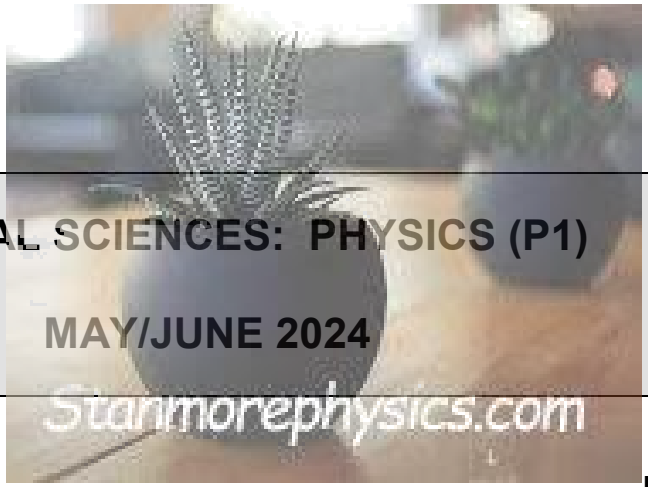
basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS



PHYSICAL SCIENCES: PHYSICS (P1)

MAY/JUNE 2024

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN 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 book rests on a table. Which ONE of the following forces will form an action-reaction pair with the weight of the book?

A Force of the Earth on the book

B Force of the book on the Earth

C Force of the book on the table

D Force of the table on the book (2)

1.2 A person is standing on a bathroom scale in a moving lift. Which ONE of the following motions of the lift will result in the SMALLEST reading on the scale?

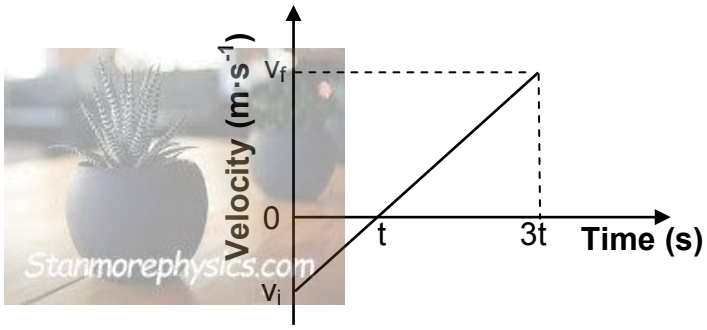
A The lift accelerates upwards.

B The lift accelerates downwards.

C The lift moves upwards at a constant velocity.

D The lift moves downwards at a constant velocity. (2)

1.3 The velocity versus time sketch graph below represents the motion of a ball which was in free fall. The ball struck the ground after 3t seconds.



Which ONE of the following statements is CORRECT?

The ball was …

A dropped from a height above the ground.

B thrown vertically upwards from the ground.

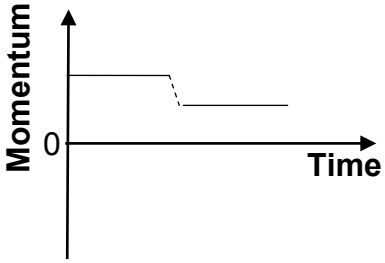
C thrown vertically upwards from a height above the ground.

D thrown vertically downwards from a height above the ground. (2)

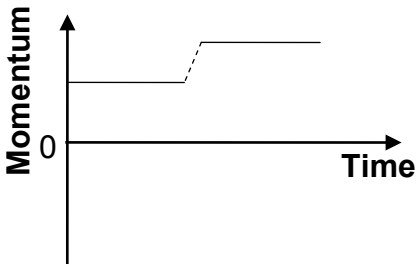
1.4 The vector diagram below shows the initial momentum (p_1), the final momentum (p_2) and the change in momentum (Δp) for a car that moved on a straight horizontal road.

Which ONE of the following sketch graphs CORRECTLY shows the momentum of the car for the time the car moved on the road?

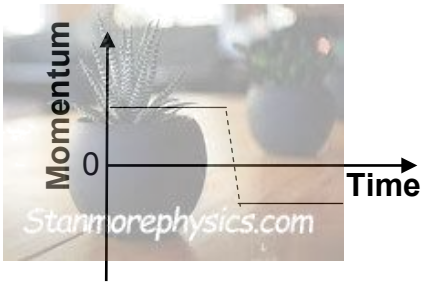
A



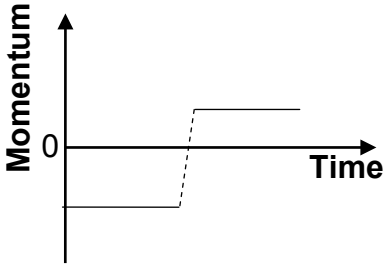
B



C



D



(2)

1.5 A stone of mass m is dropped from a height h above the ground. Ignore the effects of air friction.

Which ONE of the following combinations in the table below CORRECTLY represents the kinetic energy and the total mechanical energy of the stone at the instant the stone has fallen through a distance of ¼ h?

	KINETIC ENERGY	TOTAL MECHANICAL ENERGY
A	¾ mgh	¼ mgh
B	¼ mgh	¾ mgh
C	¾ mgh	mgh
D	¼ mgh	mgh

(2)

1.6 The spectrum of helium emitted from a star moving away from Earth is compared to the spectrum of helium found on Earth.

Which ONE of the following statements is CORRECT?

The observed spectral lines from the moving star will have a …

A lower frequency and a longer wavelength.

B lower frequency and a shorter wavelength.

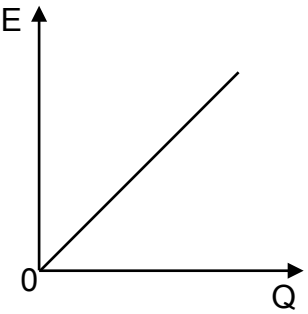
C higher frequency and a shorter wavelength.

D higher frequency and a longer wavelength. (2)

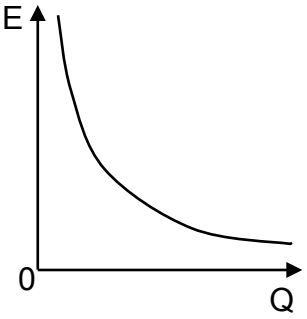
1.7 The magnitudes of electric fields generated by different point charges are measured at a fixed point. For each measurement, the distance between this fixed point and the charges are the same.

Which ONE of the following sketch graphs CORRECTLY shows the relationship between the magnitude of the electric field (E) and the magnitude of the charge (Q)?

