9

C-G:

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

$$-15,3 = (-10,74) \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$t = 0,98 \text{ s}$$

$$v_f = v_i + a \Delta t \checkmark$$

$$v_f = -10,74 + (-9,8)(0,98) \checkmark$$

$$v_f = -20,34 \text{ m} \cdot \text{s}^{-1}$$

DURING COLLISION/
TYDENS BOTSING

$$\Delta E_k = E_{kf} - E_{ki}$$

$$\Delta E_k = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\Delta E_k = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$\Delta E_k = \frac{1}{2} (0,5) [(11,92)^2 - (20,38)^2] \checkmark$$

$$\Delta E_k / E_{k \text{ lost}} = -68,31 \text{ J} \checkmark$$

✓ Any one/
Enige een

OR/OF

$$\Delta E_k = \frac{1}{2} (0,5) [(20,38)^2 - (11,92)^2] \checkmark$$

$$\Delta E_k / E_{k \text{ lost}} = 68,31 \text{ J} \checkmark$$

OPTION 10/OPSIE 10

A-G: $W_{\text{net}} = \Delta E_k$
 $w\Delta y \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } ✓ Any one/
Enige een
 $(0,5)(9,8)(15,3)\cos 0^\circ = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓
 $v_f = 20,38 \text{ m}\cdot\text{s}^{-1}$ →

OPTION 11/OPSIE 11

B-G: $W_{\text{net}} = \Delta E_k$
 $w\Delta y \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } ✓ Any one/
Enige een
 $(0,5)(9,8)(21,19)\cos 0^\circ = \frac{1}{2}(0,5)v_f^2 - 0$ ✓
 $v_f = 20,38 \text{ m}\cdot\text{s}^{-1}$ →

OPTION 12/OPSIE 12

C-G: $W_{\text{net}} = \Delta E_k$
 $w\Delta y \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } ✓ Any one/
Enige een
 $(0,5)(9,8)(15,3)\cos 0^\circ = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓
 $v_f = 20,38 \text{ m}\cdot\text{s}^{-1}$ →

OPTION 13/OPSIE 13

A-G OR/OF C-G:
 $W_{\text{nc}} = \Delta K + \Delta U$
 $W_{\text{nc}} = [\frac{1}{2} m(v_f^2 - v_i^2)] + [mg(h_f - h_i)]$ } ✓ Any one/
Enige een
 $0 = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$ →
 $0 = [\frac{1}{2}(0,5)v_f^2 - (10,74)^2] + [0 - (0,5)(9,8)(15,3)]$ ✓
 $v_f = 20,38 \text{ m}\cdot\text{s}^{-1}$

OPTION 14/OPSIE 14

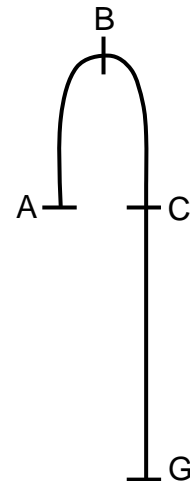
B-G:
 $W_{\text{nc}} = \Delta K + \Delta U$
 $W_{\text{nc}} = [\frac{1}{2} m(v_f^2 - v_i^2)] + [mg(h_f - h_i)]$ } ✓ Any one/
Enige een
 $0 = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$ →
 $0 = [\frac{1}{2}(0,5)v_f^2 - 0] + [0 - (0,5)(9,8)(21,19)]$ ✓
 $v_f = 20,38 \text{ m}\cdot\text{s}^{-1}$

OPTION 15/OPSIE 15

$\Delta y = v_i \Delta t + \frac{1}{2}a \Delta t^2$
 $-15,3 = (10,74)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
 $t = 3,18 \text{ s}$
 $F_{\text{net}} \Delta t = \Delta p$
 $mg \Delta t = m(v_f - v_i)$ } ✓ Any one/
Enige een
 $(-9,8)(3,18) = v_f - 10,74$ ✓
 $v_i = -20,38 \text{ m}\cdot\text{s}^{-1}$ ✓

OPTION 16/OPSIE 16

$(E_k + E_p)_{\text{top}} = (E_k + E_p)_{\text{bottom}}$
 $(0 + mgh)_{\text{top}} = (\frac{1}{2}mv_i^2 + 0)_{\text{bottom}}$ } ✓ Any one/
Enige een
 $0 + (0,5)(9,8)(21,19) = \frac{1}{2}(0,5)v^2 + 0$ ✓
 $v_i = 20,3795 \text{ m}\cdot\text{s}^{-1}$ ✓



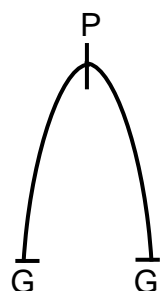
DURING COLLISION/TYDENS BOTSING

$\Delta E_k = E_{kf} - E_{ki}$
 $\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } ✓ Any one/
Enige een
 $\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$
 $\Delta E_k = \frac{1}{2}(0,5)[(11,92)^2 - (20,38)^2]$ ✓
 $\Delta E_k/E_{k \text{ lost}} = -68,31 \text{ J}$ ✓

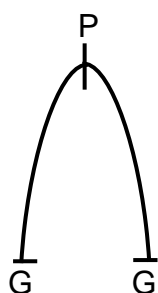
OR/OF

$\Delta E_k = \frac{1}{2}(0,5)[(20,38)^2 - (11,92)^2]$ ✓
 $\Delta E_k/E_{k \text{ lost}} = 68,31 \text{ J}$ ✓

