



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 18 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 combinations consists of only SCALAR quantities?
- A Velocity, speed and time
- B Time, distance and speed
- C Acceleration, speed and distance
- D Displacement, velocity and acceleration (2)

- 1.2 The acceleration due to gravity on Earth is g .

Which ONE of the following represents the acceleration due to gravity on a planet that has TWICE the mass and HALF the radius of the Earth?

- A $\frac{1}{2}g$
- B $2g$
- C $4g$
- D $8g$ (2)
- 1.3 A ball is projected vertically upwards from the ground and reaches its maximum height after a while.

Ignore the effects of air friction.

How will the ACCELERATION and TOTAL MECHANICAL ENERGY of the ball at its maximum height compare to that immediately after it was projected?

	ACCELERATION	TOTAL MECHANICAL ENERGY
A	Equal to	Equal to
B	Greater than	Smaller than
C	Equal to	Greater than
D	Smaller than	Equal to

(2)

- 1.4 A car travels at **CONSTANT VELOCITY** along a horizontal road. A constant frictional force acts on the car during its motion.

Which **ONE** of the following statements about the power dissipated by the engine of the car during the motion is **CORRECT**?

The power ...

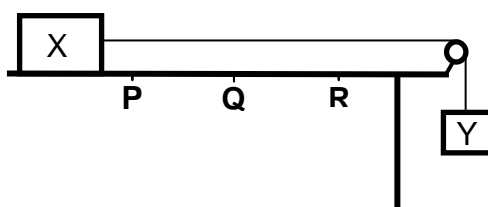
- A is zero.
- B increases.
- C decreases.
- D remains constant.

(2)

- 1.5 Block X is placed on a horizontal table and is connected to block Y by a light inextensible string passing over a frictionless pulley, as shown below.

A constant frictional force acts on block X while it moves to the right.

P, **Q** and **R** are points on the table such that the distance from **P** to **Q** is equal to that from **Q** to **R**.



When block X reaches point **Q**, the string is cut and block X continues to move towards point **R**. Ignore the effect of air friction.

Consider the following statements:

- (i) The work done by the frictional force acting on block X is greater when the block moves from point **P** to point **Q** than when the block moves from point **Q** to point **R**.
- (ii) Both the momentum and kinetic energy of block X decrease when the block moves from point **Q** to point **R**.
- (iii) The total mechanical energy of block X remains constant when the block moves from point **Q** to point **R**.

Which of the statements above is/are **CORRECT** as block X moves from point **Q** to point **R**?

- A (i) only
- B (ii) only
- C (i) and (ii) only
- D (ii) and (iii) only

(2)

- 1.6 Light emitted from a distant star contains a spectral line X of frequency f . The spectral lines of this star when observed on Earth are red shifted.

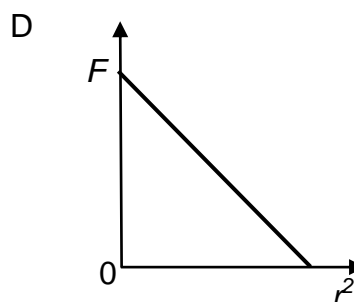
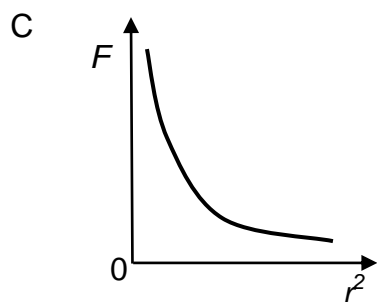
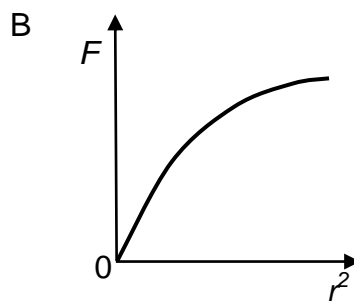
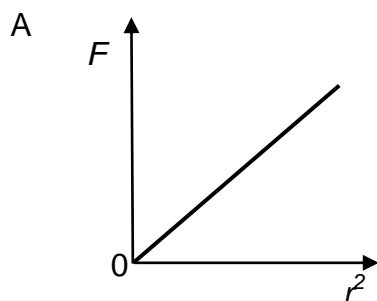
Which ONE of the following combinations of the OBSERVED FREQUENCY of spectral line X and the MOTION OF THE STAR is CORRECT?

	OBSERVED FREQUENCY	MOTION OF THE STAR
A	Greater than f	Away from Earth
B	Greater than f	Towards Earth
C	Smaller than f	Away from Earth
D	Smaller than f	Towards Earth

(2)

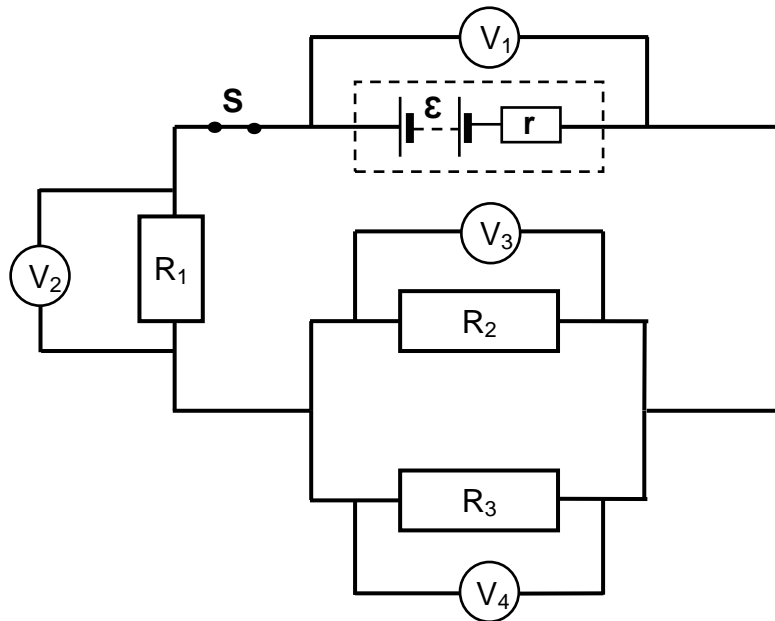
- 1.7 A proton and an electron are a distance r apart. The magnitude of the electrostatic force that they exert on each other is F .

Which ONE of the following graphs shows the relationship between F and r^2 as the proton and the electron approach each other?



(2)

- 1.8 The emf of a battery is \mathcal{E} and its internal resistance is r . The battery is connected to three resistors and four voltmeters, as shown below. The resistance of the conducting wires is negligible, while the voltmeters have very high resistances.

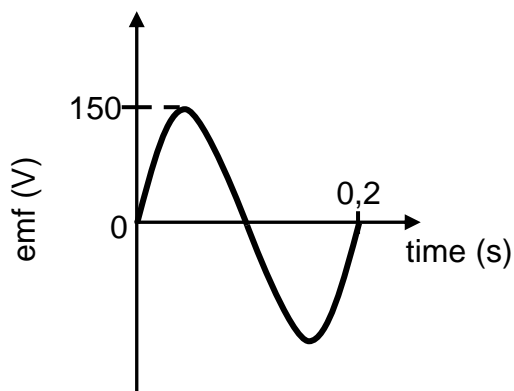


Which ONE of the following equations represents the reading on voltmeter V_1 in terms of the readings on the other voltmeters?

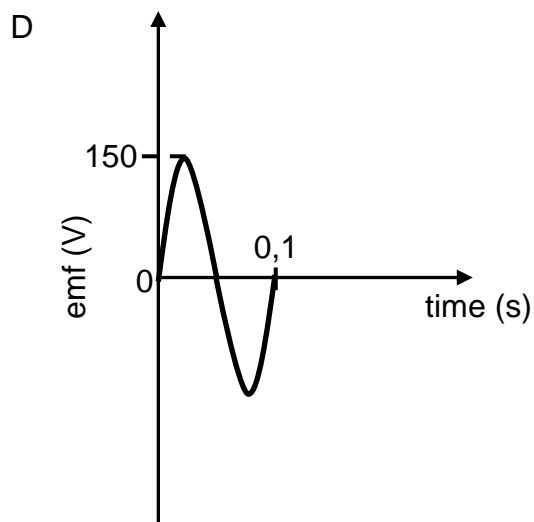
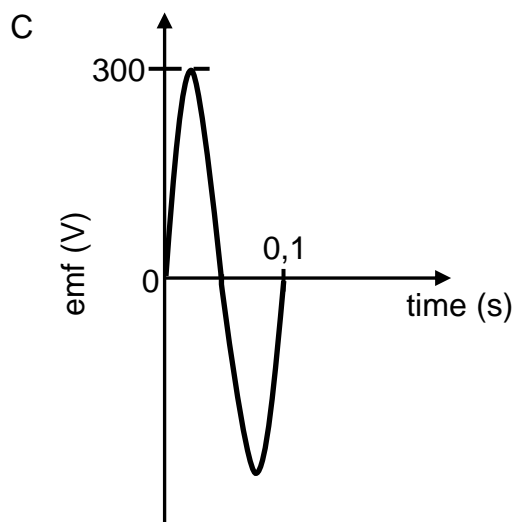
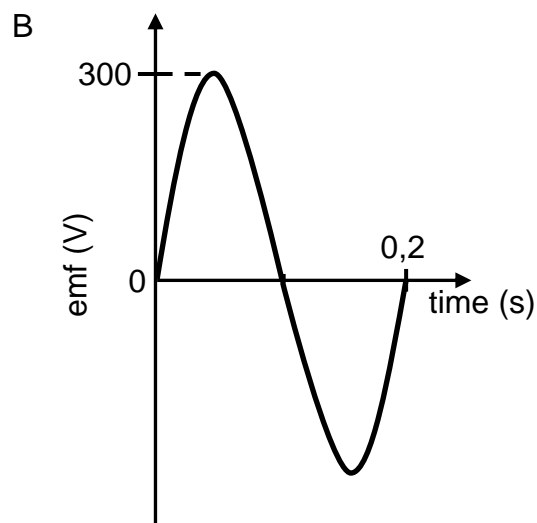
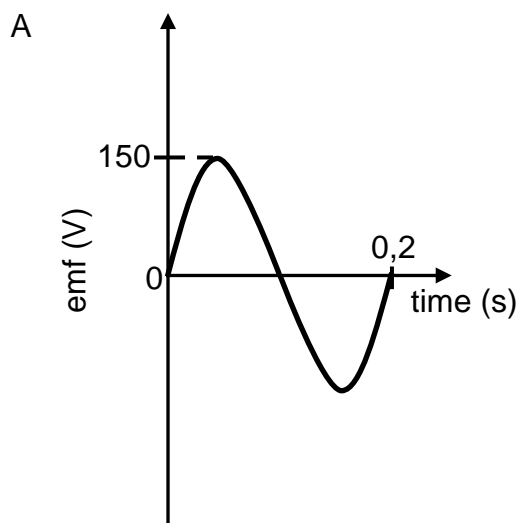
- A $V_1 = V_2 + V_3$
- B $V_1 = V_2 + \frac{1}{2}V_3$
- C $V_1 = V_2 + V_3 + V_4$
- D $V_1 = V_2 + 2V_3$

(2)

- 1.9 An AC generator consists of a coil which is rotated in a magnetic field. The emf time graph for one complete rotation of the coil is shown below.

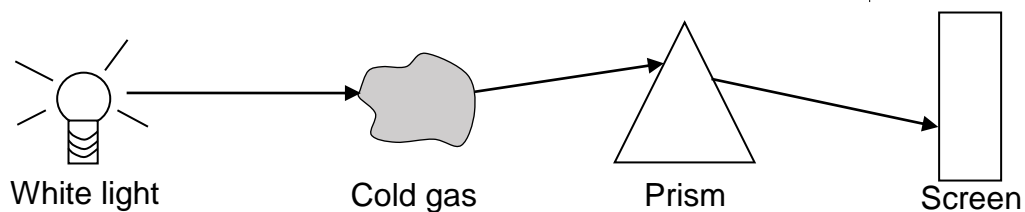


If the speed of rotation of the coil is now DOUBLED, which ONE of the following graphs is CORRECT for one complete rotation of the coil?



(2)

- 1.10 White light is passed through a cold gas and then through a prism, as shown below. A line spectrum is observed on the screen.