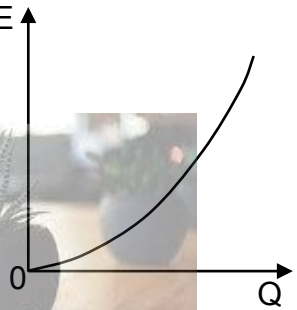
A



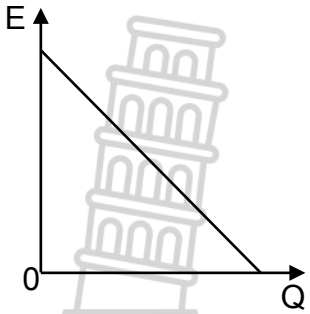
B



C

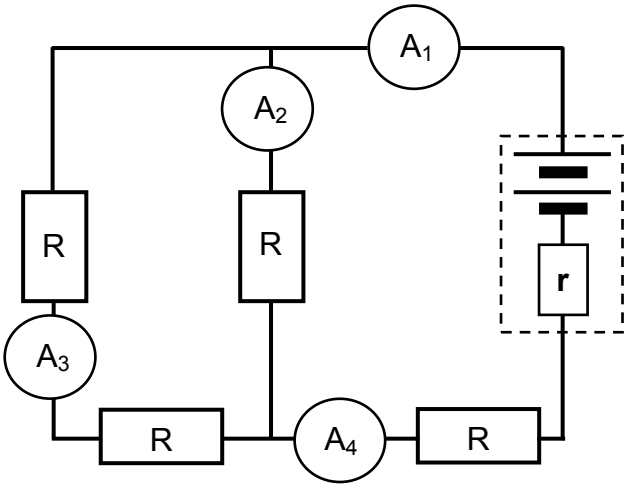


D



(2)

1.8 The diagram below represents a circuit in which all the external resistors have the same resistance.



Which ONE of the ammeters in the circuit will have the LOWEST reading?

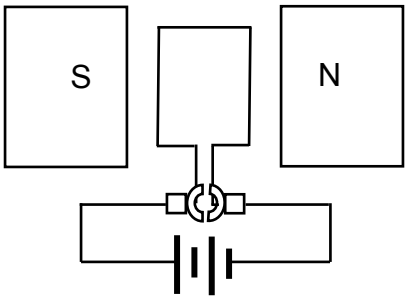
A A_1

B A_2

C A_3

D A_4 (2)

1.9 A simplified diagram of an electrical machine is shown below.



What type of machine is this?

A A DC motor

B An AC motor

C A DC generator

D An AC generator (2)

1.10 Which ONE of the following combinations is CORRECT for a line absorption spectrum in terms of the ENERGY TRANSITIONS OF THE ATOMS and the APPEARANCE OF THE NARROW LINES IN THE SPECTRUM?

	ENERGY TRANSITION OF THE ATOMS	APPEARANCE OF THE NARROW LINES IN THE SPECTRUM
A	Higher to lower energy state	Dark lines
B	Lower to higher energy state	Coloured lines
C	Lower to higher energy state	Dark lines
D	Higher to lower energy state	Coloured lines

(2)

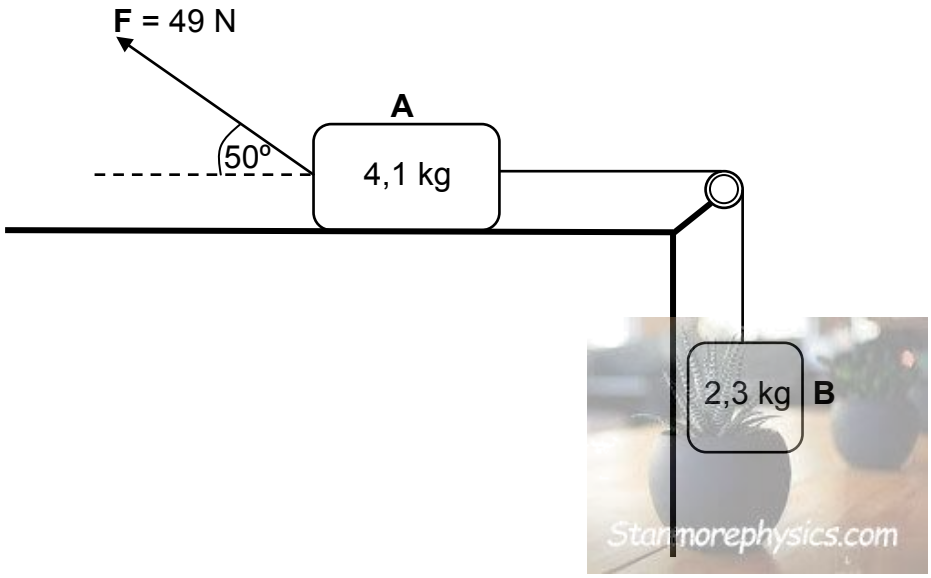
[20]

QUESTION 2 (Start on a new page.)

Block **A** of mass 4,1 kg is connected to block **B** of mass 2,3 kg by a light inextensible string passing over a frictionless pulley. Block **A** is at rest on a rough horizontal table and block **B** hangs vertically, as shown in the diagram below.

A force **F** of magnitude 49 N is applied on block **A** at an angle of 50º to the horizontal, causing block **A** to accelerate TO THE LEFT from rest along the table.

The coefficient of kinetic friction between the surface of the table and block **A** is 0,35.



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

2.2 Draw a labelled free-body diagram showing all the forces acting on block **A** while it accelerates to the left. (5)

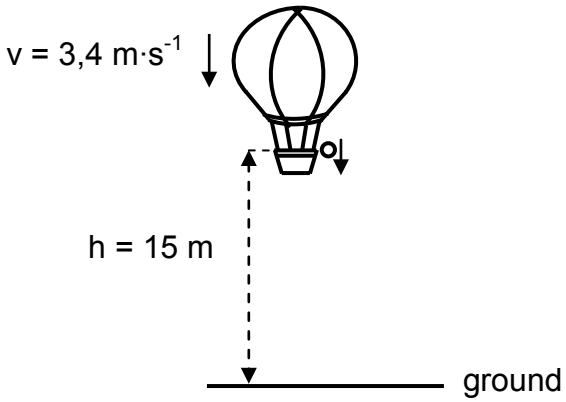
2.3 Calculate the magnitude of the:

2.3.1 Kinetic frictional force exerted on block **A** (3)

2.3.2 Acceleration of block **A**, by applying Newton's Second Law to each block separately (5)
[15]

QUESTION 3 (Start on a new page.)

A hot-air balloon moves vertically downwards at a constant velocity of 3,4 m·s^{-1}. When the balloon is 15 m above the ground, a small ball is dropped from the balloon. Refer to the diagram below.

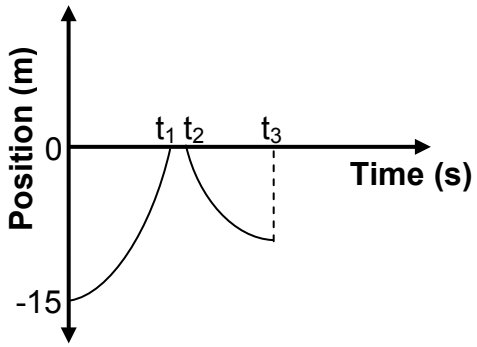


The ball strikes the ground and bounces vertically upwards. The hot-air balloon continues to move downwards at the same constant velocity.