3.3.2



Marking criteria/Nasienkriteria <ul style="list-style-type: none"> Correct formula to calculate Δt. / <i>Korrekte formule om Δt te bereken.</i> ✓ Correct substitution to calculate Δt. / <i>Korrekte vervanging om Δt te bereken.</i> ✓ Correct final answer. / <i>Korrekte finale antwoord: 1,22 s</i> ✓ 	
OPTION 1/OPSIE 1 G-P: UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = 11,92 + (-9,8) \Delta t$ ✓ $\Delta t = 1,22 \text{ s}$ ✓	G-P: DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = (-11,92) + (9,8)\Delta t$ ✓ $\Delta t = 1,22 \text{ s}$ ✓
OPTION 2/OPSIE 2 P-G: UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-11,92 = 0 + (-9,8) \Delta t$ ✓ $\Delta t = 1,22 \text{ s}$ ✓	P-G: DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $11,92 = 0 + (9,8)\Delta t$ ✓ $\Delta t = 1,22 \text{ s}$ ✓
OPTION 3/OPSIE 3 G - G: UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-11,92 = 11,92 + (-9,8) \Delta t$ ✓ $\Delta t = 2,43 \text{ s}$ $t \text{ to reach } h_{\max}/t \text{ tot } h_{\max} = \frac{2,43}{2}$ $= 1,22 \text{ s}$ ✓	G - G: DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $11,92 = -11,92 + (9,8) \Delta t$ ✓ $\Delta t = 2,43 \text{ s}$ $t \text{ to reach } h_{\max}/t \text{ tot } h_{\max} = \frac{2,43}{2}$ $= 1,22 \text{ s}$ ✓
OPTION 4/OPSIE 4 G-P: UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (11,92)^2 + 2(-9,8)\Delta y$ $\Delta y = 7,25 \text{ m}$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $7,25 = (11,92)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 1,22 \text{ s}$ ✓ OR/OF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $7,25 = \left(\frac{11,92 + 0}{2} \right) \Delta t$ ✓ $\Delta t = 1,22 \text{ s}$ ✓

**G-P:****DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = (-11,92)^2 + 2(9,8)\Delta y$$

$$\Delta y = -7,25 \text{ m}$$

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

$$\frac{-7,25 = (-11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

OR/OF

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

$$\frac{-7,25 = \left(\frac{-11,92 + 0}{2} \right) \Delta t \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

OPTION 5/OPSIE 5**P-G:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$(-11,92)^2 = 0 + 2(-9,8)\Delta y$$

$$\Delta y = -7,25 \text{ m}$$

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

$$\frac{-7,25 = \frac{1}{2}(-9,8)\Delta t^2 \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

OR/OF

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

$$\frac{-7,25 = \left(\frac{0 - 11,92}{2} \right) \Delta t \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

P-G:**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$(11,92)^2 = 0 + 2(9,8)\Delta y$$

$$\Delta y = 7,25 \text{ m}$$

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

$$\frac{7,25 = (11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

OR/OF

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

$$\frac{7,25 = \left(\frac{0 + 11,92}{2} \right) \Delta t \checkmark}{\Delta t = 1,22 \text{ s} \checkmark}$$

<p>OPTION 6/OPSIE 6</p> $W_{\text{net}} = \Delta E_k$ $w\Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(0,5)(9,8)\Delta y \cos 180^\circ = \frac{1}{2}(0,5)(0 - (11,92)^2)$ $\Delta y = 7,25 \text{ m}$ <p>OR/OF</p> $W_{\text{nc}} = \Delta K + \Delta U$ $W_{\text{nc}} = \left[\frac{1}{2} m(v_f^2 - v_i^2) \right] + [mg(h_f - h_i)]$ $0 = \left[\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right] + [mgh_f - mgh_i]$ $0 = \frac{1}{2}(0,5)[(0 - (11,92)^2) + (0,5)(9,8)\Delta h]$ $\Delta h = 7,25 \text{ m}$ <p>OR/OF</p> $\sum E_{\text{Mi}} = \sum E_{\text{Mf}}$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$ $\frac{1}{2}(0,5)(11,92)^2 + 0 = 0 + (0,5)(9,8)(h_f)$ $\Delta h = 7,25 \text{ m}$	<p>UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $7,25 = (11,92)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$ <p>OR/OF</p> $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$ $7,25 = \left(\frac{11,92 + 0}{2} \right) \Delta t \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$ <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF</p> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $-7,25 = (-11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$ <p>OR/OF</p> $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark$ $-7,25 = \left(\frac{-11,92 + 0}{2} \right) \Delta t \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$
<p>OPTION 7/OPSIE 7</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF</p> $F_{\text{net}} \Delta t = \Delta p = m(v_f - v_i) \checkmark$ $mg\Delta t = m(v_f - v_i)$ $(0,5)(9,8)\Delta t = (0,5)[0 - (11,92)] \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$	<p>UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $F_{\text{net}} \Delta t = \Delta p = m(v_f - v_i) \checkmark$ $mg\Delta t = m(v_f - v_i)$ $(0,5)(9,8)\Delta t = (0,5)[0 - (-11,92)] \checkmark$ $\Delta t = 1,22 \text{ s} \checkmark$

(3)

3.4 **POSITIVE MARKING FROM QUESTIONS 3.2 AND 3.3.2**
POSITIEWE NASIEN VANAF VRAE 3.2 EN 3.3.2

3.4.1 $11,92 \text{ (m} \cdot \text{s}^{-1}) \checkmark$ (1)

3.4.2 $10,74 \text{ (m} \cdot \text{s}^{-1}) \checkmark$ (1)

3.4.3 $1,22 \text{ (s)} \checkmark$ (1)

[16]

QUESTION 4/VRAAG 4

- 4.1 591 N to the right/original direction of bullet/Accept East ✓
591 N na regs/in oorspronklike rigting van koeël/Aanvaar Oos (1)