Which ONE of the following correctly describes the ENERGY TRANSITION of the atoms of the gas and the TYPE OF LINE SPECTRUM observed on the screen?

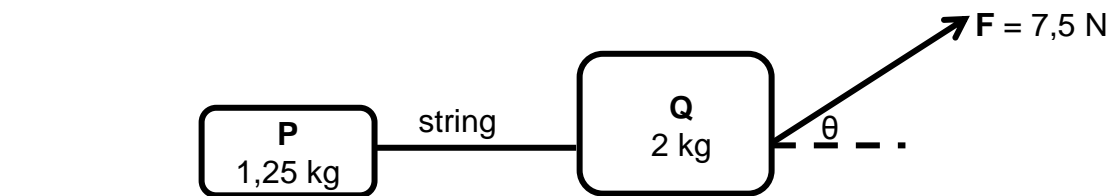
	ENERGY TRANSITION	TYPE OF LINE SPECTRUM
A	Higher to lower energy level	Emission
B	Lower to higher energy level	Emission
C	Higher to lower energy level	Absorption
D	Lower to higher energy level	Absorption

(2)
[20]

QUESTION 2 (Start on a new page.)

Crate **P** of mass 1,25 kg is connected to another crate, **Q**, of mass 2 kg by a light inextensible string. The two crates are placed on a rough horizontal surface. A constant force **F** of magnitude 7,5 N, acting at angle θ to the horizontal, is applied on crate **Q**, as shown in the diagram below.

The crates accelerate at $0,1 \text{ m}\cdot\text{s}^{-2}$ to the right.



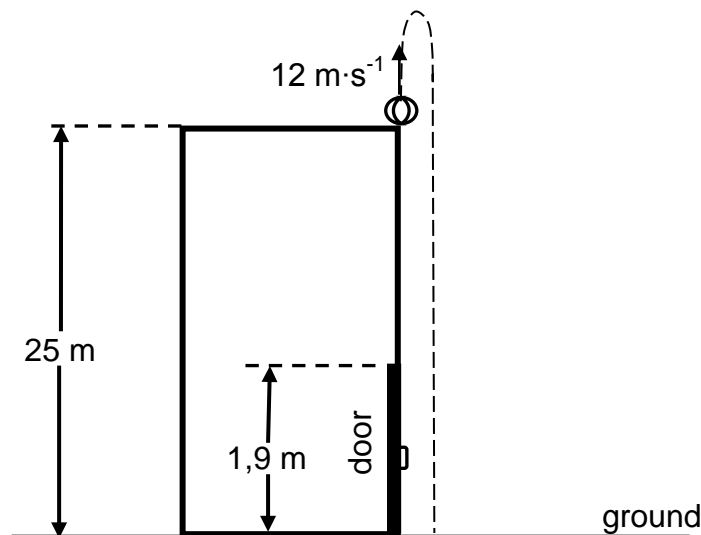
Crate **P** experiences a constant frictional force of 1,8 N and crate **Q** experiences a constant frictional force of 2,2 N.

- 2.1 State Newton's Second Law of Motion in words. (2)
 - 2.2 Draw a labelled free-body diagram for crate **P**. (4)
 - 2.3 Calculate the magnitude of:
 - 2.3.1 The tension in the string (4)
 - 2.3.2 Angle θ (3)
- [13]**

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards from the top of a building of height 25 m with a velocity of $12 \text{ m}\cdot\text{s}^{-1}$. On its way down, the ball passes a door which has a height of 1,9 m and then strikes the ground, as shown in the diagram below.

Ignore the effects of air friction.



- 3.1 Define the term *free fall*. (2)
- 3.2 Calculate the:
- 3.2.1 Time taken for the ball to reach its maximum height (3)
- 3.2.2 Velocity with which the ball strikes the ground (4)
- 3.2.3 Time it took the ball to move from the top of the door to the ground (4)
- 3.3 Draw a velocity versus time graph for the motion of the ball from the moment that the ball is thrown upwards until it strikes the ground. Use the ground as zero reference.

Clearly indicate the following on your graph:

- The velocity with which the ball was thrown upwards
- Time taken by the ball to reach its maximum height
- The velocity with which the ball strikes the ground

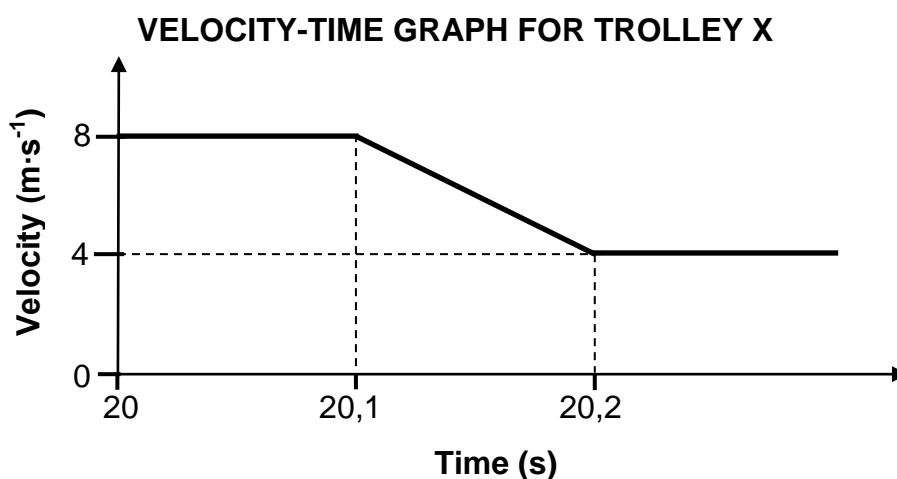
(3)
[16]

QUESTION 4 (Start on a new page.)

Trolley X of mass 1,2 kg travels at $8 \text{ m}\cdot\text{s}^{-1}$ east and collides with trolley Y of mass 0,5 kg which is initially at rest.

Ignore all frictional effects.

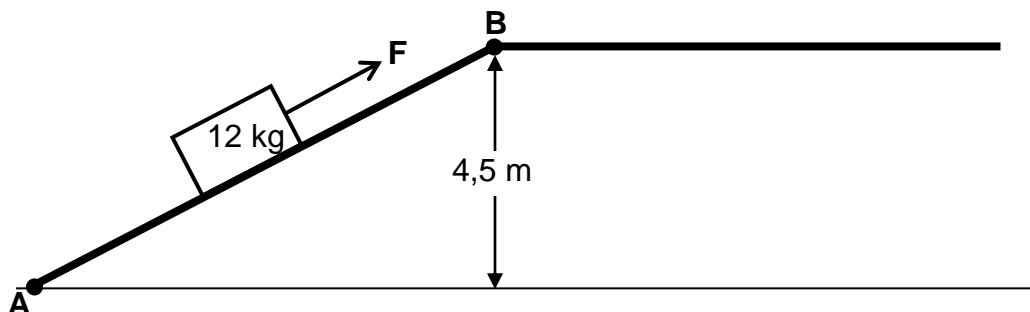
The velocity-time graph below shows the velocity of trolley X before, during and after the collision with trolley Y.



- 4.1 State the *principle of conservation of linear momentum*. (2)
- 4.2 Calculate the magnitude of the:
- 4.2.1 Velocity of trolley Y immediately after the collision (4)
- 4.2.2 Average net force that trolley X exerts on trolley Y during the collision (3)
- 4.3 Is the collision ELASTIC or INELASTIC?
Explain the answer by means of suitable calculations. (5)
- [14]**

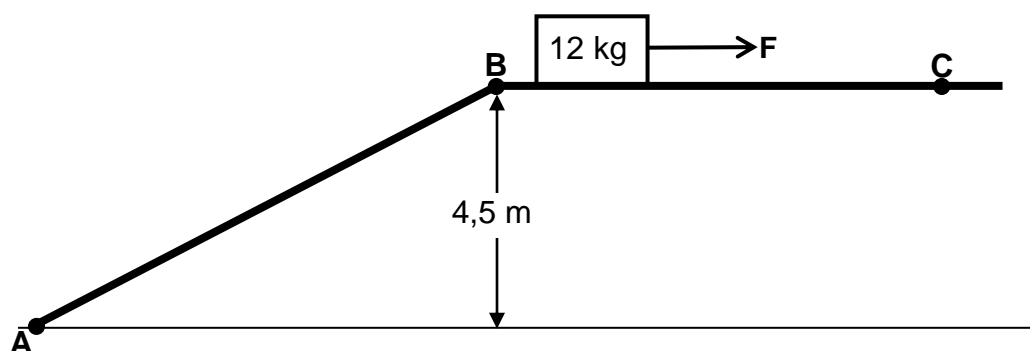
QUESTION 5 (Start on a new page.)

A 12 kg block is initially at rest at point **A** at the bottom of a ROUGH inclined plane. The block is pulled up the incline by a constant force **F** acting parallel to the incline. The block reaches point **B**, which is at a vertical height of 4,5 m above the horizontal, with a speed of $2,25 \text{ m}\cdot\text{s}^{-1}$. See the diagram below.



- 5.1 Define the term *non-conservative force*. (2)
- 5.2 Draw a labelled free-body diagram for the block when it is pulled up the inclined plane. (4)
- 5.3 Calculate the total work done on the block by the NON-CONSERVATIVE forces when the block moved from point **A** to point **B**. (4)

The same constant force **F** now moves the block at a CONSTANT VELOCITY across a rough horizontal surface from point **B** to point **C**, as shown below. Force **F** acts parallel to the horizontal surface.



The magnitude of the constant frictional force acting on the block while moving from point **B** to point **C** is 42 N LARGER than the magnitude of the constant frictional force acting on the block when it moves from point **A** to point **B**.

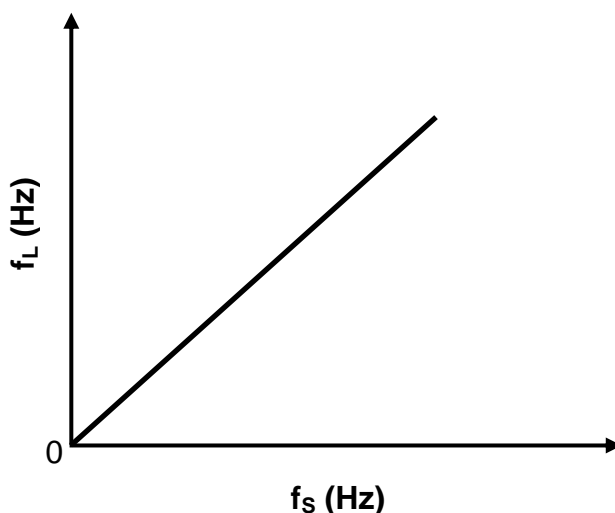
- 5.4 Calculate the distance from point **A** to point **B**. (5)
[15]

QUESTION 6 (Start on a new page.)

A learner investigates the relationship between the observed frequency and the frequency of sound waves emitted by a stationary source.

The learner moves towards the source at a constant velocity and records the observed frequency (f_L) for a given source frequency (f_s). This process is repeated for different frequencies of the source, with the learner moving at the same constant velocity each time.

The graph below shows how the observed frequency changes as the frequency of sound waves emitted by the source changes.



6.1 Name the phenomenon illustrated by the graph. (1)

6.2 Name ONE application in the medical field of the phenomenon in QUESTION 6.1. (1)

6.3 Write down the type of proportionality that exists between f_L and f_s , as illustrated by the graph. (1)

6.4 The gradient of the graph obtained is found to be 1,06.

If the speed of sound in air is $340 \text{ m}\cdot\text{s}^{-1}$, calculate the magnitude of the velocity at which the learner approaches the source. (5)

The investigation is now repeated with the learner moving at a HIGHER constant velocity towards the sound source.

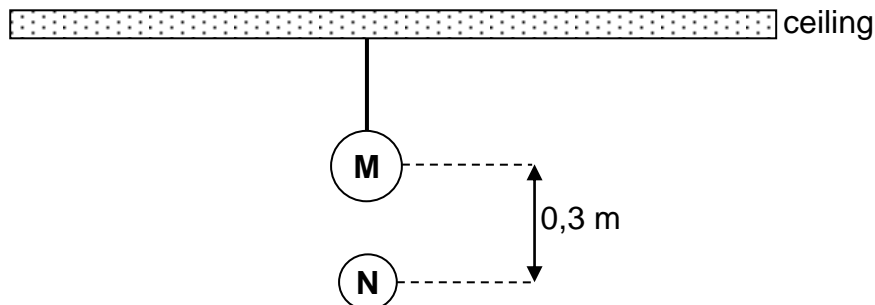
6.5 Copy the graph above in your ANSWER BOOK and label it as **A**. On the same set of axes, sketch the graph that will be obtained when the learner is moving at the HIGHER velocity. Label this graph as **B**. (2)

[10]

QUESTION 7 (Start on a new page.)