Ignore the effects of air friction acting on the ball.

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

The sketch graph below (not drawn to scale) represents the positions of the ball relative to the ground from the time the ball is dropped until the time it reaches its maximum height after the first bounce.



3.2 Was the ball in free fall between t_1 and t_2 seconds? Write down either YES or NO. (1)

3.3 Use only EQUATIONS OF MOTION to calculate:

3.3.1 The value of t_1 indicated on the graph (3)

3.3.2 The height of the hot-air balloon above the ground at the instant when the ball struck the ground (4)

3.4 The ball was in contact with the ground for 0,2 s and left the ground with a vertical upward velocity of 7,2 m·s^{-1}.

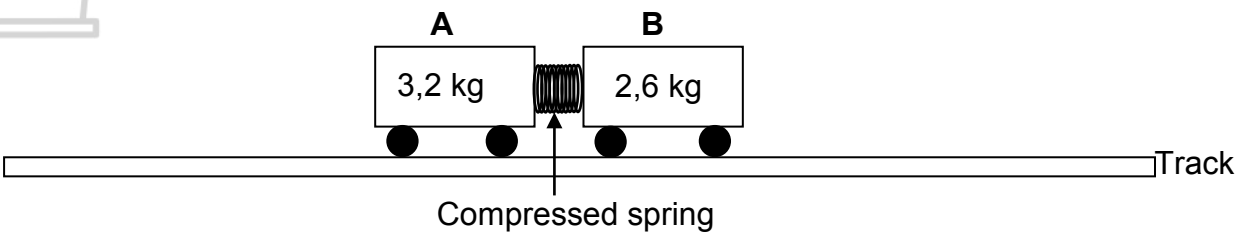
Use only EQUATIONS OF MOTION to calculate the value of t_3 indicated on the graph. (4)

[14]

QUESTION 4 (Start on a new page.)

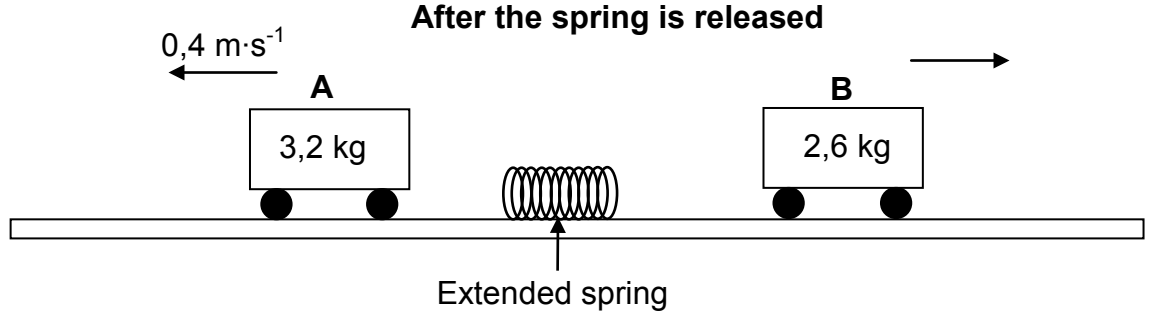
Two trolleys **A** and **B** of mass 3,2 kg and 2,6 kg respectively are held at rest on a straight horizontal, frictionless track, with a compressed spring between them, as shown in the diagram below.

Before the spring is released



After the trolleys are released, the spring extends to its natural length and then falls onto the track. Trolley **A** now moves with a constant velocity of 0,4 $m \cdot s^{-1}$ to the left, while trolley **B** moves with a constant unknown velocity to the right. Trolley **B** reaches the end of the track after 1,3 s.

After the spring is released



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

4.2 Calculate the distance travelled by trolley **B** in 1,3 s. (5)

The average force exerted by the extended spring on each trolley while they were in contact with the spring was 4,2 N.

4.3 Calculate the time it took the spring to extend to its natural length. (3)

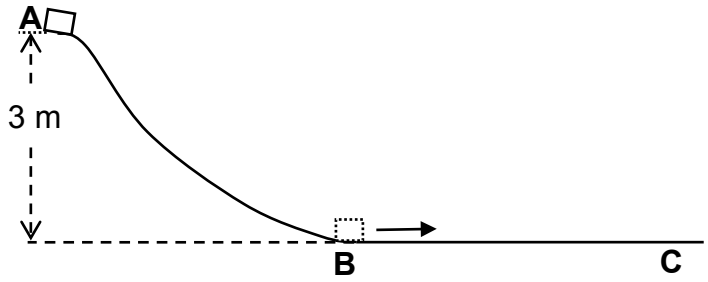
4.4 Trolley **B** is now replaced by trolley **C**, which has a larger mass. The same compressed spring is placed between trollies **A** and **C**. The trolleys are then released. The average force exerted by the extended spring on the trolleys remains at 4,2 N for the same period of time as calculated in QUESTION 4.3.

How does the magnitude of the velocity of trolley **C** compare to the magnitude of the velocity of trolley **B** after the spring has fallen to the track? Write only GREATER THAN, LESS THAN or EQUAL TO. Explain the answer. (3)

[13]

QUESTION 5 (Start on a new page.)

A crate of mass 18 kg, initially at rest, slides down a frictionless slope from point **A** to point **B**. The crate then moves along a rough horizontal surface from point **B** towards point **C**. Point **A** is 3 m above the horizontal surface. See the diagram below.



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

5.2 Using ENERGY PRINCIPLES only, calculate the speed of the crate at point **B**. (3)

A constant frictional force of 40,6 N acts on the crate as it moves from point **B** towards point **C**. The crate comes to rest at point **C**.

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

5.4 Using ENERGY PRINCIPLES only, calculate the distance that the crate travelled from point **B** to point **C**. (4)

5.5 The height of the track is now lowered so that point **A** is at a vertical height less than 3 m. The same crate is again released from point **A**.

How will the distance now, travelled by the crate along the horizontal surface before it comes to rest, compare to the distance calculated in QUESTION 5.4? Write only GREATER THAN, SMALLER THAN or EQUAL TO. Explain the answer. (3)
[14]

QUESTION 6 (Start on a new page.)

A stationary listener records the frequency of the sound emitted by the siren of a police car. When the car which is travelling at a constant velocity of 26 $m \cdot s^{-1}$, approaches the listener, the recorded frequency is 615 Hz. The car passes the listener at time t_1 and then moves away from the listener. The recorded frequency now is 526 Hz.

Ignore the effects of wind.