4.2 **Marking criteria/Nasienkriteria**

- Any correct formula for conservation of momentum./Enige korrekte formule vir behoud van momentum. ✓
- Correct substitutions./Korrekte vervangings. ✓✓
- Correct final answer./Korrekte finale antwoord: $395,58 \text{ m}\cdot\text{s}^{-1}$ ✓

Range/Gebied: $(394 \text{ to } 395,58 \text{ m}\cdot\text{s}^{-1})$

OPTION 1/OPSIE 1

$$F_{\text{net}} \Delta t = \Delta p = m(v_f - v_i)$$

$$(591)(0,02) = 2,7[v_f - (-3)]$$

$$v_f = 1,38 \text{ m}\cdot\text{s}^{-1}$$

OR/OF

$$\Sigma p_i = \Sigma p_f$$

$$m_b v_{bi} + m_t v_{ti} = (m_b + m_t) v_f$$

$$(0,03)v_{bi} + (2,7)(-3) = (0,03 + 2,7)(1,38) \checkmark$$

$$(0,03)v_{bi} = 11,86$$

$$v_i = 395,58 \text{ m}\cdot\text{s}^{-1} \checkmark$$

$$\Delta p_{(\text{bullet})} = -\Delta p_{(\text{trolley})} \checkmark$$

$$m(v_f - v_i) = -(591)(0,02) \checkmark$$

$$(0,03)(1,38 - v_i) \checkmark = -11,82$$

$$1,38 - v_i = -394$$

$$v_i = 395,38 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

- 4.3 **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.

The total (linear) momentum in an isolated system is conserved/remains constant. ✓✓

Die totale (lineêre) momentum in 'n geïsoleerde sisteem bly behoue/konstant.

Accept for 1 mark/Aanvaar vir 1 punt

In a isolated system the total momentum before a collision is equal to the total momentum after a collision.

In 'n geïsoleerde sisteem is die totale momentum voor 'n botsing gelyk aan die totale momentum na 'n botsing.

(2)

4.4 **POSITIVE MARKING FROM QUESTION 4.2.**
POSITIEWE NASIEN VANAF VRAAG 4.2.

OPTION 1/OPSIE 1

RIGHT AS POSITIVE/REGS AS POSITIEF

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_x v_{ix} + m_y v_{iy} &= m_x v_{fx} + m_y v_{fy} \end{aligned} \right\} \checkmark \text{Any one/Enige een}$$

$$(0,03)(395,58) + (2,7)(-3) \checkmark = v_f(0,03 + 2,7) \checkmark$$

$$\therefore v_f = 1,38 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ Range/Gebied: } (1,36 - 1,38 \text{ m}\cdot\text{s}^{-1})$$

LEFT AS POSITIVE/LINKS AS POSITIEF

$$\left. \begin{aligned} \sum p_i &= \sum p_f \\ m_x v_{ix} + m_y v_{iy} &= m_x v_{fx} + m_y v_{fy} \end{aligned} \right\} \checkmark \text{Any one/Enige een}$$

$$(0,03)(-395,58) + (2,7)(3) \checkmark = v_f(0,03 + 2,7) \checkmark$$

$$\therefore v_f = -1,38 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = 1,38 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ Range/Gebied: } (1,36 - 1,38 \text{ m}\cdot\text{s}^{-1})$$

OPTION 2/OPSIE 2

$$F_{\text{net}} \Delta t = \Delta p = m(v_f - v_i) \checkmark$$

$$(591)(0,02) \checkmark = 2,7[v_f - (-3)] \checkmark$$

$$v_f = 1,38 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ Range/Gebied: } (1,36 - 1,38 \text{ m}\cdot\text{s}^{-1})$$

OPTION 3/OPSIE 3

RIGHT AS POSITIVE/REGS AS POSITIEF

$$\left. \begin{aligned} \Delta p_{\text{(bullet)}} + \Delta p_{\text{(trolley)}} &= 0 \\ m_1(v_{1f} - v_{1i}) + m_2(v_{2f} - v_{2i}) &= 0 \end{aligned} \right\} \checkmark \text{Any one/Enige een}$$

$$(0,03)(v_f - 395,58) \checkmark + (2,7)(v_f + 3) \checkmark = 0$$

$$v_f = 1,38 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ Range/Gebied: } (1,36 - 1,38 \text{ m}\cdot\text{s}^{-1})$$

LEFT AS POSITIVE/LINKS AS NEGATIEF

$$\left. \begin{aligned} \Delta p_{\text{(bullet)}} + \Delta p_{\text{(trolley)}} &= 0 \\ m_1(v_{1f} - v_{1i}) + m_2(v_{2f} - v_{2i}) &= 0 \end{aligned} \right\} \checkmark \text{Any one/Enige een}$$

$$(0,03)(v_f + 395,58) \checkmark + (2,7)(v_f - 3) \checkmark = 0$$

$$v_f = -1,38 \text{ m}\cdot\text{s}^{-1}$$

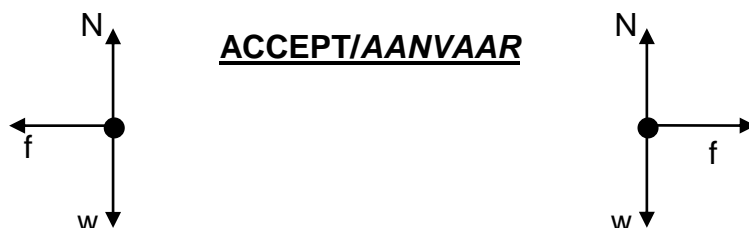
$$v_f = 1,38 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ Range/Gebied: } (1,36 - 1,38 \text{ m}\cdot\text{s}^{-1})$$

(4)

[11]