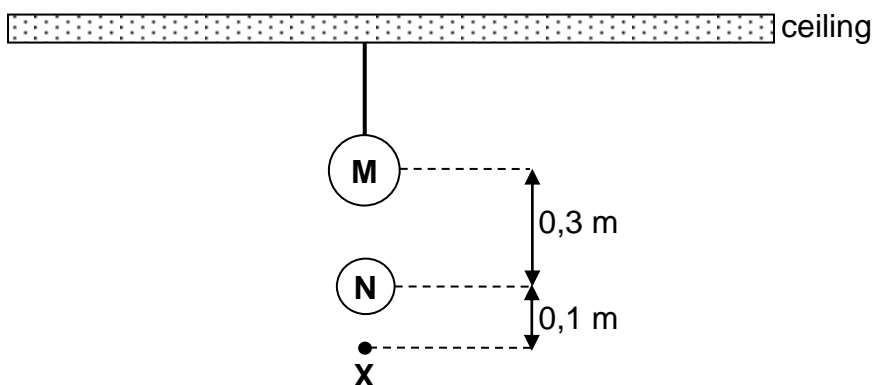
A charged sphere **M** is suspended from a ceiling by a light inextensible, insulated string.

Another charged sphere **N**, of mass $2,04 \times 10^{-3}$ kg and carrying a charge of $+ 8,6 \times 10^{-8}$ C, hangs STATIONARY vertically below sphere **M**. The centres of the spheres are 0,3 m apart, as shown in the diagram below.



- 7.1 State Coulomb's law in words. (2)
- 7.2 State whether the charge on sphere **M** is POSITIVE or NEGATIVE. (1)
- 7.3 Draw a labelled free-body diagram for sphere **N**. (2)
- 7.4 Calculate the magnitude of the charge on sphere **M**. (5)
- 7.5 How does the electrostatic force that sphere **M** exerts on sphere **N** compare to that exerted by sphere **N** on sphere **M** with respect to:
- 7.5.1 Magnitude (1)
- 7.5.2 Direction (1)

Point **X** is 0,1 m vertically below the centre of sphere **N**, as shown below.

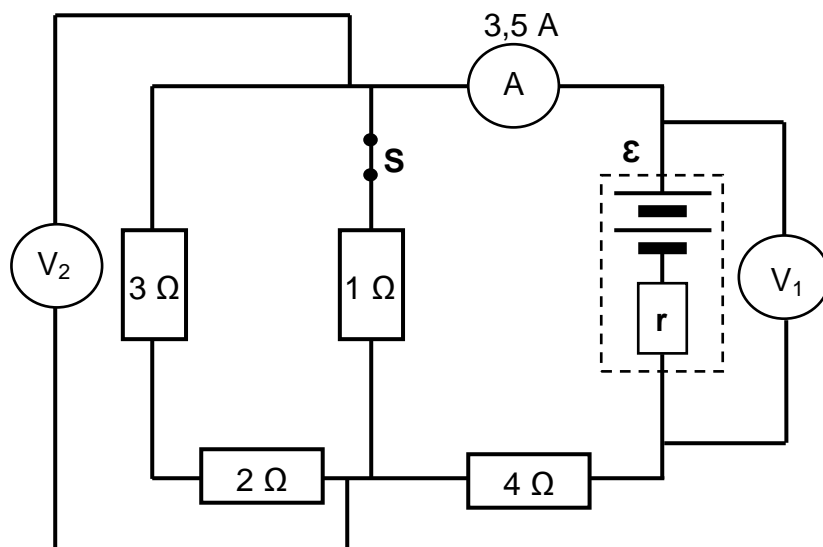


- 7.6 Calculate the net electric field at point **X**. (5)

[17]

QUESTION 8 (Start on a new page.)

The circuit diagram below shows four resistors connected to a battery of emf \mathcal{E} and internal resistance r . The resistances of the ammeter and the connecting wires are negligible, while the voltmeters have very high resistances.



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

Switch **S** is CLOSED.

8.2 The reading on the ammeter is 3,5 A.

8.2.1 Calculate the total external resistance of the circuit. (4)

8.2.2 Calculate the reading on voltmeter V_1 . (3)

8.2.3 How does the reading on voltmeter V_2 compare to the reading on voltmeter V_1 ? Choose from SMALLER THAN, EQUAL TO or GREATER THAN. (1)

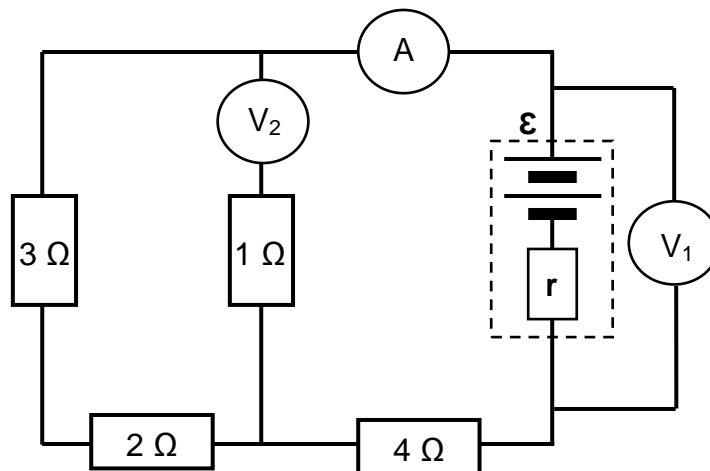
8.3 A learner concludes that the emf of the battery is equal to the reading on voltmeter V_1 .

8.3.1 Define the term *emf*. (2)

8.3.2 Is the learner's conclusion CORRECT? Choose from YES or NO. (1)

8.3.3 Give a reason for the answer to QUESTION 8.3.2. (1)

Switch **S** is now removed and replaced by voltmeter V_2 , as shown in the circuit diagram below.



8.4 How will EACH of the following change?

(Choose from INCREASES, DECREASES or REMAINS THE SAME.)

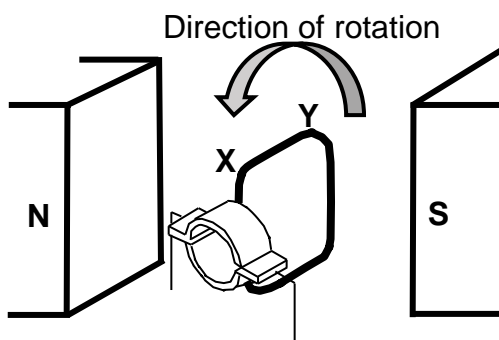
8.4.1 The power dissipated by the $4\ \Omega$ resistor (1)

8.4.2 The reading on voltmeter V_1 (1)

8.5 Explain the answer to QUESTION 8.4.2. (4)
[20]

QUESTION 9 (Start on a new page.)

- 9.1 The diagram below shows the initial position of the coil in a simple DC generator. The coil is rotated in an anticlockwise direction, as shown.



- 9.1.1 Name the component in this generator that ensures that the induced current in the external circuit is in one direction only. (1)
- 9.1.2 Is the direction of the induced current from **X to Y** or from **Y to X**? (1)

A maximum voltage of 90 V is generated when the coil is rotating at a frequency of 20 Hz.

- 9.1.3 Write down the time taken for the coil to complete ONE rotation. (1)
- 9.1.4 The coil starts rotating from the initial position, as shown in the diagram above.

Sketch a graph of output voltage versus time for one complete rotation of the coil. Indicate the maximum voltage and the relevant time values on the graph. (4)

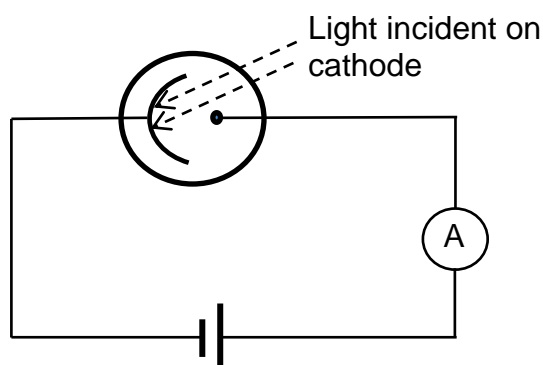
- 9.2 Wall sockets supply rms voltage and current.

A 220 V AC voltage is supplied from a wall socket to an electric kettle having a resistance of 32 Ω .

Calculate the average energy dissipated by the kettle in TWO minutes. (4)
[11]

QUESTION 10 (Start on a new page.)

Light is incident on the cathode of a photoelectric cell connected to a battery and a sensitive ammeter, as shown below.



- 10.1 What conclusive evidence about the nature of light is provided by the photoelectric effect? (1)

The cathode has a work function of $3,42 \times 10^{-19}$ J.

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

Light of frequency $5,96 \times 10^{14}$ Hz is shone onto the cathode.

- 10.3 Calculate the maximum kinetic energy of an electron ejected from the cathode. (4)

- 10.4 The ammeter registers a constant current of 0,012 A.

Calculate the minimum number of photons of light that strike the cathode in a 10 s period. (4)

- 10.5 The intensity of the incident light is now INCREASED. How will this change affect the reading on the ammeter?

Choose from INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (3)

[14]

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 gravitasiekonstant</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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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

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

NOVEMBER 2022

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**These marking guidelines consist of 32 pages.
*Hierdie nasienriglyne bestaan uit 32 bladsye.***

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | B ✓✓ | (2) |
| 1.2 | D ✓✓ | (2) |
| 1.3 | A ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | B ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | C ✓✓ | (2) |
| 1.8 | A ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | D ✓✓ | (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 krag en omgekeerd eweredig aan die massa van die voorwerp.

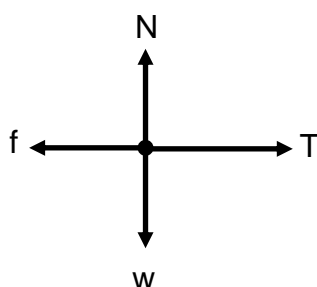
OR/OF

The resultant/net force acting on an object is equal to the rate of change of momentum of the object. **(2 or 0)**

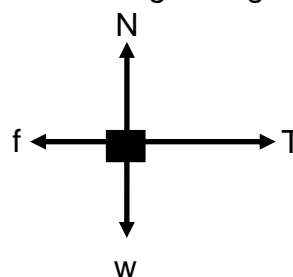
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. **(2 of 0)**

(2)

2.2



Accept force diagram/
Aanvaar kragte-diagram:



Accepted labels/Aanvaarde benoemings	
W	F_g / F_w / $F_{\text{earth on P}}$ / weight / mg / 12,25 N / gravitational force F_g / F_w / $F_{\text{aarde op P}}$ / gewig / mg / 12,25 N / gravitasiekrag
T	F_T / F_{string} / F_{tou} / F_t / tension / spanning / F_s
f	F_f / f_k / (kinetic) friction / (kinetiese) wrywing / 1,8 N / F_w
N	F_N / Normal / F_{normal} / F_{normaal} / 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 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 $\frac{3}{4}$ If everything correct, but no arrows/Indien alles korrek, maar geen pyltjies: Max/Maks $\frac{3}{4}$ If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$ 	

(4)

2.3.1

<p>For P/Vir P RIGHT AS POSITIVE/ REGS AS POSITIEF</p> $\left. \begin{array}{l} F_{\text{net}} = ma \\ T + f = ma \\ T - f = ma \end{array} \right\} \checkmark \text{ Any one/} \\ \text{Enige een}$ $\frac{T - 1,8}{T} = \frac{(1,25)(0,1)}{1,93 \text{ N}} \checkmark$	<p>For P/Vir P LEFT AS POSITIVE/ LINKS AS POSITIEF</p> $\left. \begin{array}{l} F_{\text{net}} = ma \\ T + f = ma \\ -T + f = ma \end{array} \right\} \checkmark \text{ Any one/} \\ \text{Enige een}$ $\frac{-T + 1,8}{T} = \frac{(1,25)(-0,1)}{1,93 \text{ N}} \checkmark$
--	---