6.1 State the Doppler effect in words. (2)

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

6.3 Calculate the wavelength of the sound emitted by the police siren. (4)

6.4 Sketch the graph of recorded frequency versus time for the motion of the car as it moved towards the listener, passed the listener and then moved away from the listener.

Label time t_1 on the graph.

No values need to be indicated on the frequency axis. (3)
[14]

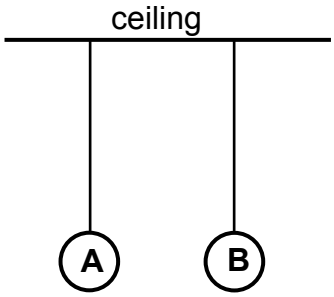
QUESTION 7 (Start on a new page.)

7.1 X is a point 0,025 m away from a +4 nC point charge. See the diagram below.

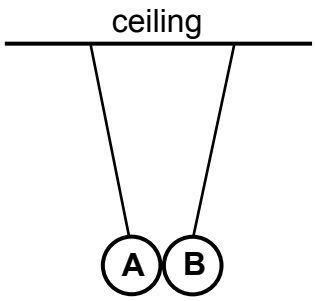
7.1.1 Draw the electric field pattern due to the +4 nC charge. (2)

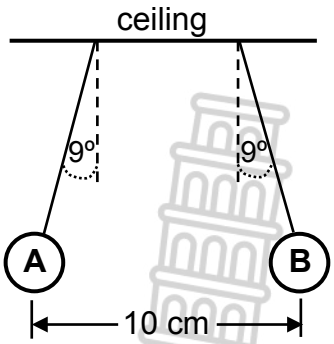
7.1.2 Calculate the magnitude of the electric field at point X. (3)

7.2 Two identical neutral polystyrene balls **A** and **B** are suspended from a ceiling by insulated, light inextensible strings of equal length, as shown in the diagram below.



Ball **B** is then given an initial negative charge, Q_B, of unknown magnitude. The balls attract each other, touch and then repel each other. The balls come to rest with their centres 10 cm apart so that each string makes an angle of 9º with the vertical. See the diagrams below.





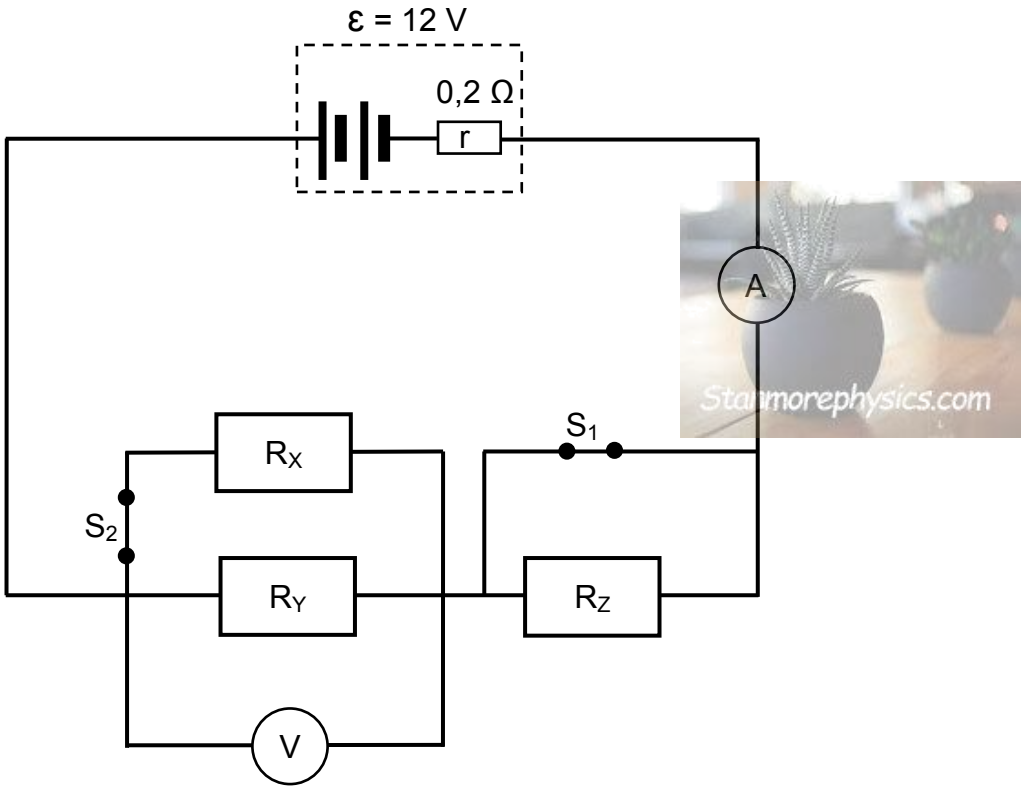
7.2.1 State Coulomb's Law in words. (2)

7.2.2 Calculate the magnitude of the initial charge Q_B given to ball **B** if the mass of each ball was 0,012 kg. (6)

[13]

QUESTION 8 (Start on a new page.)

A battery of emf 12 V and internal resistance 0,2 Ω is connected to three resistors, a high-resistance voltmeter and two switches, an ammeter and connecting wires of negligible resistance, as shown in the circuit diagram below. The three resistors have different and unknown resistances.



The resistance of R_Y is TWICE the resistance of R_X.

When both switches are CLOSED, the reading on the ammeter is 5,5 A.

8.1 Give a reason why there is no current through resistor R_Z. (1)

8.2 Calculate the resistance of resistor R_Y. (5)

8.3 Calculate the power dissipated by resistor R_X. (4)

When both switches are now OPENED, the reading on the ammeter is 1,3 A.

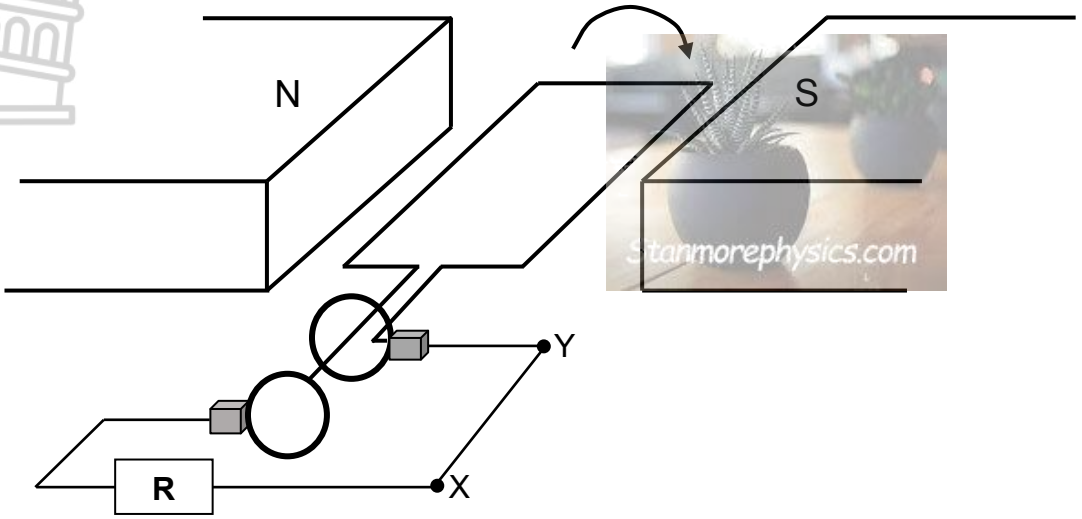
8.4 Calculate the reading on the voltmeter. (3)

Switch S_1 remains OPEN while switch S_2 is now CLOSED.