QUESTION 5/VRAAG 5

5.1



Accepted labels/Aanvaarde benoemings	
w	$F_w / F_g / F_{\text{Earth on trolley}} / F_{\text{Aarde op trollie}} / mg / \text{gravitational force} / \text{gravitasiekrag} / \text{weight} / \text{gewig}$
f	$F_f / f_k / (\text{kinetic}) \text{ Friction} / (\text{kinetiese}) \text{ wrywing} / F_w$
N	$F_N / F_{\text{surface on trolley}} / F_{\text{oppervlak op trollies}} / \text{Normal} / \text{Normaal}$
Notes/Aantekeninge: <ul style="list-style-type: none"> Mark awarded for label <u>and</u> arrow./Punt toegeken vir benoeming <u>en</u> pyltjie. Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie. Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks $\frac{2}{3}$ If everything is correct, but no arrows/Indien alles korrek is, maar geen pyltjies: Max/Maks $\frac{2}{3}$ If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{2}{3}$ 	

(3)

5.2

Initial kinetic energy/Aanvanklike kinetiese energie/ $E_{kA} / E_{ki} / K_i \checkmark$

(1)

5.3

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.

The net/total work done (on an object) is equal to the change in the object's kinetic energy. $\checkmark \checkmark$

Die netto/totale arbeid wat (op 'n voorwerp) verrig is, is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/OF

The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. $\checkmark \checkmark$

Die arbeid verrig op in voorwerp deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

5.4

<p>Marking criteria/Nasienkriteria OPTION 1/OPSIE 1</p> <ul style="list-style-type: none"> • Relating frictional force to gradient./Verband tussen wrywingskrag en helling. ✓ • Correct substitution of two values or ratio from the graph./Korrekte vervanging van twee waardes of verhouding vanaf die grafiek. ✓✓ • Formula to calculate mass./Formule om massa te bereken. ✓ • Correct substitution of μ and 9,8./Korrekte vervanging van μ en 9,8. ✓ • Correct final answer/Korrekte finale antwoord: 2,27 kg ✓ 	$\text{gradient} = \frac{\Delta y}{\Delta x} = \frac{\Delta x}{E_{ki}} = \frac{1}{f} \quad \checkmark$ $\frac{1,5}{6} \text{ OR/OF } \frac{3}{12} \text{ OR/OF } \frac{4,5}{18} = \frac{1}{4} \checkmark$ $f = 4 \text{ N}$ $f_k = \mu_k F_N \checkmark$ $4 = (0,18)(m)(9,8) \checkmark$ $m = 2,27 \text{ kg} \checkmark$
<p>Marking criteria/Nasienkriteria OPTIONS 2 TO 5/OPSIES 2 TOT 5</p> <ul style="list-style-type: none"> • Correct formula for work./Korrekte formule vir arbeid. ✓ • Correct substitution of two co-ordinate values from the graph. Correct negative ΔE_k value (any two correct co-ordinates used). ✓✓ Korrekte vervanging van twee koördinaat waardes vanaf die grafiek Korrekte negatiewe ΔE_k waarde (enige twee korrekte koördinate gebruik). • Formula to calculate mass./Formule om massa te bereken. ✓ • Correct substitution of μ and 9,8./Korrekte invervanging van μ en 9,8. ✓ • Correct final answer/Korrekte finale antwoord: 2,27 kg ✓ 	<p>OPTION 2/OPSIE 2</p> <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> $\left. \begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{net} &= \Delta E_k \\ W_{net} &= E_{kf} - E_{ki} \\ W_f &= \Delta E_k \\ W_f &= E_{kf} - E_{ki} \\ f\Delta x \cos 180^\circ &= E_{kf} - E_{ki} \end{aligned} \right\}$ </div> <div style="margin-right: 10px;"> <p>✓ Any one/ Enige een</p> </div> <div style="border-left: 1px solid black; padding-left: 10px;"> $-f(1,5) \checkmark = 0 - 6 \checkmark$ <p>OR/OF</p> $-f(3) = 0 - 12$ <p>OR/OF</p> $-f(4,5) = 0 - 18$ $f = 4 \text{ N}$ </div> </div> <div style="margin-top: 20px;"> <p>OPTION 3/OPSIE 3</p> $W_{net} = F_{net} \Delta x \cos \theta \checkmark$ $-6 \checkmark = f(1,5) \cos 180^\circ \checkmark \quad \text{OR/OF}$ $-12 = f(3) \cos 180^\circ \quad \text{OR/OF}$ $-18 = f(4,5) \cos 180^\circ$ $f = 4 \text{ N}$ </div> <div style="margin-top: 20px;"> $f_k = \mu_k F_N \checkmark$ $4 = (0,18)(m)(9,8) \checkmark$ $m = 2,27 \text{ kg} \checkmark$ </div>

OPTION 4/OPSIE 4

$$f_k = \mu_k N \checkmark$$

$$= 0,18(9,8)(m) \checkmark$$

$$= 1,76m$$

$$W_{\text{net}} = \Delta E_k$$

$$F_{\text{net}} \Delta x \cos \theta = E_{\text{kf}} - E_{\text{ki}}$$

$$f_k \Delta x \cos \theta = E_{\text{kf}} - E_{\text{ki}}$$

$$\mu_k N \Delta x \cos \theta = E_{\text{kf}} - E_{\text{ki}}$$

$$\mu_k N \Delta x \cos 180^\circ = E_{\text{kf}} - E_{\text{ki}}$$

✓ Any one/Enige een

$$- (1,76m)(4,5) \checkmark = 0 - 18 \checkmark$$

OR/OF

$$- (1,76m)(3) = 0 - 12$$

OR/OF

$$- (1,76m)(1,5) = 0 - 6$$

$$m = 2,27 \text{ kg} \checkmark$$

OPTION 5/OPSIE 5

$$W_{\text{net}} = \Delta E_k \checkmark$$

$$\mu_k mg \Delta x \cos \theta = E_{\text{kf}} - E_{\text{ki}}$$

$$(0,18)(m)(9,8)(4,5) \cos 180^\circ = 0 - 18 \checkmark$$

$$m = 2,27 \text{ kg} \checkmark$$

OPTION 6/OPSIE 6

$$f_k = \mu_k N \checkmark$$

$$= 0,18(9,8)(m) \checkmark$$

$$= 1,76m$$

$$F_{\text{net}} = ma$$

$$-1,76m = ma$$

$$a = -1,764 \text{ m} \cdot \text{s}^{-2}$$

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$0 = v_i^2 + 2(-1,764)(4,5) \checkmark$$