(4)

2.3.2

<p>POSITIVE MARKING FROM QUESTION 2.3.1/ POSITIEWE NASIEN VANAF VRAAG 2.3.1. RIGHT AS POSITIVE/REGS AS POSITIEF: For Q/Vir Q</p> $\begin{array}{l} F_{\text{net}} = ma \\ F \cos \theta - T - f = ma \\ F \cos \theta + T + f = ma \\ \frac{7,5 \cos \theta - 1,93 - 2,2}{\theta} = \frac{(2)(0,1)}{54,74^\circ} \checkmark \end{array}$ <p>(Range: 54,55° - 54,78°)</p>	<p>Accept/Aanvaar Sin(90° - θ)</p>
<p>LEFT AS POSITIVE/LINKS AS POSITIEF: For Q/Vir Q</p> $\begin{array}{l} F_{\text{net}} = ma \\ -F \cos \theta + T + f = ma \\ F \cos \theta + T + f = ma \\ \frac{-7,5 \cos \theta + 1,93 + 2,2}{\theta} = \frac{(2)(-0,1)}{54,74^\circ} \checkmark \end{array}$ <p>(Range: 54,55° - 54,78°)</p>	<p>Accept/Aanvaar Sin(90° - θ)</p>

(3)
[13]

QUESTION 3/VRAAG 3

3.1

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

OR/OF

Motion in which the only force acting is gravity/weight/gravitational force.
Beweging waar die enigste krag wat inwerk, gravitasie/gewig/swaartekrag is.
(2 or/of 0)

(2)

3.2.1

Marking criteria/Nasienkriteria

- Formula with Δt /Formule met Δt ✓
- Correct substitution into formula/Korrekte vervanging in formule ✓
- Final answer/Finale antwoord: 1,22 s ✓ (1,22 s to/tot 1,23 s)

OPTION 1/OPSIE 1**A-B:**

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$$0 = 12 + (-9,8)\Delta t \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$$0 = -12 + (9,8)\Delta t \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

OPTION 2/OPSIE 2**B-C:**

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$$-12 = 0 + (-9,8)\Delta t \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$$12 = 0 + (9,8)\Delta t \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

OPTION 3/OPSIE 3**A-C:**

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$$-12 = 12 + (-9,8)\Delta t \quad \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \quad \checkmark$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$$12 = -12 + (9,8)\Delta t \quad \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \quad \checkmark$$

OPTION 4/OPSIE 4**A-C:**

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$$0 = (12)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \quad \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \quad \checkmark$$

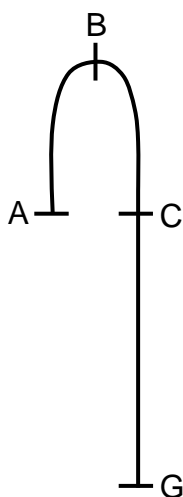
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

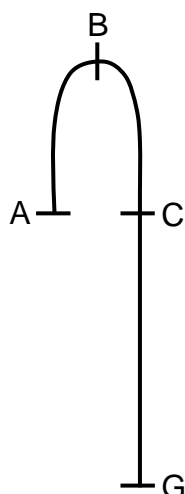
$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \checkmark$$

$$0 = (-12)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \quad \checkmark$$

$$\Delta t = 2,45 \text{ s}$$

$$\Delta t_{\text{up}} = 1,23 \text{ s} \quad \checkmark$$



**OPTION 5/OPSIE 5****A-B OR/OF B-C:**

$$(E_{\text{mech}})_{\text{Top/Bo}} = (E_{\text{mech}})_{25\text{ m}}$$

$$(E_P + E_K)_{\text{Top/Bo}} = (E_P + E_K)_{25\text{ m}}$$

$$(mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} = (mgh + \frac{1}{2}mv^2)_{25\text{ m}}$$

$$(9,8)h + 0 = 0 + (\frac{1}{2})(12)^2$$

$$\Delta h = 7,35\text{ m}$$

OPTION 6/OPSIE 6**A-B OR/OF B-C**

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$W_{\text{nc}} = \Delta K + mg(h_f - h_i)$$

$$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$$

$$0 = \frac{1}{2}(0^2 - 12^2) + (9,8)\Delta h$$

$$\Delta h = 7,35\text{ m}$$

OPTION 7/OPSIE 7**A-B OR/OF B-C**

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

$$w\Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$(9,8)\Delta y \cos 180^\circ = 0 - \frac{1}{2}(12)^2$$

$$\Delta y = 7,35\text{ m}$$

OPTION 8/OPSIE 8**A-B:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

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

$$0^2 = 12^2 + 2(-9,8)\Delta y$$

$$\Delta y = 7,35\text{ m}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

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

$$0^2 = (-12)^2 + 2(9,8)\Delta y$$

$$\Delta y = -7,35\text{ m}$$

OPTION 9/OPSIE 9**B-C:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

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

$$(-12)^2 = 0^2 + 2(-9,8)\Delta y$$

$$\Delta y = -7,35\text{ m}$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

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

$$(12)^2 = 0^2 + 2(9,8)\Delta y$$

$$\Delta y = 7,35\text{ m}$$

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

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

$$7,35 = \left(\frac{12 + 0}{2} \right) \Delta t \checkmark$$

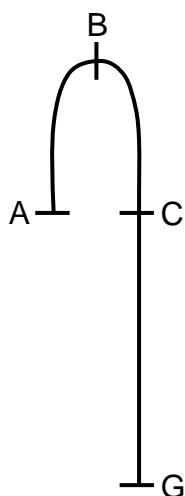
$$\Delta t = 1,23\text{ s} \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

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

$$-7,35 = \left(\frac{-12 + 0}{2} \right) \Delta t \checkmark$$

$$\Delta t = 1,23\text{ s} \checkmark$$

**OPTION 10/OPSIE 10****A-B:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

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

$$\Delta y = \left(\frac{12 + 0}{2} \right) \Delta t$$

$$\Delta y = 6\Delta t$$

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

$$0 = (12)^2 + 2(-9,8)(6\Delta t) \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

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

$$\Delta y = \left(\frac{-12 + 0}{2} \right) \Delta t$$

$$\Delta y = -6\Delta t$$

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

$$0 = (-12)^2 + 2(9,8)(-6\Delta t) \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

OPTION 12/OPSIE 12**A-B:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

$$F_{\text{net}}\Delta t = m\Delta v$$

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

$$-(9,8)\Delta t = 0 - 12 \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

$$F_{\text{net}}\Delta t = m\Delta v$$

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

$$(9,8)\Delta t = 12 - 0 \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

OPTION 11/OPSIE 11**B-C:****UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

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

$$\Delta y = \left(\frac{0 - 12}{2} \right) \Delta t$$

$$\Delta y = -6\Delta t$$

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

$$-12 = (0)^2 + 2(-9,8)(-6\Delta t) \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

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

$$\Delta y = \left(\frac{12 + 0}{2} \right) \Delta t$$

$$\Delta y = 6\Delta t$$

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

$$12^2 = 0^2 + 2(9,8)(6\Delta t) \quad \checkmark$$

$$\Delta t = 1,22 \text{ s} \quad \checkmark$$

(3)

3.2.2

Marking criteria/Nasienkriteria

- Formula with v_f . / Formule met v_f . ✓
- Correct substitution into formula. / Korrekte vervanging in formule. ✓
- Correct final answer / Korrekte finale antwoord:
 $25,18 \text{ m} \cdot \text{s}^{-1}$ ✓ ($25,03 \text{ m} \cdot \text{s}^{-1}$ to/tot $25,59 \text{ m} \cdot \text{s}^{-1}$)
- Correct direction (only if numerical value is given). / Korrekte rigting (slegs indien numeriese waarde gegee is). ✓

OPTION 1/OPSIE 1**A-G:**

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

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

$$v_f^2 = (12)^2 + 2(-9,8)(-25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

A-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

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

$$v_f^2 = (-12)^2 + 2(9,8)(25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 2/OPSIE 2**C-G:**

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

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

$$v_f^2 = (-12)^2 + 2(-9,8)(-25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

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

$$v_f^2 = (12)^2 + 2(9,8)(25) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 3/OPSIE 3**B-G**

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF**

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

$$v_f^2 = (0)^2 + 2(-9,8)(-32,35) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

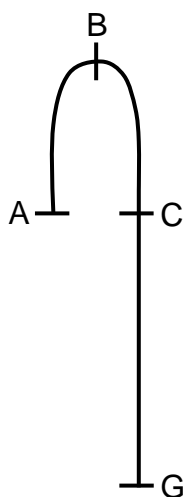
**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

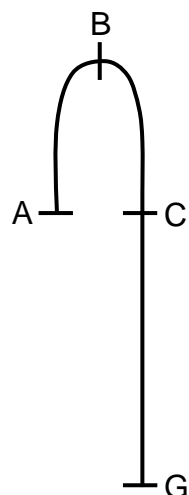
$$v_f^2 = v_i^2 + 2a\Delta y \quad \checkmark$$

$$v_f^2 = (0)^2 + 2(9,8)(32,35) \quad \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \quad \checkmark \text{ downwards } \checkmark$$

afwaarts



**OPTION 4/OPSIE 4****A-G:****UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:**

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

$$-25 = 12 \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 3,79 \text{ s}$$

A-G

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

$$-25 = \left(\frac{12 + v_f}{2} \right) 3,79$$

$$v_f = -25,18 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

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

$$v_f = 0 + (-9,8)(3,79 - 1,22) \checkmark$$

$$v_f = -25,19 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G

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

$$v_f = -12 + (-9,8)(1,35) \checkmark$$

$$v_f = -25,19 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

A-G:

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

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

$$25 = -12 \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 3,79 \text{ s}$$

A-G

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

$$25 = \left(\frac{-12 + v_f}{2} \right) 3,79 \checkmark$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

B-G

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

$$= 0 + (9,8)(3,79 - 1,22) \checkmark$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G

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

$$v_f = 12 + (9,8)(3,79 - 2(1,22)) \checkmark$$

$$v_f = 25,19 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

OPTION 5/OPSIE 5

C-G:

**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:**

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

$$-25 = -12 \Delta t + \frac{1}{2} (-9,8) \Delta t^2$$

$$\Delta t = 1,34 \text{ s}$$

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

$$-25 = \left(\frac{-12 + v_f}{2} \right) 1,34 \checkmark$$

$$v_f = -25,18 \text{ m} \cdot \text{s}^{-1}$$

$$\therefore v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

afwaarts

C-G:

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:**

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

$$25 = 12 \Delta t + \frac{1}{2} (9,8) \Delta t^2$$

$$\Delta t = 1,34 \text{ s}$$

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

$$25 = \left(\frac{12 + v_f}{2} \right) 1,34 \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards } \checkmark$$

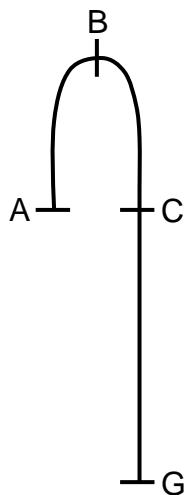
afwaarts

OPTION 6/OPSIE 6

$$\left. \begin{aligned} (E_{\text{mech/meg}})_i &= (E_{\text{mech/meg}})_f \\ (E_P + E_K)_i &= (E_P + E_K)_f \\ (mgh + \frac{1}{2}mv^2)_i &= (mgh + \frac{1}{2}mv^2)_f \end{aligned} \right\} \begin{aligned} &\checkmark \text{ Any one/} \\ &\text{Enige een} \end{aligned}$$

$$m(9,8)(25) + \frac{1}{2}m(12^2) = 0 + \frac{1}{2}mv_f^2 \checkmark$$

$$v_f = 25,18 \text{ m} \cdot \text{s}^{-1} \checkmark \text{ downwards/afwaarts } \checkmark$$



OPTION 7/OPSIE 7

$$\begin{aligned}
 W_{nc} &= \Delta E_k + \Delta E_p \\
 &= (E_{kf} - E_{ki}) + (E_{pf} - E_{pi}) \\
 &= \left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\right) + (mgh_f - mgh_i) \quad \left. \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array} \right\} \\
 0 &= \left[\frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2\right] + [0 - m(9,8)(25)] \checkmark \\
 v_f &= 25,18 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ downwards/afwaarts } \checkmark
 \end{aligned}$$