8.5 Calculate the reading on the ammeter. (6)
[19]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an AC generator with a coil rotating clockwise. X and Y are two points in the external circuit.



9.1 What is the direction of the current in the external circuit? Write either X to Y or Y to X. (2)

9.2 State the energy conversion that takes place in this generator. (1)

The maximum voltage produced by the generator is 125 V.

9.3 Define the term *root mean square voltage*. (2)

9.4 Calculate the root mean square voltage of the generator. (3)

9.5 The total resistance in the external circuit is 42,4 Ω.

Calculate the maximum current induced. (3)

9.6 The generator induced current at a frequency of 20 Hz. The coil started rotating from the initial position, as shown in the diagram above.

Sketch a graph of induced current versus time for two complete rotations of the coil.

Indicate the following on the graph:

- The time taken for two rotations
- The maximum current induced by the generator (4)

[15]

QUESTION 10 (Start on a new page.)

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

10.2 Light of wavelength 4,7 x 10^{-7} m is shone onto the surface of a piece of caesium metal. If the threshold frequency of caesium is 4,37 x 10^{14} Hz, calculate the maximum speed of an electron ejected from the surface of the metal. (5)

10.3 A simple electroscope consists of a zinc disc, a metal stem and a thin length of gold foil. When the electroscope is neutral, the foil hangs vertically, as shown in DIAGRAM 1 below. When the electroscope is negatively charged, the foil is repelled from the stem, as shown in DIAGRAM 2 below.

Neutral electroscope

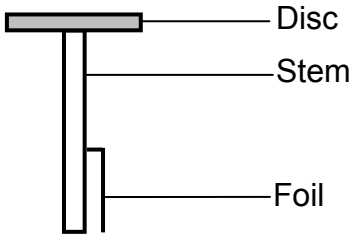


DIAGRAM 1

Negatively charged electroscope

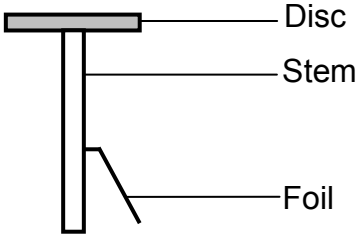


DIAGRAM 2

When ultraviolet light is shone on the disc of the negatively charged zinc electroscope, the foil collapses towards the stem (hangs vertically).

10.3.1 How does the frequency of the ultraviolet light compare to the threshold frequency of zinc? Write only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

10.3.2 Explain why the foil of the electroscope collapses. (3)

Green light is now shone on another negatively charged zinc electroscope. The foil does not collapse.

10.3.3 Will the foil collapse if the intensity of the green light is increased? Write either YES or NO. Give a reason for the answer. (2)

[13]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_p = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta K = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

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

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

MAY/JUNE/*MEI/JUNIE* 2024

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages.
Hierdie nasienriglyne bestaan uit 19 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (2)

1.6 A ✓✓ (2)

1.7 A ✓✓ (2)

1.8 C ✓✓ (2)

1.9 A ✓✓ (2)

1.10 C ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

2.1

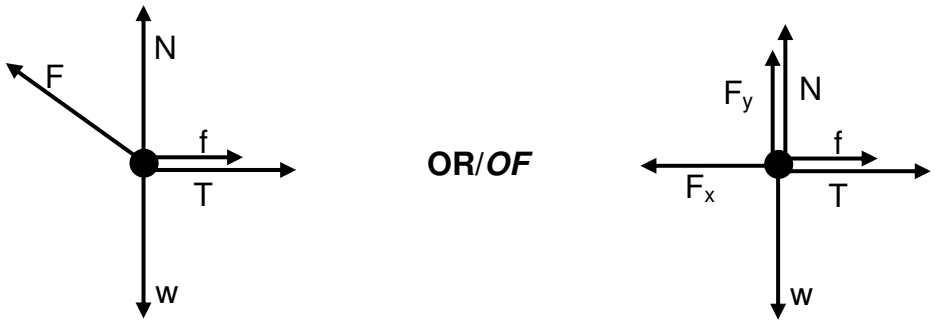
Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

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

2.2



Accepted labels/*Aanvaarde benoemings:*	
w	F_g/F_w/40,18 N/mg/weight/gravitational force/*gewig*/*gravitasiekrag*
T	F_T/tension/*spanning*/F_{string}/*F_{tou}*
f	(kinetic) friction/F_f/f_k/*(kinetiese) wrywing*
N	F_N/Normal/F_{normal} /*$F_{normaal}$*/*Normaal*
F	F_{app}/*F_{toeg}*/49 N

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.*
- Any other additional force(s)./*Enige ander addisionele krag(te):* Max/*Maks* $^4/_5$
- If everything is correct, but no arrows./*Indien alles korrek, maar geen pyltjies nie*: Max/*Maks* $^4/_5$
- If force(s) do not make contact with the dot./*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks* $^4/_5$

(5)

2.3.1

$f_k = \mu_k F_N$
$f_k = \mu_k(F_g - F_y)$
$f_k = \mu_k(mg - F\sin\theta)$
✓ Any one/ *Enige een*

$= \underline{(0,35)[(4,1)(9,8) - 49\sin50°]}$ ✓
$= 0,93$ N ✓ (0,925 N)

(3)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.3.1./**
POSITIEWE NASIEN VANAF VRAAG 2.3.1.