$$v_i = 3,98 \text{ m} \cdot \text{s}^{-1}$$

$$\Delta E_k = \frac{1}{2} m \Delta v^2 \checkmark$$

$$-18 = \frac{1}{2} m (0 - 3,98^2) \checkmark$$

$$m = 2,27 \text{ kg} \checkmark$$

(6)

[12]

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 sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The change in frequency (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. ✓✓

Die verandering in frekwensie (toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, 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

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \text{OR/OF} \quad f_L = \frac{v}{v + v_s} f_s \quad \checkmark$$

$$512,64 \checkmark = \left(\frac{v}{v + 25} \right) (550) \checkmark$$

$$v = 343,04 \text{ m} \cdot \text{s}^{-1} \checkmark \quad \text{Range/Gebied: } (332,14 - 343,04 \text{ m} \cdot \text{s}^{-1})$$

(5)

6.1.3

a) Remains the same/Bly dieselfde ✓ (1)

b) Remains the same/Bly dieselfde ✓ (1)

c) Decreases/Afneem ✓ (1)

6.2.1

AWAY FROM/WEG VAN ✓ (1)

6.2.2

Marking criteria/Nasienkriteria:

Second mark is only awarded if red is linked to lower frequency/longer wavelength./Tweede punt word slegs toegeken indien vergelyking getref word tussen rooi en laer frekwensie en langer golflengte.

- A lower frequency/longer wavelength ✓ is detected.
- The spectral lines are shifted to the red end of the spectrum. ✓
- 'n Laer frekwensie/langer golflengte word waargeneem.
- Die spektrale lyne word geskuif na die rooi end van die spektrum.

(2)

[13]

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.

Electric field is a region/space in which an electric charge experiences a force.✓✓

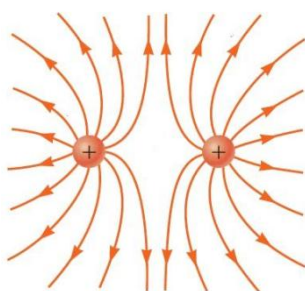
'n Gebied/ruimte waarin 'n elektriese lading 'n krag ondervind.

NOTE: If electric field at a point is defined: $0/2$

NOTA: Indien elektriese veld by 'n punt gedefinieer is: $0/2$

(2)

7.2



Criteria for sketch/Kriteria vir skets	Marks/Punte
Correct direction of field lines./Korrekte rigting van veldlyne.	✓
Correct shape of the electric field lines between charges and on the outside of the charges./Korrekte vorm van elektrieseveld tussen ladings en die buitekant van die ladings.	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge./Geen veldlyne wat mekaar kruis nie. Veldlyne moet die lading raak, maar nie die lading binnegaan nie.	✓
Note: If learner draws field pattern of two opposite charges: $0/3$ If only one charge is drawn, max: $1/3$ for direction. Nota: Indien leerder elektrieseveld van twee teenoorgestelde ladings teken: $0/3$. Indien slegs een lading geteken is, maks: $1/3$ vir rigting.	

(3)

7.3

Marking criteria/Nasienkriteria

- Formula/Formule: $E = \frac{kQ}{r^2}$. ✓
- Correct substitution for either A or B ✓/Korrekte vervanging vir of A of B.
- Substitution of 27 or -27 for E_{net} . ✓/Vervanging van 27 of -27 vir E_{net} .
- Subtraction of/Aftrek van ($E_A - E_B$ **OF/OR** $E_B - E_A$) ✓
- Correct final answer/Korrekte finale antwoord: 0,87 (m) ✓

OPTION 1/OPSIE 1

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_A = \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2}$$

$$E_B = \frac{(9 \times 10^9)(3 \times 10^{-9})}{(2r)^2}$$

✓ Any one/Enige een

$$E_{\text{net}} = E_A - E_B$$

$$27 \checkmark = \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})}{4r^2}$$

$$r = 0,87 \text{ (m)} \checkmark$$

OR/OF

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_A = \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2}$$

$$E_B = \frac{(9 \times 10^9)(3 \times 10^{-9})}{(2r)^2}$$

✓ Any one/Enige een

$$E_{\text{net}} = E_B - E_A$$

$$-27 \checkmark = \frac{(9 \times 10^9)(3 \times 10^{-9})}{4r^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2}$$

$$r = 0,87 \text{ (m)} \checkmark$$

OPTION 2/OPSIE 2

Marking criteria/Nasienkriteria:

- Formula for Coulomb's law./Formule vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's formula for either F_A or F_B ./ ✓
Korrekte vervanging in Coulomb se formule vir of F_A of F_B .
- Substitution of $27q$ or $-27q$ for F_{net} . ✓/Vervanging van $27q$ of $-27q$ vir F_{net} .
- Subtraction of/Aftrek van $(F_A - F_B)$ **OF/OR** $F_B - F_A$ ✓
- Correct final answer/Korrekte finale antwoord: $0,87 \text{ (m)}$ ✓

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_A = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{r^2}$$

$$F_B = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{(2r)^2}$$

$$F_{\text{net}} = F_A - F_B$$

$$27q \checkmark = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{r^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{4r^2}$$

$$r = 0,87 \text{ (m)} \checkmark$$

✓ Any one/Enige een

OR/OF

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_A = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{r^2}$$

$$F_B = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{(2r)^2}$$

$$-F_{\text{net}} = F_B - F_A$$

$$-27q \checkmark = \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{4r^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})(q)}{r^2}$$

$$r = 0,87 \text{ (m)} \checkmark$$

✓ Any one/Enige een

(5)

7.4

OPTION 1/OPSIE 1

$$F = Eq \checkmark$$

$$= (27)(1,6 \times 10^{-19}) \checkmark$$

$$= 4,32 \times 10^{-18} \text{ N} \checkmark$$

Note: Do not penalize for $-1,6 \times 10^{-19}$, but penalize for negative final answer.