OPTION 8/OPSIE 8

$$\begin{aligned}
 W_{net} &= \Delta E_k \\
 &= (E_{kf} - E_{ki}) \\
 &= \left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\right) \quad \left. \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array} \right\} \\
 m(9,8)(25) &= \frac{1}{2}mv_f^2 - \frac{1}{2}m(12)^2 \checkmark \\
 v_f &= 25,18 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ downwards/afwaarts } \checkmark
 \end{aligned}$$

(4)

3.2.3

POSITIVE MARKING FROM QUESTION 3.2.2.**POSITIEWE NASIEN VANAF VRAAG 3.2.2.****Marking criteria/Nasienkriteria**

- Substitution into formula to calculate v at the top of the door ✓
Vervanging in formule om v bokant die deur te bereken.
- Formula to calculate Δt from top to bottom of door. ✓
Formule om Δt te bereken van bokant tot onderkant van deur.
- Substitution to calculate Δt . ✓
Vervanging om Δt te bereken.
- Final answer/Finale antwoord: 0,07 to/tot 0,08 s ✓

OPTION 1/OPSIE 1**UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:****A-D:**

$$\begin{aligned}
 v_f^2 &= v_i^2 + 2a\Delta y \\
 v_f^2 &= (12)^2 + 2(-9,8)(-23,1) \checkmark \\
 v_f &= 24,43 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

C-D:

$$\begin{aligned}
 v_f^2 &= v_i^2 + 2a\Delta y \\
 v_f^2 &= (-12)^2 + 2(-9,8)(-23,1) \checkmark \\
 v_f &= 24,43 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

D-G:

$$\begin{aligned}
 v_f^2 &= v_i^2 + 2a\Delta y \\
 (-25,18)^2 &= (v_i)^2 + 2(-9,8)(-1,9) \checkmark \\
 v_i &= 24,43 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

B-D

$$\begin{aligned}
 v_f^2 &= v_i^2 + 2a\Delta y \\
 v_f^2 &= 0 + 2(-9,8)(-30,447) \checkmark \\
 &= 24,43 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

D-G:

$$\begin{aligned}
 E_{(\text{mech top/meg bo})} &= E_{(\text{mech bot/meg ond})} \\
 (E_p + E_k)_{\text{top/bo}} &= (E_p + E_k)_{\text{bot/ond}} \\
 (mgh + \frac{1}{2}mv^2)_{\text{top/bo}} &= (mgh + \frac{1}{2}mv^2)_{\text{bot/ond}} \\
 m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 &= 0 + \frac{1}{2}m(25,18)^2 \checkmark \\
 v_i &= 24,43 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

D-G:

$$\begin{aligned}
 v_f &= v_i + a\Delta t \checkmark \\
 -25,18 &= -24,43 + (-9,8)\Delta t \checkmark \\
 \Delta t &= 0,08 \text{ s } \checkmark
 \end{aligned}$$

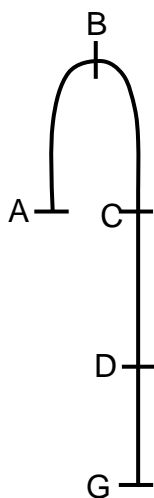
D-G:

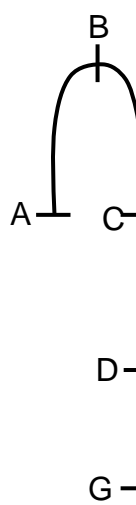
$$\begin{aligned}
 \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark \\
 -1,9 &= -24,43\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark \\
 \Delta t &= 0,08 \text{ s } \checkmark
 \end{aligned}$$

D-G:

$$\begin{aligned}
 \Delta y &= \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark \\
 -1,9 &= \left(\frac{-24,43 - 25,18}{2}\right)\Delta t \checkmark
 \end{aligned}$$

$$\Delta t = 0,08 \text{ s } \checkmark$$



DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:


A-D:

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

$$v_f^2 = (-12)^2 + 2(9,8)(23,1) \checkmark$$

$$v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$$

C-D:

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

$$v_f^2 = (12)^2 + 2(9,8)(23,1) \checkmark$$

$$v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$$

D-G:

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

$$(25,18)^2 = (v_i)^2 + 2(9,8)(1,9) \checkmark$$

$$v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$$

B-D

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

$$v_f^2 = 0 + 2(9,8)(30,447) \checkmark$$

$$= 24,43 \text{ m}\cdot\text{s}^{-1}$$

D-G:

$$E_{(\text{mech top/meg bo})} = E_{(\text{mech bot/meg ond})}$$

$$(E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bot/ond}}$$

$$(mgh + \frac{1}{2}mv^2)_{\text{top/bo}} = (mgh + \frac{1}{2}mv^2)_{\text{bot/ond}}$$

$$m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2 \checkmark$$

$$v_i = 24,43 \text{ m}\cdot\text{s}^{-1}$$

D-G:

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

$$25,18 = 24,43 + (9,8)\Delta t \checkmark$$

$$\Delta t = 0,08 \text{ s} \checkmark$$

D-G:

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

$$1,9 = 24,43\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = 0,08 \text{ s} \checkmark$$

D-G:

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

$$1,9 = \left(\frac{24,43 + 25,18}{2} \right) \Delta t \checkmark$$

$$\Delta t = 0,08 \text{ s} \checkmark$$

Marking criteria OPTION 2 and 3/Nasienkriteria OPSIE 2 en 3

- Either one of the formula to calculate Δt . / Enige een van die formules om Δt te bereken. ✓
- Substitute into formula to calculate time from A to G or C to G / Vervanging in formule om tyd te bereken tussen A tot G of C tot G ✓
- Substitute into formula to calculate time from A to D or C to D / Vervanging in formule om tyd te bereken tussen A tot D of C tot D ✓
- Final answer / Finale antwoord: 0,07 s ✓ (0,07s to/tot 0,08s)

OPTION 2/OPSIE 2**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:****A-G:**

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

$$\underline{-25,18 = 12 + (-9,8) \Delta t} \checkmark$$

$$\Delta t = 3,79 \text{ s}$$

✓ Any one/
Enige een**A-D:**

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

$$\underline{-23,1 = (12) \Delta t + \frac{1}{2} (-9,8) \Delta t^2} \checkmark$$

$$\Delta t = 3,72 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$3,79 - 3,72 = 0,07 \text{ s} \checkmark$$

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

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

$$\underline{25,18 = -12 + (9,8) \Delta t} \checkmark$$

$$\Delta t = 3,79 \text{ s}$$

✓ Any one/
Enige een**A-D:**

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

$$\underline{23,1 = (-12) \Delta t + \frac{1}{2} (9,8) \Delta t^2} \checkmark$$

$$\Delta t = 3,72 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$3,79 - 3,72 = 0,07 \text{ s} \checkmark$$

OPTION 3/OPSIE 3**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:****C-G:**

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

$$\underline{-25,18 = -12 + (-9,8) \Delta t} \checkmark$$

$$\Delta t = 1,34 \text{ s}$$

✓ Any one/
Enige een**C-D:**

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

$$\underline{-23,1 = (-12) \Delta t + \frac{1}{2} (-9,8) \Delta t^2} \checkmark$$

$$\Delta t = 1,27 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$1,34 - 1,27 = 0,07 \text{ s} \checkmark$$

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

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

$$\underline{25,18 = 12 + (9,8) \Delta t} \checkmark$$

$$\Delta t = 1,34 \text{ s}$$

✓ Any one/
Enige een**C-D:**

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

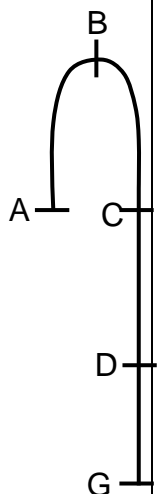
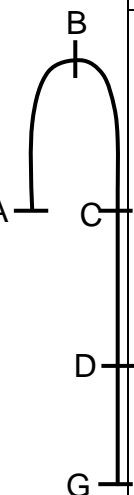
$$\underline{23,1 = (12) \Delta t + \frac{1}{2} (9,8) \Delta t^2} \checkmark$$

$$\Delta t = 1,27 \text{ s}$$

Time from top to bottom of door / Tyd van bokant tot onderkant van deur:

D-G:

$$1,34 - 1,27 = 0,07 \text{ s} \checkmark$$



OPTION 4/OPSIE 4**UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:****G-D:**

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

$$1,9 \checkmark = \frac{25,18 \Delta t}{1} + \frac{1}{2} (-9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 0,08 \text{ s } \checkmark \quad (0,077 \text{ s})$$

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

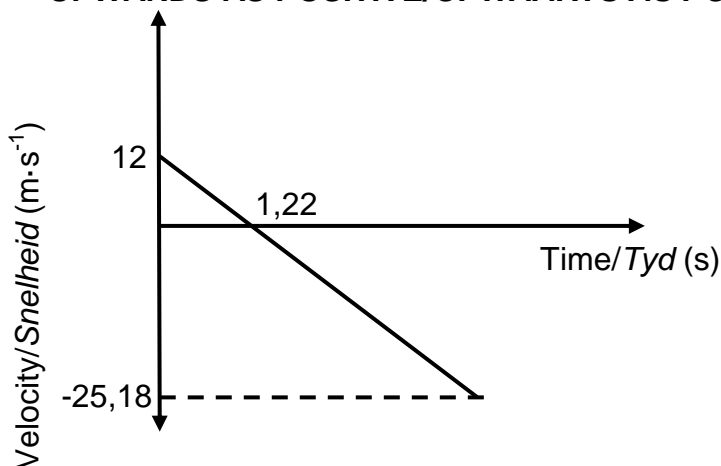
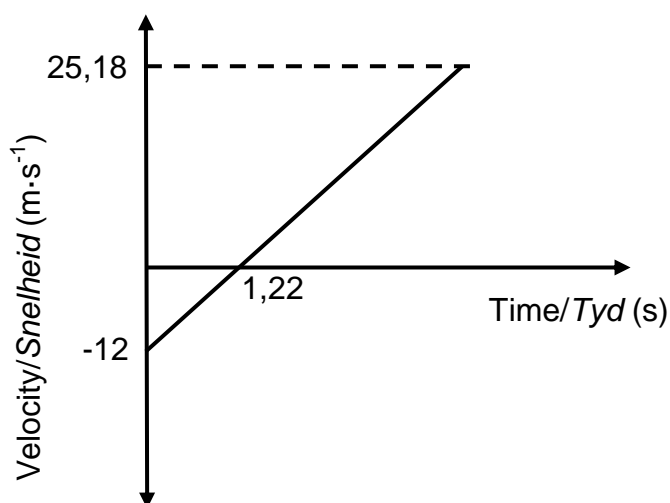
$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$$

$$-1,9 \checkmark = \frac{-25,18 \Delta t}{1} + \frac{1}{2} (9,8) \Delta t^2 \quad \checkmark$$

$$\Delta t = 0,08 \text{ s } \checkmark \quad (0,077 \text{ s})$$

(4)

3.3

POSITIVE MARKING FROM QUESTION 3.2.1 AND QUESTION 3.2.2.**POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN VRAAG 3.2.2.****UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:****DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:****Criteria for graph/Kriteria vir grafiek**

Straight line starting at $v = 12 \text{ m} \cdot \text{s}^{-1}$ with negative final velocity or straight line starting at $v = -12 \text{ m} \cdot \text{s}^{-1}$ with positive final velocity. /Reguitlyn wat begin by $v = 12 \text{ m} \cdot \text{s}^{-1}$ met negatiewe finale snelheid of reguitlyn wat begin by $v = -12 \text{ m} \cdot \text{s}^{-1}$ met positiewe finale snelheid.	✓
Straight line cuts time axis at time calculated in Question 3.2.1/ Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.1.	✓
Correct final velocity as calculated in Question 3.2.2 is indicated./Korrekte finale snelheid soos uitgewerk in Vraag 3.2.2 is aangedui.	✓

(3)

[16]

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/closed system the total (linear) momentum is conserved/remains constant. ✓✓

In 'n geïsoleerde/geslote sisteem bly die totale (lineêre) momentum behoue/konstant. (2)