For A/*Vir A*:
LEFT AS POSITIVE/
LINKS AS POSITIEF

$F_{net} = ma$
$F_x - T - f = ma$
$F\cos\theta - T - \mu_k F_N = ma$
✓ Any one/ *Enige een*

$\underline{49\cos50° - T - 0,93}$ ✓ $= \underline{(4,1)a}$
$T = 30,57 - 4,1a$ ... equation 1

For B/*Vir B*:
UPWARDS AS POSITIVE/
OPWAARTDS AS POSITIEF

$F_{net} = ma$
$T - F_g = ma$
$\underline{T - (2,3)(9,8)}$ ✓$= \underline{(2,3)a}$
$T = 2,3a + 22,54$... equation 2

✓ Any one/ *Enige een*

$30,57 - 4,1a = 2,3a + 22,54$
$a = 1,25\ m\cdot s^{-2}$ ✓

For A/*Vir A*:
RIGHT AS POSITIVE/
REGS AS POSITIEF

$F_{net} = ma$
$-F_x + T + f = ma$
$-F\cos\theta + T + \mu_k F_N = ma$
✓ Any one/ *Enige een*

$\underline{-49\cos50° + T + 0,93}$ ✓ $= \underline{(4,1)a}$
$T = 30,57 + 4,1a$ ... equation 1

For B/*Vir B*:
DOWNWARDS AS POSITIVE/
AFWAARTDS AS POSITIEF

$F_{net} = ma$
$F_g - T = ma$
$\underline{(2,3)(9,8) - T}$ ✓$= \underline{(2,3)a}$
$T = 22,54 - 2,3a$... equation 2

✓ Any one/ *Enige een*

$30,57 + 4,1a = 22,54 - 2,3a$
$a = -1,25\ m\cdot s^{-2}$
$a = 1,25\ m\cdot s^{-2}$ ✓

(5)
[15]

QUESTION 3/*VRAAG 3*

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

Motion under the influence of gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasiekrag/ swaartekrag.
OR/*OF*
Motion in which the only force acting is gravitational force.
Beweging waar die enigste krag wat inwerk, gravitasiekrag/swaartekrag is.

(2)

NOTE: if projectile is defined 0/2
NOTA: indien projektiel gedefinieer is 0/2

3.2. NO/*NEE* ✓ (1)

3.3.1

Marking criteria/*Nasienkriteria:*
- Formula with Δt./*Formule met Δt* ✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Final answer/*Finale antwoord*: 1,44 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-15 = -3,4\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓	$15 = 3,4\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 1,44$ s ✓	$\Delta t = 1,44$ s ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-3,4)^2 + 2(-9,8)(-15)$	$v_f^2 = (3,4)^2 + 2(9,8)(15)$
$v_f = -17,48$ m·s^{-1}	$v_f = 17,48$ m·s^{-1}
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-17,48 = -3,4 + (-9,8)\Delta t$ ✓	$17,48 = 3,4 + (9,8)\Delta t$ ✓
$\Delta t = 1,44$ s ✓	$\Delta t = 1,44$ s ✓

OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-3,4)^2 + 2(-9,8)(-15)$	$v_f^2 = (3,4)^2 + 2(9,8)(15)$
$v_f = -17,48$ m·s^{-1}	$v_f = 17,48$ m·s^{-1}
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15 = \left(\frac{-3,4 - 17,48}{2}\right)\Delta t$ ✓	$15 = \left(\frac{3,4 + 17,48}{2}\right)\Delta t$ ✓
$\Delta t = 1,44$ s ✓	$\Delta t = 1,44$ s ✓

(3)

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

Marking criteria/*Nasienkriteria:*
- Correct formula to calculate Δy./Korrekte *formule om Δy te bereken.*✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Subtraction of displacement from initial height./*Aftrekking van verplasing van oorspronklike hoogte.* ✓
- Final answer/*Finale antwoord*: 10,1 m ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$\Delta y = \underline{-3,4(1,44)} + \frac{1}{2}(0)(1,44)^2$ ✓	$\Delta y = \underline{3,4(1,44)} + \frac{1}{2}(0)(1,44)^2$ ✓
$\Delta y = -4,896$ m	$\Delta y = 4,896$ m
Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓	Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$\Delta y = \boxed{\left(\frac{-3,4 - 3,4}{2}\right)(1,44)}$ ✓	$\Delta y = \boxed{\left(\frac{3,4 + 3,4}{2}\right)(1,44)}$ ✓
$\Delta y = -4,896$ m	$\Delta y = 4,896$ m
Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓	Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓

OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$v = \frac{\Delta y}{\Delta t}$ ✓	$v = \frac{\Delta y}{\Delta t}$ ✓
$\boxed{-3,4 = \frac{\Delta y}{1,44}}$ ✓	$\boxed{3,4 = \frac{\Delta y}{1,44}}$ ✓
$\Delta y = -4,896$ m	$\Delta y = 4,896$ m
Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓	Height = $\underline{15 - 4,896}$ ✓ = 10,1 m ✓

(4)

3.4 **POSITIVE MARKING FROM Q 3.3.1./*POSITIEWE NASIEN VANAF VR 3.3.1.***

Marking citeria/*Nasienkriteria:*
- Correct formula to calculate Δt./*Korrekte formule om Δt te bereken.* ✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Addition of three time values./*Bymekaartel van drie tydwaardes.* ✓
- Final answer/*Finale antwoord*: 2,37 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS +/*OPWAARTS AS +*

$v_f = v_i + a\Delta t$ ✓

$0 = \underline{7,2 + (-9,8)\Delta t}$ ✓

$\Delta t = 0,73$ s

DOWNWARDS AS +/*AFWAARTS AS +*

$v_f = v_i + a\Delta t$ ✓

$0 = \underline{-7,2 + (9,8)\Delta t}$ ✓

$\Delta t = 0,73$ s

Note/*Aantekening*: Accept for all options if v_i and v_f are swapped./*Aanvaar vir alle opsies indien v_i en v_f omgeruil is.*

OPTION 2/*OPSIE 2*

UPWARDS AS +/*OPWAARTS AS +*

$v_f = v_i + a\Delta t$ ✓

$-7,2 = \underline{7,2 + (-9,8)\Delta t}$ ✓

$\Delta t = 1,47$ s

Time to max height/*Tyd tot maks hoogte* $\Delta t = 0,73$ s

DOWNWARDS AS +/*AFWAARTS AS +*

$v_f = v_i + a\Delta t$ ✓

$7,2 = \underline{-7,2 + (9,8)\Delta t}$ ✓

$\Delta t = 1,47$ s

Time to max height/*Tyd tot maks hoogte* $\Delta t = 0,73$ s

OPTION 3/*OPSIE 3*

UPWARDS AS +/*OPWAARTS AS +*

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

$0 = (7,2)^2 + 2(-9,8)\Delta y$

$\Delta y = 2,64$ m

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

$2,64 = \left(\frac{7,2 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 0,73$ s

OR/*OF*

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

$\underline{2,64 = 7,2\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$\Delta t = 0,73$ s

DOWNWARDS AS +/*AFWAARTS AS +*

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

$0 = (-7,2)^2 + 2(9,8)\Delta y$

$\Delta y = -2,64$ m

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

$-2,64 = \left(\frac{-7,2 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 0,73$ s

OR/*OF*

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

$\underline{-2,64 = -7,2\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓

$\Delta t = 0,73$ s

$t_3 = \underline{1,44 + 0,2 + 0,73}$ ✓

$= 2,37$ s ✓

(4)

[14]

QUESTION 4 / *VRAAG 4*

4.1

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

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

(2)