Nota: Moenie penaliseer vir $-1,6 \times 10^{-19}$ nie, maar wel vir negatiewe finale antwoord.

POSITIVE MARKING FROM QUESTION 7.3.

POSITIEWE NASIEN VANAF VRAAG 7.3.

OPTION 2/OPSIE 2

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_{\text{net}} = F_A - F_B$$

$$F_{\text{net}} = \frac{(9 \times 10^9)(3 \times 10^{-9})(1,6 \times 10^{-19})}{(0,87)^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})(1,6 \times 10^{-19})}{(1,74)^2}$$

$$= 4,28 \times 10^{-18} \text{ N} \checkmark$$

OR/OF

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F_{\text{net}} = F_B - F_A$$

$$F_{\text{net}} = \frac{(9 \times 10^9)(3 \times 10^{-9})(1,6 \times 10^{-19})}{(1,74)^2} - \frac{(9 \times 10^9)(3 \times 10^{-9})(1,6 \times 10^{-19})}{(0,87)^2}$$

$$= -4,28 \times 10^{-18} \text{ N}$$

$$= 4,28 \times 10^{-18} \text{ N} \checkmark$$

(3)
[13]

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 (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓

Die potensiaalverskil (spanning) oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.

OR/OF

The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if temperature is constant. ✓✓

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is.

OR/OF

The ratio of potential difference to current is constant provided the temperature remains the same. ✓✓

Die verhouding van potensiaalverskil tot stroom is konstant indien die temperatuur konstant bly.

(2)

8.2.1

Marking criteria/Nasienkriteria

- Any correct formula to calculate the effective resistance of any of the two parallel combinations./Enige korrekte formule om die effektiewe weerstand van enige een van die parallel kombinasies te bereken. ✓
- Correct substitution in formula to calculate effective resistance of both parallel combinations./Korrekte vervanging in formule om effektiewe weerstand van beide parallel gedeeltes te bereken. ✓✓
- Adding the 10 Ω to the first parallel combination and using this to calculate the external resistance (R_{ext})/Bymekaartel van 10 Ω en die gebruik daarvan om die eksterne weerstand te bereken ✓
- Correct final answer/Korrekte finale antwoord: 7,5 Ω ✓

OPTION 1/OPSIE 1

$$R_{12L} = R_L + \left(\frac{R_1 R_2}{R_1 + R_2} \right)$$

$$= \underline{10} + \frac{10 \times 10}{10 + 10} \checkmark$$

$$= 15 \Omega$$

✓ Any one/
enige een

$$R_p = \left(\frac{R_3 R_{12L}}{R_3 + R_{12L}} \right)$$

$$R_p = \frac{15 \times 15}{15 + 15} \checkmark$$

$$R_p = 7,5 \Omega \checkmark$$

OPTION 2/OPSIE 2

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{OR/OF} \quad R_{12} = \left(\frac{R_1 R_2}{R_1 + R_2} \right)$$

$$\frac{1}{R_{12}} = \frac{1}{10} + \frac{1}{10} \checkmark \quad \text{OR/OF} \quad \frac{10 \times 10}{10 + 10} \checkmark$$

$$R_{12} = 5 \Omega$$

$$R_{12L} = R_L + R_{12}$$

$$= \underline{10} + 5$$

$$= 15 \Omega$$

✓ Any one/
enige een

$$\frac{1}{R_p} = \frac{1}{R_{12L}} + \frac{1}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{15} + \frac{1}{15} \checkmark$$

$$R_p = 7,5 \Omega \checkmark$$

(5)

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

<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>
$\epsilon = I(R + r) \checkmark$ $12 = I(7,5 + 0,5) \checkmark$ $I = 1,5 \text{ A} \checkmark$	$R = \frac{V}{I} \quad / \quad R_T = \frac{\epsilon}{I} \checkmark$ $(7,5 + 0,5) = \frac{12}{I} \checkmark$ $I = 1,5 \text{ A} \checkmark$

(3)