4.2.1

OPTION 1/OPSIE 1

EAST AS POSITIVE/OOS AS POSITIEF

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

$$(1,2)(8) \checkmark + (0,5)(0) = (1,2)(4) + (0,5)(v_{fy}) \checkmark$$

$$\therefore v_{fy} = 9,6 \text{ m}\cdot\text{s}^{-1} \checkmark$$

WEST AS POSITIVE/WES AS POSITIEF

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

$$(1,2)(-8) \checkmark + (0,5)(0) = (1,2)(-4) + (0,5)(v_{fy}) \checkmark$$

$$v_{fy} = -9,6 \text{ m}\cdot\text{s}^{-1}$$

$$\therefore v_{fy} = 9,6 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 2 /OPSIE 2

EAST AS POSITIVE/OOS AS POSITIEF

$$\left. \begin{aligned} \Delta p_x &= -\Delta p_y \\ m(v_{xf} - v_{xi}) &= -m(v_{yf} - v_{yi}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$1,2(4 - 8) \checkmark = -0,5(v_f - 0) \checkmark$$

$$\therefore v_{fy} = 9,6 \text{ m}\cdot\text{s}^{-1} \checkmark$$

WEST AS POSITIVE/WES AS POSITIEF

$$\left. \begin{aligned} \Delta p_x &= -\Delta p_y \\ m(v_{xf} - v_{xi}) &= -m(v_{yf} - v_{yi}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$1,2(-4 + 8) \checkmark = -0,5(v_f - 0) \checkmark$$

$$v_{fy} = -9,6 \text{ m}\cdot\text{s}^{-1}$$

$$\therefore v_{fy} = 9,6 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

4.2.2

OPTION 1/OPSIE 1

EAST POSITIVE/OOS POSITIEF:

For X/Vir X:

$$\left. \begin{aligned} F_{\text{net}} \Delta t &= \Delta p \\ F_{\text{net}} \Delta t &= m(v_f - v_i) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$F_{\text{net}}(0,1) = 1,2(4 - 8) \checkmark$$

$$F_{\text{net}} = -48 \text{ N} \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST POSITIVE/WES POSITIEF:

For X /Vir X:

$$\left. \begin{aligned} F_{\text{net}} \Delta t &= \Delta p \\ F_{\text{net}} \Delta t &= m(v_f - v_i) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$F_{\text{net}}(0,1) = 1,2(-4 + 8) \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 2/OPSIE 2**POSITIVE MARKING FROM QUESTION 4.2.1.****POSITIEWE NASIEN VANAF VRAAG 4.2.1.****EAST AS POSITIVE****OOS AS POSITIEF****For Y/Vir Y:**

$$\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ F_{\text{net}}\Delta t &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$F_{\text{net}}(0,1) = 0,5(-9,6 - 0) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE**WES AS POSITIEF****For Y/Vir Y:**

$$\left. \begin{aligned} F_{\text{net}}\Delta t &= \Delta p \\ F_{\text{net}}\Delta t &= m(v_f - v_i) \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$F_{\text{net}}(0,1) = 0,5(9,6 - 0) \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 3/OPSIE 3**EAST AS POSITIVE for X****OOS AS POSITIEF vir X**

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

$$-4 = -8 + a(0,1)$$

$$a = -40 \text{ m}\cdot\text{s}^{-2}$$

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

$$F_{\text{net}} = (1,2)(-40) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE for X**WES AS POSITIEF vir X**

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

$$4 = 8 + a(0,1)$$

$$a = 40 \text{ m}\cdot\text{s}^{-2}$$

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

$$F_{\text{net}} = (1,2)(40) \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 4/OPSIE 4**EAST AS POSITIVE for X****OOS AS POSITIEF vir X**

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

$$\Delta x = \left(\frac{8 + 4}{2} \right) (0,1)$$

$$\Delta x = 0,6 \text{ m}$$

$$F_{\text{net}}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark$$

$$F_{\text{net}}(0,6)\cos 180^\circ = \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2 \checkmark$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

WEST AS POSITIVE for X**WES AS POSITIEF vir X**

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

$$\Delta x = \left(\frac{-8 - 4}{2} \right) (0,1)$$

$$\Delta x = -0,6 \text{ m}$$

$$F_{\text{net}}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \checkmark$$

$$F_{\text{net}}(0,6)\cos 0^\circ = \frac{1}{2}(1,2)(-4)^2 - \frac{1}{2}(1,2)(-8)^2 \checkmark$$

$$F_{\text{net}} = -48 \text{ N} \checkmark$$

$$\therefore F_{\text{net}} = 48 \text{ N} \checkmark$$

OPTION 5/OPSIE 5

$$\begin{aligned} \text{Gradient} &= \frac{\Delta y}{\Delta x} \\ &= \frac{\Delta v}{\Delta t} \\ &= \frac{4 - 8}{0,1} \\ &= -40 \text{ m}\cdot\text{s}^{-2} \end{aligned}$$

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

$$F_{\text{net}} = (1,2)(-40) \checkmark$$

$$F_{\text{net}} = -48 \text{ N}$$

$$F_{\text{net}} = 48 \text{ N} \checkmark$$

(3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2.1/
POSITIEWE NASIEN VANAF VRAAG 4.2.1.**

OPTION 1/OPSIE 1

Inelastic/oneelasties ✓

$$E_k = \frac{1}{2}mv^2 \quad \checkmark$$

$$\begin{aligned} \sum E_{ki} &= \frac{1}{2}m_X v_{Xi}^2 + \frac{1}{2}m_Y v_{Yi}^2 \\ &= \frac{1}{2}(1,2)(8)^2 + 0 \quad \checkmark \\ &= 38,4 \text{ J} \end{aligned}$$

$$\begin{aligned} \sum E_{kf} &= \frac{1}{2}m_X v_{Xf}^2 + \frac{1}{2}m_Y v_{Yf}^2 \\ &= \frac{1}{2}(1,2)(4)^2 + \frac{1}{2}(0,5)(9,6)^2 \quad \checkmark \\ &= 32,64 \text{ J} \end{aligned}$$

$$\sum E_{ki} \neq \sum E_{kf} \quad \checkmark$$

OPTION 2/OPSIE 2 (Change in $E_{k\text{total}}$ total /verandering in $E_{k\text{totaal}}$)

Inelastic/oneelasties ✓

$$E_k = \frac{1}{2}mv^2 \quad \checkmark$$

$$\begin{aligned} \Delta E_k(X) &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2 \quad \checkmark \\ &= -28,8 \text{ J} \end{aligned}$$

$$\begin{aligned} \Delta E_k(Y) &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}(0,5)(9,6)^2 - \frac{1}{2}(0,5)(0)^2 \quad \checkmark \\ &= 23,04 \text{ J} \end{aligned}$$

$$\Delta E_k(X) \neq \Delta E_k(Y) \quad \checkmark$$

Note/Aantekening:

If candidate starts with conservation of kinetic energy//Indien kandidaat begin met behoud van kinetiese energie: max/maks $\frac{4}{5}$

(5)
[14]

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 done by the force on an object (which is moving between two points) depends on the path taken. ✓✓

'n Krag waarvoor die arbeid wat verrig word deur die krag op 'n voorwerp (wat tussen twee punte beweeg,) afhanklik is van die pad wat gevolg word.

OR/OF

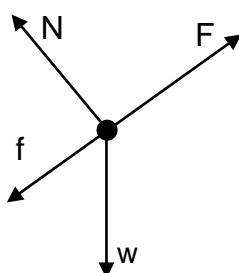
A force is non-conservative if the work it does in moving an object around a closed path is non-zero.

'n Krag is nie-konserwatief wanneer die arbeid wat dit verrig om 'n voorwerp in 'n geslote pad te beweeg, nie nul is nie.

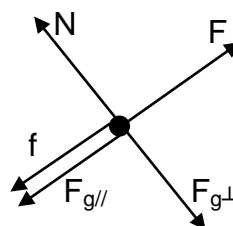
Note/Aantekening:

-If work done is omitted/ Indien arbeid verrig uitgelaat word: $\frac{0}{2}$

5.2



OR/OF



Accepted labels/Aanvaarde benoemings

w	F_w / F_g / mg / 117,6 N / gravitational force / <i>gravitasiekrag</i> / weight / <i>gewig</i>
F	F_A / Applied force / T / <i>Toegepaste krag</i> / F_T
f	F_f / f_k / (kinetic) Friction / (<i>kinetiese</i>) <i>wrywing</i> / F_w
N	F_N / Normal / <i>Normaal</i>

Notes/Aantekeninge:

- 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.
- If w is not shown but $F_{//}$ and $F_{g\perp}$ are shown, give 1 mark for both./Indien w nie aangetoon is nie maar $F_{//}$ en $F_{g\perp}$ is getoon, ken 1 punt toe vir beide.
- Any other additional force(s)/Enige ander addisionele krag(te):
Max/Maks $\frac{3}{4}$
- If everything is correct, but no arrows/Indien alles korrek is, maar geen pyltjies: Max/Maks $\frac{3}{4}$ •
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$

5.3

OPTION 1/OPSIE 1

$$\begin{aligned}
 W_{nc} &= \Delta E_k + \Delta E_p \\
 W_{nc} &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \quad \checkmark \text{ Any one/Enige een} \\
 &= \frac{1}{2}(12)(2,25^2 - 0) \checkmark + (12)(9,8)(4,5 - 0) \checkmark \\
 &= 559,58 \text{ J } \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 W_{Fg//} &= F_{g//}\Delta x \cos\theta \\
 &= (mg\sin\theta)\Delta x \cos\theta \\
 &= (12)(9,8)\left(\frac{4,5}{\Delta x}\right)\Delta x \cos 180^\circ \\
 &= -529,2 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 W_{Fg} &= F_g \Delta x \cos(90^\circ + \theta) \\
 &= mg\Delta x(-\sin\theta) \\
 &= (12)(9,8)\left(-\frac{4,5}{\Delta x}\right)\Delta x \\
 &= -529,2 \text{ J}
 \end{aligned}$$

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

$$\begin{aligned}
 &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 &= \frac{1}{2}(12)(2,25)^2 - 0^2 \checkmark \\
 &= 30,375 \text{ J}
 \end{aligned}$$

$$W_{net} = W_{nc} + W_c \checkmark$$

$$\begin{aligned}
 30,375 &= W_{nc} + (-529,2) \checkmark \\
 W_{nc} &= 559,575 \text{ J } \checkmark \quad (559,58 \text{ J})
 \end{aligned}$$

OPTION 3/OPSIE 3

$$\sin\theta = \frac{4,5}{\Delta x}$$

$$\Delta x = \frac{4,5}{\sin\theta}$$

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

$$W_F + W_f + W_w = \Delta E_k$$

$$W_{nc} + (mg\sin\theta)\Delta x(\cos\beta) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

✓ Any one/
Enige een

$$W_{nc} + (12)(9,8)\left(\frac{4,5}{\sin\theta}\right)\sin\theta\cos 180^\circ \checkmark = \frac{1}{2}(12)(2,25)^2 - 0^2 \checkmark$$

$$W_{nc} = 559,58 \text{ J } \checkmark$$

(4)

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

Marking criteria for OPTION 1 /Nasienkriteria vir OPSIE 1

- Formula for W_{nc} /Formule vir W_{nc} ✓
- Correct substitution of 559,58 J in W_{nc} along inclined plane ✓
Korrekte vervanging van 559,58 J in W_{nc} langs die skuinsvlak
- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane ✓
*Korrekte kragvergelyking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). ✓
Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Correct answer/Korrekte antwoord: 13,32 m. ✓

OPTION 1/OPSIE 1

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$\left. \begin{aligned} W_{nc} &= W_F + W_f \\ W_{nc} &= F\Delta x \cos 0^\circ + f_1 \Delta x \cos 180^\circ \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$559,58 = F\Delta x \cos 0^\circ + f_1 \Delta x \cos 180^\circ$$

$$559,58 \checkmark = (F - f_1)\Delta x \dots\dots\dots(1)$$

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTAL

$$\begin{aligned} F - f_2 &= ma \\ F - f_2 &= 0 \checkmark \end{aligned} \quad \boxed{\text{OR/OF } F = f_2}$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F - f_1 = 42 \dots\dots\dots(2)$$