4.2

Marking citeria/*Nasienkriteria:*
- Correct momentum formula/*Korrekte momentumformule.* ✓
- Correct substitution into momentum formula./*Korrekte vervanging in momentum formule.* ✓✓
- Correct substitution into equation of motion/*Korrekte vervanging in bewegingsvergelyking.* ✓
- Final correct answer/*Finale korrekte antwoord*: 0,64 m ✓

OPTION 1/*OPSIE 1*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\sum p_i = \sum p_f$ } ✓Any one/*Enige een*
$m_Av_{iA} + m_Bv_{iB} = m_Av_{fA} + m_Bv_{fB}$ }
0 ✓$= \underline{(3,2)(-0,4) + (2,6)v_f}$ ✓
$\therefore v_f = 0,49\ m\cdot s^{-1}$

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\sum p_i = \sum p_f$ } ✓Any one/*Enige een*
$m_Av_{iA} + m_Bv_{iB} = m_Av_{fA} + m_Bv_{fB}$ }
0 ✓$= \underline{(3,2)(0,4) + (2,6)v_f}$ ✓
$\therefore v_f = -0,49\ m\cdot s^{-1}$

OPTION 2/*OPSIE 2*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\Delta p_A = -\Delta p_B$ } ✓Any one/*Enige een*
$m(v_{Af} - v_{Ai}) = -m(v_{Bf} - v_{Bi})$ }
$\underline{3,2(-0,4 - 0)}$ ✓$= \underline{-2,6(v_{Bf} - 0)}$ ✓
$\therefore v = 0,49\ m\cdot s^{-1}$

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\Delta p_A = -\Delta p_B$ } ✓Any one/*Enige een*
$m(v_{Af} - v_{Ai}) = -m(v_{Bf} - v_{Bi})$ }
$\underline{3,2(0,4 - 0)}$ ✓$= \underline{-2,6(v_{Bf} - 0)}$ ✓
$\therefore v = -0,49\ m\cdot s^{-1}$

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$v = \frac{\Delta x}{\Delta t}$

$0,49 = \frac{\Delta x}{1,3}$ ✓

$\Delta x_B = 0,64$ m ✓

OR/*OF*

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

$= \left(\frac{0,49 + 0,49}{2}\right)1,3$ ✓

$\Delta x_B = 0,64$ m ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$v = \frac{\Delta x}{\Delta t}$

$-0,49 = \frac{\Delta x}{1,3}$ ✓

$\Delta x_B = -0,64$ m ✓

OR/*OF*

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

$= \left(\frac{-0,49 - 0,49}{2}\right)1,3$ ✓

$\Delta x_B = -0,64$ m ✓

(5)

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

OPTION 1/*OPSIE 1*	
RIGHT AS POSITIVE/ ***REGS AS POSITIEF:*** **For A/*Vir A:*** $F_{net}\Delta t = \Delta p$ / $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $(-4,2)\Delta t = 3,2(-0,4 - 0)$ ✓ $\Delta t = 0,3$ s ✓	**LEFT AS POSITIVE/** ***LINKS AS POSITIEF:*** **For A/*Vir A:*** $F_{net}\Delta t = \Delta p$ / $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $(4,2)\Delta t = 3,2(0,4 - 0)$ ✓ $\Delta t = 0,3$ s ✓
OPTION 2/*OPSIE 2*	
RIGHT AS POSITIVE/ ***REGS AS POSITIEF:*** **For B/*Vir B:*** $F_{net}\Delta t = \Delta p$ / $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $(4,2)\Delta t = 2,6(0,49 - 0)$ ✓ $\Delta t = 0,3$ s ✓	**LEFT AS POSITIVE/** ***LINKS AS POSITIEF:*** **For B/*Vir B:*** $F_{net}\Delta t = \Delta p$ / $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $(-4,2)\Delta t = 2,6(-0,49 - 0)$ ✓ $\Delta t = 0,3$ s ✓

(3)

4.4 LESS THAN✓
Final momentum/change in momentum remains constant. ✓
If mass/inertia increases, velocity decreases.✓

KLEINER AS
Finale momentum/verandering in momentum bly konstant.
Indien massa/traagheid toeneem, sal snelheid afneem. (3)
[13]

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.*

The total mechanical energy/sum of the gravitational potential energy and kinetic energy/sum of E_p and E_k in an isolated system remains constant. ✓✓
Die totale meganiese energie/som van die gravitasie potensiële energie en kinetiese energie/som van E_p en E_k in 'n geïsoleerde sisteem bly konstant. (2)

5.2

OPTION 1/*OPSIE 1*

$(E_{mech})_{A/Top/Bo} = (E_{mech})_{B/Bottom/Onder}$
$(E_P + E_K)_{A/Top/Bo} = (E_P + E_K)_{B/Bottom/Onder}$
$(mgh + ½mv^2)_{A/Top/Bo} = (mgh + ½mv^2)_{B/Bottom/Onder}$ } ✓ Any one/E*nige een*
$\underline{(18)(9,8)(3) + 0 = 0 + (½)(18)v^2}$ ✓
$v = 7,67\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ } ✓ Any one/*Enige een*
$W_{nc} = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$
$\underline{0 = ½(18)(v_f^2 - 0^2) + (18)(9,8)(0 - 3)}$ ✓
$v = 7,67\ m\cdot s^{-1}$ ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta E_k$
$mg\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$ } ✓ Any one/*Enige een*
$(18)(9,8)(3)\cos0° = ½(18)v_f^2 - 0$ ✓
$v = 7,67\ m\cdot s^{-1}$ ✓

(3)

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

(2)

5.4

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

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_k / E_{kf} - E_{ki} / ½mv_f^2 - ½mv_i^2$
$W_f = \Delta E_k / E_{kf} - E_{ki} / ½mv_f^2 - ½mv_i^2$ } ✓ Any one/ *Enige een*
$f\Delta x\cos180° = \Delta E_k / E_{kf} - E_{ki} / ½mv_f^2 - ½mv_i^2$
$\underline{(40,6)\Delta x(-1)}$ ✓ $= \underline{½(18)[(0)^2 - (7,67)^2]}$ ✓
$\Delta x = 13,04\ m$ ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$
$W_{nc} = mg(h_B - h_C) + ½mv_f^2 - ½mv_i^2$
$W_f = \Delta E_p + \Delta E_k$ } ✓ Any one/Enige een
$f\Delta x\cos180° = mg\Delta h + ½mv_f^2 - ½mv_i^2$
$\underline{(40,6)\Delta x(-1)}$ ✓ $= 0 + \underline{½(18)[(0)^2 - (7,67)^2]}$ ✓
$\Delta x = 13,04\ m$ ✓

(4)