8.2.3 **POSITIVE MARKING FROM QUESTIONS 8.2.1 AND 8.2.2**
POSITIEWE NASIEN VANAF VRAE 8.2.1 EN 8.2.2

<u>Marking criteria/Nasienkriteria</u>			
<ul style="list-style-type: none"> Substitution of the correct current or potential difference for R_3./ <i>Vervanging van die korrekte stroom of potensiaalverskil vir R_3.</i> ✓ Correct formula for power, leading to the answer./<i>Korrekte formule vir drywing wat lei tot die antwoord.</i> ✓ Correct substitution to calculate power./<i>Korrekte vervanging om drywing te bereken.</i> ✓ Correct final answer./<i>Korrekte finale antwoord: 8,44 W.</i> ✓ 			
$1,5 = 2I_{R_3}$ $I = 0,75 \text{ A}$	$R_{\text{ext}} = \frac{V_{\text{ext}}}{I}$ $V = (7,5)(1,5)$ $V = 11,25 \text{ V}$ $R_3 = \frac{V_{\text{ext}}}{I}$ $15 = \frac{11,25}{I}$ $I = 0,75 \text{ A}$	$I_{R_3} = \frac{R_{\text{II}}}{R_3} \times I_{\text{total}}$ $= \frac{7,5}{15} \times 1,5$ $= 0,75 \text{ A}$	$I_{R_3} = \left(\frac{R_S}{R_S + R_3} \right)$ $I = \left(\frac{15}{15 + 15} \right) (1,5)$ $= 0,75 \text{ A}$
↓	↓	↓	↓
<u>OPTION 1/</u> <u>OPSIE 1</u> $P = I^2 R \checkmark$ $= (0,75)^2 15 \checkmark$ $= 8,44 \text{ W} \checkmark$	<u>OPTION 2/</u> <u>OPSIE 2</u> $V = IR \checkmark$ $= (0,75)(15) \checkmark$ $= 11,25 \text{ V}$ $P = \frac{V^2}{R} \checkmark$ $= \frac{(11,25)^2}{15} \checkmark$ $= 8,44 \text{ W} \checkmark$	<u>OPTION 3/</u> <u>OPSIE 3</u> $V = IR \checkmark$ $= (0,75)(15) \checkmark$ $= 11,25 \text{ V}$ $P = VI \checkmark$ $= (11,25)(0,75) \checkmark$ $= 8,44 \text{ W} \checkmark$	<u>OPTION 4/</u> <u>OPSIE 4</u> $\epsilon = V_{\text{ext}} + Ir$ $12 = V_{\text{ext}} + (1,5)(0,5) \checkmark$ $V_{\text{ext}} = 11,25 \text{ V}$ $P = \frac{V^2}{R} \checkmark$ $= \frac{(11,25)^2}{15} \checkmark$ $= 8,44 \text{ W} \checkmark$

(4)

8.3.1 INCREASES/NEEM TOE ✓

(1)

- 8.3.2
- Total resistance of the circuit increases and total current in circuit decreases. ✓
 - V_{internal} /internal volts/ V_{lost} decreases and V_{external} /external volts / V_{RL} increases. ✓
 - Power output increases ✓ therefore brightness increases.
 - Totale weerstand van die stroombaan neem toe en die totale stroom neem af.
 - V_{intern} /interne volts/ V_{verlore} neem af en V_{ekstern} /eksterne volts / V_{RL} neem toe
 - Drywing neem toe daarom sal die helderheid toeneem.
- OR/OF**
- $\epsilon = I(R + r)$
 $12 = I(15 + 0,5)$
 $I = 0,77 \text{ A}$ ✓
 - I_L has increased/ I_L het toegeneem ✓
 - Power output increases ✓ therefore brightness increases.
Drywing neem toe daarom sal die helderheid toeneem.

(3)
[18]

QUESTION 9/VRAAG 9

9.1.1 Split ring/Commutator/*Splitring/Kommutator* ✓ (1)

9.1.2 Electrical to mechanical/kinetic ✓
Elektries na meganies/kineties ✓ (1)

9.1.3 Clockwise/*Kloksgewys* ✓✓ (2)

9.1.4 Any **two** of the following./Enige **twee** van die volgende:

- Increase the strength of the magnetic field e.g. use stronger magnets/bring magnets closer/use curved magnets./
Toename in die sterkte van die magneetveld bv. gebruik sterker magnete/bring magnete nader aan mekaar/gebruik geboë magnete.
- Increase the current./use battery with higher potential difference./more cells in series./Increase EMF./
Verhoog die stroom./gebruik battery met hoër potensiaalverskil./meer selle in serie./verhoog EMK.
- Increase the area of the coil./Vergroot die oppervlakte van die spoel.
- Increase the number of turns in the coil./Vermeerder die aantal windings in die spoel.

(2)

9.2.1 **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.

Root-mean-square current is the alternating current (AC) that dissipates the same amount of energy/heating effect as an equivalent direct current (DC) current. ✓✓

Die wortelgemiddeldekwadraat-stroom is die wisselstroom (WS) wat dieselfde hoeveelheid energie/verhittingseffek as 'n ekwivalente gelykstroom (GS) het.

(2)

Note: If energy or heating effect is omitted: 0/2

Nota: Indien energie of verhittingseffek uitgelaat is: 0/2

9.2.2

$$\begin{aligned} I_{\text{rms}} &= \frac{I_{\text{max}}}{\sqrt{2}} \quad \checkmark \\ &= \frac{3,6}{\sqrt{2}} \quad \checkmark \\ &= 2,55 \text{ A} \quad \checkmark \end{aligned}$$

(3)

9.2.3

Marking criteria/Nasienkriteria

- Formula for W ./Formule vir W . ✓
- Correct substitution for W ./Korrekte vervanging vir W . ✓
- Correct final answer./Korrekte finale antwoord: $69\,168\text{ J}$ ✓ ($6,92 \times 10^3$)
(Range/Gebied: $69\,167,56\text{ J} - 69\,168,44\text{ J}$)