Substitute/Vervang (2) into/in (1):

$$559,58 = 42\Delta x$$

$$\Delta x = 13,32 \text{ m } \checkmark$$

Marking criteria for OPTION 2 and 3 /Nasienkriteria vir OPSIE 2 en 3

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane ✓
*Korrekte kragvergelyking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). ✓
Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Formula for W_{nc} **OR** W_{net} /Formule vir W_{nc} **OF** W_{net} ✓
- Correct substitution into equation for W_{nc} **OR** W_{net} on the horizontal plane ✓
*Korrekte vervanging in W_{nc} **OF** W_{net} vergelyking langs die skuinsvlak*
- Correct answer/Korrekte antwoord: 13,32 m. ✓

OPTION 2/OPSIE 2

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTAL

$$\begin{aligned} F - f_2 &= ma \\ F - f_2 &= 0 \checkmark \end{aligned} \quad \boxed{\text{OR/OF } F = f_2}$$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42$$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

$$\left. \begin{aligned} W_{nc} &= \Delta E_K + \Delta E_P \\ (F - f_1)\Delta x \cos \theta &= \left[\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right] + [mgh_f - mgh_i] \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$$

$$(f_1 + 42 - f_1)\Delta x \cos 0^\circ = \left[\frac{1}{2}(12)(2,25)^2 - 0^2 \right] + [(12)(9,8)(4,5) - 0] \checkmark$$

$$\Delta x = 13,32 \text{ m } \checkmark (13,32 \text{ m})$$

OPTION 3/OPSIE 3

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTALAAL

$$F - f_2 = ma$$

$$F - f_2 = 0 \checkmark$$

OR/OF $F = f_2$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42$$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

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

$$(F - f_1 - F_{g//})\Delta x \cos \theta = \left[\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right]$$

} \checkmark Any one/
Enige een

$$\left[(42) - (12)(9,8) \left(\frac{4,5}{\Delta x} \right) \right] \Delta x \cos 0^\circ = \frac{1}{2}(12)(2,25)^2 \checkmark - 0^2$$

$$\Delta x = 13,323214 \text{ m } \checkmark (13,32 \text{ m})$$

OPTION 4/OPSIE 4

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

$$W_{\text{nc}} = \left[\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right] + [mgh_f - mgh_i]$$

} \checkmark Any one/
Enige een

$$(f_1 + 42 - f_1) \checkmark \Delta x \cos 0^\circ \checkmark = 559,575 \checkmark$$

$$(42) \Delta x \cos 0^\circ = 559,575$$

$$\Delta x = 13,323214 \text{ m } \checkmark (13,32 \text{ m})$$

Marking criteria for OPTION 5/Nasienkriteria vir OPSIE 5

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane \checkmark / *Korrekte kragvergelgelyking en vervanging van 0 vir F_{net} **OF** $F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2). \checkmark
Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Correct substitution to calculate a. / *Korrekte vervanging om a te bereken.* \checkmark .
- Substitution to calculate F_{net} . / *Vervanging om F_{net} te bereken.* \checkmark
- Correct answer / *Korrekte antwoord:* 13,32 m. \checkmark

OPTION 5/OPSIE 5

ALONG THE HORIZONTAL/BC/LANGS DIE HORIZONTALAAL

$$F - f_2 = ma$$

$$F - f_2 = 0 \checkmark$$

OR/OF $F = f_2$

$$F - (f_1 + 42) \checkmark = 0$$

$$F = f_1 + 42 \dots\dots(1)$$

ALONG THE INCLINE/AB/TEEN DIE SKUINSVLAK

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

$$2,25^2 = 0 + 2a\Delta x \checkmark$$

$$a = \frac{2,53}{\Delta x}$$

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

$$F - F_{g//} - f_1 = ma$$

$$F - mgsin\theta - f_1 = 12a \dots\dots$$

$$F - (12)(9,8)sin\theta - f_1 = 12 \left(\frac{2,53}{\Delta x} \right) \checkmark \dots\dots(2)$$

Substitute / *Vervang* (2) into / *in* (1):

$$42 - (12)(9,8) \left(\frac{4,5}{\Delta x} \right) = 30,38$$

$$\Delta x = 13,32 \text{ m } \checkmark$$

(5)
[15]

QUESTION/VRAAG 6

6.1 Doppler Effect/*Doppler-effek* ✓ (1)

6.2 Measurement of foetal heartbeat./*Meting van die hartklop van 'n fetus.*✓

OR/OF

Measurement of blood flow./*Meting van bloedvloe.* ✓

OR/OF

Doppler flow meter/*Doppler vloeimeter* ✓

(1)

6.3 $f_L \propto f_s$ ✓

OR/OF

Directly (proportional)/Direk (eweredig)

(1)

6.4

Marking criteria/Nasienkriteria

- Doppler formula/Doppler formule ✓
- Correct substitution for v and v_s . /Korrekte vervanging van v en v_s . ✓
- Substitution for $\frac{f_L}{f_s} = 1,06$ **OR** $f_L = 1,06 f_s$ **OR** any set of values for f_L and f_s so that
 $f_L = 1,06 f_s$ / Vervanging van $\frac{f_L}{f_s} = 1,06$ **OF** $f_L = 1,06 f_s$ **OF** enige stel waardes vir
 f_L en f_s sodat $f_L = 1,06 f_s$ ✓✓
- Final answer/Finale antwoord: $20,4 \text{ m} \cdot \text{s}^{-1}$ ✓

OPTION 1/OPSIE 1

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

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

$$1,06 = \frac{340 + v_L}{340} \checkmark$$

$$v_L = 20,4 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 2/OPSIE 2

$$\text{Gradient} = \frac{0 - f_L}{0 - f_s}$$

$$1,06 = \frac{0 - f_L}{0 - f_s}$$

$$f_L = 1,06 f_s$$

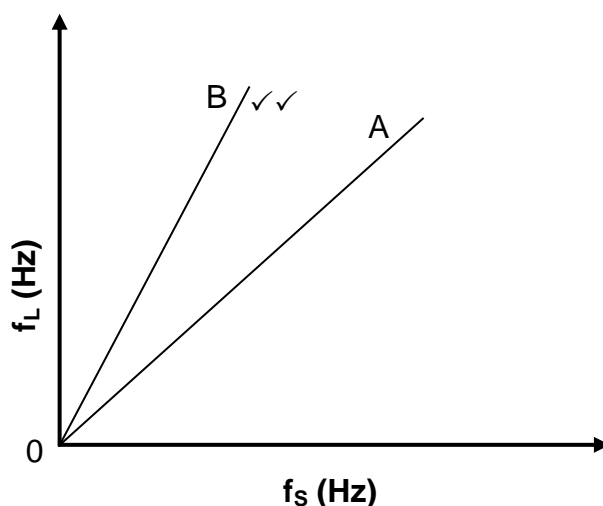
$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_s$$

$$1,06 f_s = \left(\frac{340 + v_L}{340} \right) f_s \checkmark$$

$$v_L = 20,4 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

6.5



Marking criteria/Nasienkriteria	
Graph is a straight line starting at the origin./ Grafiek is 'n reguitlyn wat by die oorsprong begin.	✓
Gradient of B is greater than gradient of A./ Gradiënt van B is groter as gradiënt van A.	✓

(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.

The magnitude of the electrostatic force exerted by one point charge on another is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓

Die grootte van die elektrostatiese krag wat een puntlading op 'n ander uitoefen, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

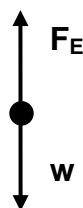
(2)

7.2

Negative/negatief ✓

(1)

7.3



Accepted labels/Aanvaarde byskrifte	
F_E	$F_{\text{electrostatic}}$ / F / $F_{M \text{ ON } N}$ / electrostatic force / F_M $F_{\text{elektrostaties}}$ / F / $F_{M \text{ OP } N}$ / elektrostatische krag / F_M
w	F_g / w / mg / gravitational force / F_w / weight / gravity F_g / w / mg / gravitasiekrag / F_w / gewig / swaartekrag
Notes/Aantekeninge: <ul style="list-style-type: none"> Do not penalise for length of arrows./Moenie vir lengte van die pyltjie penaliseer nie. Any other additional force(s)/Enige addisionele krag(te): Max/Maks $1/2$ If arrows are omitted but correctly labelled/Indien pyltjies weggelaat is, maar korrek benoem: Max/Maks $1/2$ If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $1/2$ 	

(2)

7.4

Marking criteria/Nasienkriteria	
<ul style="list-style-type: none"> Correct substitution to calculate weight of M./Korrekte vervanging om gewig van M te bereken. ✓ Coulomb's formula/Coulomb se formule ✓ Substitute/Vervang $F_{\text{net}} = 0$ / $mg = \frac{kQ_M Q_N}{r^2}$ (equating forces)/ $0,02 = \frac{kQ_M Q_N}{r^2}$ (equating forces) ✓ Correct substitution into $\frac{kQ_M Q_N}{r^2}$ /Korrekte vervanging in $\frac{kQ_M Q_N}{r^2}$ ✓ Correct final answer (accept negative value)/Korrekte finale antwoord (aanvaar negatiewe waarde): $2,33 \times 10^{-6} \text{ C}$ to/tot $2,32 \times 10^{-6} \text{ C}$ ✓ 	
$F_g = mg$ $= (2,04 \times 10^{-3})(9,8)$ ✓ $= 0,02 \text{ N}$ $F = \frac{kQ_M Q_N}{r^2}$ ✓ $F_{\text{net}} = mg - \frac{kQ_M Q_N}{r^2}$ $0 = 0,02 - \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓ $Q_M = 2,33 \times 10^{-6} \text{ C}$ ✓	IF/INDIEN: $F = \frac{kQ_M Q_N}{r^2}$ ✓ $2,04 \times 10^{-3}(9,8) \checkmark \checkmark = \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓ $Q_M = 2,33 \times 10^{-6} \text{ C}$ ✓

(5)

7.5.1 Equal/Gelyk ✓

OR/OF

Same/Dieselfde

(1)

7.5.2 Opposite **OR** upwards/Teenoorgesteld **OF** opwaarts✓

(1)

7.6 **POSITIVE MARKING FROM QUESTION 7.4.**

POSITIEWE NASIEN VANAF VRAAG 7.4.

Marking criteria/Nasienkriteria

- Formula for E./Formule vir E. ✓
- Correct substitution for M **OR** N./Korrekte vervanging vir M **OF** N. ✓
- Subtraction of $E_M - E_N$ **OR** $E_N - E_M$ /Aftrekking van $E_M - E_N$ **OF** $E_N - E_M$. ✓
- Correct final answer/Korrekte finale antwoord:
 $5,31 \times 10^4 \text{ N.C}^{-1}$ to/tot $5,37 \times 10^4 \text{ N.C}^{-1}$ ✓
- Correct direction/Korrekte rigting: upwards/opwaarts ✓

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

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

$$E_{\text{net}} = \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2} \right) - \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2} \right) \checkmark$$

$$E_{\text{net}} = 131\,062,5 - 77\,400$$

$$= 53\,662,5 \text{ N.C}^{-1} \checkmark (5,36 \times 10^4 \text{ N.C}^{-1}) \text{ upwards/towards M}$$

opwaarts/na M ✓

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

$$E_{\text{net}} = \frac{kQ}{r^2} \checkmark$$

$$E_{\text{net}} = \left(\frac{(9 \times 10^9)(8,6 \times 10^{-8})}{(0,1)^2} \right) - \left(\frac{(9 \times 10^9)(2,33 \times 10^{-6})}{(0,4)^2} \right) \checkmark$$

$$E_{\text{net}} = 77\,400 - 131\,062,5$$

$$= -5,37 \times 10^4 \text{ N.C}^{-1}$$

$$\therefore E_{\text{net}} = 53\,662,5 \text{ N.C}^{-1} \checkmark (5,36 \times 10^4 \text{ N.C}^{-1}) \text{ upwards/towards M}$$

opwaarts/na M ✓

(5)
[17]

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 temperature and all other physical conditions are constant). ✓✓

Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle 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 temperature and all other physical conditions are constant).

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

(2)

NOTE/LET WEL

Do not award the mark for addition of 4 if any other value is added to R_p / Moenie die punt vir bytel van 4 toeken indien enige ander waarde by R_p bygetel word nie.