OPTION 1/OPSIE 1

$$\begin{aligned} W &= VI\Delta t \checkmark \\ &= (220)(2,62)(120) \checkmark \\ &= 69\,168\text{ J} \checkmark (6,92 \times 10^3\text{ J}) \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} V &= IR \\ 220 &= 2,62R \\ R &= 83,97\,\Omega \end{aligned}$$

$$\begin{aligned} W &= I^2 R \Delta t \checkmark \\ &= (2,62)^2 (83,97)(120) \checkmark \\ &= 69\,168,44\text{ J} \checkmark (6,92 \times 10^3\text{ J}) \end{aligned}$$

$$\begin{aligned} W &= \frac{V^2}{R} \Delta t \checkmark \\ &= \left(\frac{220^2}{83,97} \right) (120) \checkmark \\ &= 69\,167,56\text{ J} \checkmark (6,92 \times 10^3\text{ J}) \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned} P_{\text{ave}} &= V_{\text{rms}} I_{\text{rms}} \\ &= (220)(2,62) \\ &= 576,4\text{ W} \end{aligned}$$

$$\begin{aligned} P_{\text{ave}} &= I_{\text{rms}}^2 R \\ &= (2,62)^2 (83,97) \\ &= 576,4\text{ W} \end{aligned}$$

$$\begin{aligned} P_{\text{ave}} &= \frac{V_{\text{rms}}^2}{R} \\ &= \frac{(220)^2}{83,97} \\ &= 576,4\text{ W} \end{aligned}$$

$$\begin{aligned} W &= P \Delta t \checkmark \\ &= (576,4)(120) \checkmark \\ &= 69\,168\text{ J} \checkmark (6,92 \times 10^3\text{ J}) \end{aligned}$$

OPTION 4/OPSIE 4

$$\begin{aligned} q &= I \Delta t \\ q &= (2,62)(120) \\ q &= 314,4\text{ C} \end{aligned}$$

$$\begin{aligned} W &= Vq \checkmark \\ W &= 220 \times 314,4 \checkmark \\ W &= 69\,168\text{ J} \checkmark (6,92 \times 10^3\text{ J}) \end{aligned}$$

(3)
[14]

QUESTION 10/VRAAG 10

10.1.1

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 sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓

Die minimum energie (van invallende fotone) wat elektrone kan vrystel vanuit 'n metaal/oppervlak.

NOTE: If reference to frequency: 0/2

NOTA: Indien na frekwensie verwys word: 0/2

(2)

10.1.2

OPTION 1/OPSIE 1

$$E = hf \checkmark$$

$$E = (6,63 \times 10^{-34})(2,8 \times 10^{16}) \checkmark$$

$$E = 1,86 \times 10^{-17} \text{ (J)} \checkmark$$

Since/Aangesien $E > W_0$ (or $E - W_0 > 0$) ✓, electrons will be ejected/elektrone sal vrygestel word

OPTION 2/OPSIE 2

$$W_0 = hf_0 \checkmark$$

$$6,63 \times 10^{-19} = (6,63 \times 10^{-34})f_0 \checkmark$$

$$f_0 = 1 \times 10^{15} \text{ (Hz)} \checkmark$$

Since/Aangesien $f > f_0$ (or $f - f_0 > 0$) ✓, electrons will be ejected/elektrone sal vrygestel word

OPTION 3/OPSIE 3

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

$$6,63 \times 10^{-19} = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{\lambda_0}$$

$$\lambda_0 = 3 \times 10^{-7} \text{ (m)}$$

$$v = f\lambda$$

$$3 \times 10^8 = \frac{2,8 \times 10^{16}\lambda}{\lambda}$$

$$\lambda = 1,07 \times 10^{-8} \text{ (m)}$$

✓ both/beide

any one/enige een

both/beide

Since/Aangesien $\lambda_0 > \lambda$ (or $\lambda_0 - \lambda > 0$) ✓, electrons will be ejected/elektrone sal vrygestel word.

OPTION 4/OPSIE 4

$$\left. \begin{aligned} E &= W_0 + E_{k(\max)} \\ hf &= W_0 + E_{k(\max)} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(6,63 \times 10^{-34})(2,8 \times 10^{16}) = 6,63 \times 10^{-19} + E_{k(\max)} \checkmark$$

$$E_{k(\max)} = 1,79 \times 10^{-17} \text{ (J)} \checkmark$$

Since/Aangesien $E_{k(\max)} > 0$, ✓ electrons will be ejected/elektrone sal vrygestel word

(4)

10.1.3

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2	OPTION 3/OPSIE 3
$F = \frac{kQ_1Q_2}{r^2} \checkmark$ $0,027 = \frac{(9 \times 10^9)(5,4 \times 10^{-6})Q_2}{(0,1)^2} \checkmark$ $Q_2 = 5,56 \times 10^{-9} \text{ C}$	$E = \frac{kQ}{r^2} \checkmark$ $E = \frac{9 \times 10^9 (5,4 \times 10^{-6})}{0,1^2} \checkmark$ $E = 4\,860\,000 \text{ N} \cdot \text{C}^{-1} \quad (4,86 \times 10^6)$ $E = \frac{F}{q} \checkmark$ $4\,860\,000 = \frac{0,027}{q} \checkmark$ $q = 5,56 \times 10^{-9} \text{ C}$	$E = \frac{F}{q}$ $= \frac{0,027}{5,4 \times 10^{-6}} \checkmark$ $= 5\,000 \text{ N} \cdot \text{C}^{-1} \quad (5 \times 10^3)$ $E = \frac{kQ}{r^2} \checkmark$ $5000 = \frac{(9 \times 10^9)Q_B}{0,1^2} \checkmark$ $Q_B = 5,56 \times 10^{-9} \text{ C}$
$n = \frac{Q}{e}$ $n = \frac{5,56 \times 10^{-9}}{1,6 \times 10^{-19}} \checkmark$ $n = 3,47 \times 10^{10} \text{ (electrons/elektrone)} \checkmark$ <p>number of photons/aantal fotone = $n = 3,47 \times 10^{10} \checkmark \quad (3,475 \times 10^{10})$</p>		

(6)

10.2.1 (Line) Absorption/(Lyn) Absorbsie✓

(1)

10.2.2 Continuous spectrum of white light/rainbow of colours✓ with dark/black lines✓
(replacing specific frequencies)./Kontinue spektrum van wit lig/reënboog van
kleure met donker/swart lyne (wat spesifieke frekwensies vervang).

(2)

10.2.3 Diagram B ✓✓

(2)

[17]

TOTAL/TOTAAL: 150