8.2.1

OPTION 1/OPSIE 1

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

$$\left(\frac{1}{R_p} = \frac{1}{1} + \frac{1}{5} \right) \checkmark$$

$$R_p = 0,83 \, \Omega$$

$$\begin{aligned} R_T &= 0,83 + 4 \checkmark \\ &= 4,83 \, \Omega \checkmark \end{aligned}$$

OPTION2/OPSIE2

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

$$\left(R_p = \frac{(1)(5)}{1 + 5} \right) \checkmark$$

$$R_p = 0,83 \, \Omega$$

$$\begin{aligned} R_T &= 0,83 + 4 \checkmark \\ &= 4,83 \, \Omega \checkmark \end{aligned}$$

(4)

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

OPTION 1/OPSIE 1

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

$$4,83 = \frac{V}{3,5} \checkmark$$

$$V = 16,91 \text{ V} \checkmark \quad (16,92 \text{ V})$$

OPTION 2/OPSIE 2

$$R_p = \frac{V_2}{I} \checkmark$$

$$0,83 = \frac{V}{3,5} \checkmark$$

$$V_2 = 2,91 \text{ V}$$

$$R_{4\Omega} = \frac{V_{4\Omega}}{I} \checkmark$$

$$4 = \frac{V_{4\Omega}}{3,5} \checkmark$$

$$V_{4\Omega} = 14 \text{ V}$$

$$V_1 = V_2 + V_{4\Omega}$$

$$V_1 = 2,91 + 14$$

$$= 16,91 \text{ V} \checkmark \quad (16,92 \text{ V})$$

✓ Any one/Enige een

(3)

8.2.3 Smaller than/Kleiner as ✓

(1)

8.3.1 **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.

Maximum work done by the battery per unit charge. ✓✓

Maksimum arbeid verrig deur die battery per eenheidslading.

OR/OF

Maximum energy supplied by the battery per unit charge.

Maksimum energie verskaf deur die battery per eenheidslading.

OR/OF

The total amount of electric energy supplied by the battery per coulomb/per unit charge.

Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheidslading.

(2)

8.3.2 No/Nee ✓

(1)

- 8.3.3 The battery has internal resistance. ✓
Die battery het interne weerstand.

OR/OF

Some energy per coulomb of charge/volts is used to overcome internal resistance.

'n Gedeelte van die energie per coulomb lading/volts word gebruik om interne weerstand te oorkom.

OR/OF

There is a potential drop/lost volts inside the battery.

Daar is 'n potensiaalval/verlore volts binne-in die battery.

OR/OF

$$\mathcal{E} = V_{\text{ext}} + V_{\text{int}}$$

OR/OF

$$\mathcal{E} > V_{\text{ext}}$$

(1)

- 8.4.1 Decreases/*Verlaag* ✓

(1)

- 8.4.2 Increases/*Verhoog* ✓

(1)

- 8.5 When the voltmeter is connected:

- No/very little current through the 1 Ω branch **OR** Branch with 1 Ω resistor is disabled/bypassed **OR** A voltmeter has a very high resistance **OR** The resistance of the parallel branch increases. ✓
- (Total) resistance of the circuit increases. ✓
- Current in circuit decreases. ✓
- V_{internal} / Internal volts/ V_{lost} decreases. ✓

Therefore, external volts increase for a constant emf.

Wanneer die voltmeter geskakel word:

- *Geen/baie min stroom deur die 1 Ω -tak **OF** Tak met 1 Ω -weerstand is uitgeskakel **OF** Voltmeter het baie hoë weerstand **OF** Die weerstand van die parallelle tak neem toe.*
- *(Totale) weerstand van die stroombaan neem toe.*
- *Stroom in stroombaan neem af.*
- *V_{intern} / Interne volts/ V_{verlore} neem af.*

Dus neem die eksterne volts toe vir konstante emf.

(4)

[20]

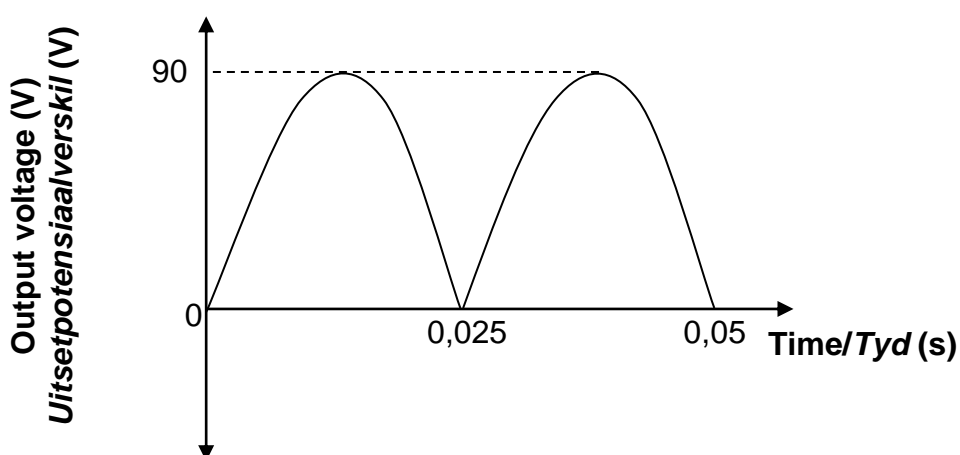
QUESTION 9/VRAAG 9

9.1.1 Split ring/commutator/*Splitring/kommutator* ✓ (1)

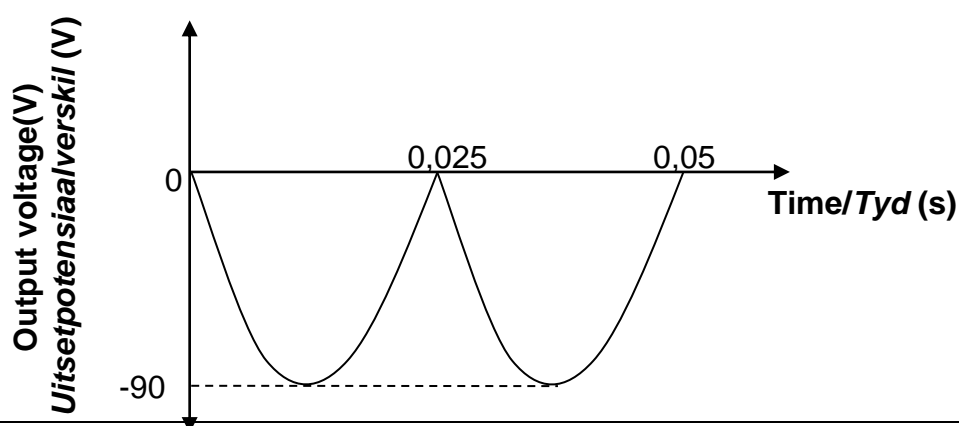
9.1.2 **Y to/na X OR/OF** 0 /no current/*geen stroom nie* ✓ (1)

9.1.3 $T = \frac{1}{f}$
 $T = \frac{1}{20}$
 $T = 0,05 \text{ s}$ ✓ (1)

9.1.4 **POSITIVE MARKING FROM QUESTION 9.1.3.**
POSITIEWE NASIEN VANAF VRAAG 9.1.3.



OR/OF



Criteria for graph/Kriteria vir grafiek	
Correct shape with one full cycle./Korrekte vorm met 1 volledige siklus.	✓
Curve starts at zero to first peak./Kurwe begin by nulpunt tot eerste piek.	✓
Any one of the correct time values at the correct position./Enige een van die korrekte tyd waardes op die korrekte posisie.	✓
Maximum voltage of 90 V OR -90 V/ Maksimum potensiaalverskil van 90 V OF -90 V	✓
NOTE/LET WEL:	
- 1 mark for half cycle/incomplete cycle or more than one cycle - 1 punt vir halwe siklus/onvoltooide siklus of meer as een siklus	

(4)

9.2

Marking criteria/Nasienkriteria

- Formula to calculate W_{ave} (do not penalise if subscripts are omitted)./
Formule om W_{gem} te bereken (moenie penaliseer indien onderskrifte uitgelaat is nie). ✓
- Substitution of 220 and 32 in correct equation. ✓
Vervanging van 220 en 32 in die korrekte vergelyking.
- Substitution of 120 for Δt /Vervanging van 120 in Δt . ✓
- Correct answer in range: 181 500 J to 181 764 J ✓
Korrekte antwoord in gebied: 181 500 J tot 181 764 J ✓

OPTION 1/OPSIE 1

$$W_{ave} = \frac{V_{rms}^2 \Delta t}{R} \checkmark$$

$$= \frac{220^2 (120)}{32} \checkmark$$

$$= 181\,500 \text{ J} \checkmark$$

OPTION 2/OPSIE 2

$$R = \frac{V_{rms}}{I_{rms}} \checkmark$$

$$32 = \frac{220}{I_{rms}}$$

$$I_{rms} = 6,88 \text{ A } (6,875 \text{ A})$$

$$W_{ave} = V_{rms} I_{rms} \Delta t \checkmark$$

$$= (220)(6,88)(120) \checkmark$$

$$= 181\,632 \text{ J} \checkmark$$

OR/OF

$$W_{ave} = I_{rms}^2 R \Delta t \checkmark$$

$$= (6,88)^2 (32)(120) \checkmark$$

$$= 181\,764,10 \text{ J} \checkmark$$

OPTION 3/OPSIE 3

$$R = \frac{V_{rms}}{I_{rms}} \checkmark$$

$$32 = \frac{220}{I_{rms}} \checkmark$$

$$I_{rms} = 6,88 \text{ A } (6,875 \text{ A})$$

$$P_{ave} = V_{rms} I_{rms}$$

$$= (220)(6,88)$$

$$= 1\,513,6 \text{ W}$$

$$(1,51 \times 10^3 \text{ W})$$

$$P_{ave} = I_{rms}^2 R$$

$$= (6,88)^2 (32)$$

$$= 1\,514,7 \text{ W } (1\,512,5 \text{ W})$$

$$(1,51 \times 10^3 \text{ W})$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$1\,513,6 = \frac{W}{120} \checkmark$$

$$W = 181\,632 \text{ J} \checkmark (1,82 \times 10^5 \text{ J})$$

OPTION 4/OPSIE 4

$$P_{ave} = \frac{V_{rms}^2}{R}$$

$$P_{ave} = \frac{220^2}{32} \checkmark$$

$$P_{ave} = 1\,512,5 \text{ W}$$

$$(1,51 \times 10^3 \text{ W})$$

(4)
[11]

QUESTION 10/VRAAG 10

- 10.1 Light has a particle nature/is quantized ✓
Lig het 'n deeltjie geaardheid/is gekwantiseerd (1)

- 10.2 **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. (2)

- 10.3
- $$\left. \begin{aligned} E &= W_0 + E_{k(\max)} \\ hf &= hf_0 + E_{k(\max)} \\ hf &= hf_0 + \frac{1}{2}mv_{\max}^2 \\ E &= W_0 + \frac{1}{2}mv_{\max}^2 \end{aligned} \right\} \begin{array}{l} \checkmark \text{ Any one/} \\ \text{Enige een} \end{array}$$

$$\frac{(6,63 \times 10^{-34})(5,96 \times 10^{14})}{5,30 \times 10^{-20} \text{ J}} \checkmark = \frac{3,42 \times 10^{-19} + E_{k(\max)}}{(5,32 \times 10^{-20} \text{ J})} \checkmark$$
- (4)

- 10.4
- $$q = I\Delta t$$
- $$= (0,012)(10) \checkmark$$
- $$= 0,12 \text{ C}$$
- $$n = \frac{Q}{e}$$
- $$n = \frac{0,12 \checkmark}{1,6 \times 10^{-19} \checkmark}$$
- $$n = 7,5 \times 10^{17} \text{ (electrons/elektrone)}$$
- number of photons/aantal fotone = $n = 7,5 \times 10^{17} \checkmark$ (4)

- 10.5 Increases/Verhoog ✓
- More photons strike the surface of the metal per unit time/ at a higher rate ✓ hence more (photo) electrons ejected per unit time ✓ (resulting in increased current).
- Meer fotone tref die oppervlak van die metaal per eenheidstyd/ teen 'n hoër tempo, gevolglik word meer (foto) elektrone per eenheidstyd vyrgesteel (wat tot 'n verhoogde stroom lei).* (3)

[14]

TOTAL/TOTAAL: 150