5.5 Less than/*Kleiner as* ✓
Mechanical/Gravitational potential energy at A is less/ *Meganiese/Gravitasie potensiële energie by A is minder* ✓
Velocity/speed/Kinetic energy at B/ΔE_k will be less ✓
Snelheid/spoed/Kinetiese energie by B/ΔE_k sal minder wees (3)
[14]

QUESTION 6/*VRAAG 6*

6.1

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

It is the (apparent) 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. ✓
Dit is die verandering in frekwensie/toonhoogte van die klank (waargeneem deur 'n luisteraar) omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting 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)

6.2

MOVING TOWARDS OBSERVER/
BEWEGING NA LUISTERAAR:

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

$615 = \left(\frac{v}{v - 26}\right) f_s$ ✓

$f_s = \frac{615(v - 26)}{v}$ equation 1/*vergelyking 1*

✓ Any one/Enige een

MOVING AWAY FROM OBSERVER/
BEWEGING WEG VAN LUISTERAAR:

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

$526 = \left(\frac{v}{v + 26}\right) f_s$ ✓

$f_s = \frac{526(v + 26)}{v}$ equation 2/*vergelyking 2*

$\frac{615(v - 26)}{v} = \frac{526(v + 26)}{v}$ ✓

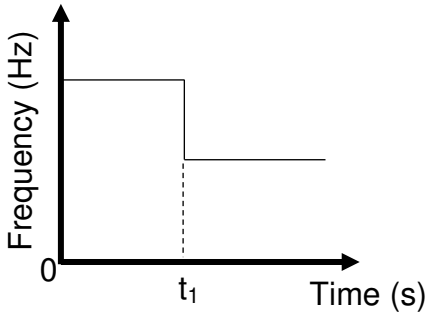
$v = 333{,}33 \text{ m·s}^{-1}$ ✓ (5)

6.3

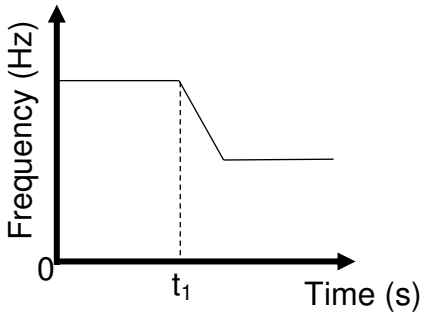
POSITIVE MARKING FROM QUESTION 6.2. *POSITIEWE NASIEN VANAF VRAAG 6.2.*	
Substitution into equation 1/ ***Vervanging in vergelyking 1***	**Substitution into equation 2/** ***Vervanging in vergelyking 2***
$f_s = \frac{615(333,33 - 26)}{333,33}$ ✓ **OR/*OF***	$f_s = \frac{526(333,33 + 26)}{333,33}$ ✓
$f_s = 567,03$ Hz	$f_s = 567,03$ Hz
$v = f\lambda$ ✓ $333,33 = 567,03\lambda$ ✓ $\lambda = 0,59$ m ✓	

(4)

6.4



OR/*OF*

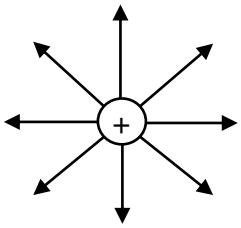


Criteria for graph/*Kriteria vir grafiek:*	
The lines before and after t_1 are horisontal./ *Die lyne voor en na t_1 is horisontaal.*	✓
The frequency after t_1 is less than before t_1./Die f*rekwensie na t_1 is kleiner as voor t_1.*	✓
Time t_1 correctly indicated./*Tyd t_1 word korrek aangedui.*	✓

(3)
[14]

QUESTION 7/VRAAG 7

7.1.1



Criteria for sketch/*Kriteria vir skets:*	
Correct shape./*Korrekte vorm.*	✓
Correct direction away from the charge./*Korrekte rigting weg van die lading.*	✓
Notes/*Aantekeninge:* If electric field lines cross or touch/*Indien elektriese veldlyne kruis of raak*: Max/*Maks* $^1/_2$	

(2)

7.1.2 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9 \times 10^{9})(4 \times 10^{-9})}{(0{,}025)^2}$ ✓

$= 5{,}76 \times 10^{4}\ N{\cdot}C^{-1}$ ✓ $(57\ 600\ N{\cdot}C^{-1})$ (3)

7.2.1

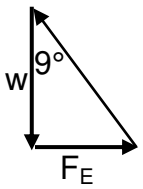
Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

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)

7.2.2

$F_E = w(\tan\theta)$
$F_E = mg(\tan\theta)$
$F_E = \frac{w}{\tan(90° - \theta)}$
✓ Any one/ Enige een



$F_E = (0{,}012)(9{,}8)(\tan 9°)$ ✓
$= 0{,}0186\ N$

$F = \frac{kQ_AQ_B}{r^2}$ ✓

$0{,}0186 = \frac{(9 \times 10^{9})(Q^2)}{0{,}1^2}$ ✓

$Q = 1{,}44 \times 10^{-7}\ C$
$Q_B = 2 \times 1{,}44 \times 10^{-7}$ ✓
$= 2{,}88 \times 10^{-7}\ C$ ✓ (range: $2{,}88 \times 10^{-7} - 2{,}98 \times 10^{-7}$) (6)

[13]

QUESTION 8/*VRAAG 8*

8.1 The resistor/R_Z is short circuited./*Die resistor/R_z word gekortsluit.* ✓

OR/*OF*

Current follows the path of least resistance./*Stroom volg die pad van minste weerstand.*

OR/*OF*

Branch with switch has no resistance./*Tak met skakelaar het geen weerstand nie.*

OR/*OF*

Total current will flow through branch with S_1./*Totale stroom vloei deur die tak met S_1.*

(1)

8.2

OPTION 1/*OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_X} + \frac{1}{R_Y}$ ✓

$\frac{1}{R_p} = \left[\frac{1}{R} + \frac{1}{2R}\right]$ ✓ ($R_X = R$)

$R_p = 0,67R$

OR/*OF*

$R_p = \frac{R_X R_Y}{R_X + R_Y}$ ✓

$R_p = \left[\frac{(R)(2R)}{R + 2R}\right]$ ✓ ($R_X = R$)

$R_p = 0,67R$

$\varepsilon = I(R + r)$ ✓

$12 = 5,5(0,67R + 0,2)$ ✓

$R = 2,96\ \Omega$

$R_Y = 2(2,96)$

$= 5,92\ \Omega$ ✓ (range 5,92 Ω – 5,95 Ω)

OPTION 2/*OPSIE 2*

$\varepsilon = I(R + r)$ ✓

$12 = 5,5(R + 0,2)$ ✓

$R = 1,98\ \Omega$

$\frac{1}{R_p} = \frac{1}{R_X} + \frac{1}{R_Y}$ ✓

$\frac{1}{1,98} = \left[\frac{1}{R} + \frac{1}{2R}\right]$ ✓ ($R_X = R$)

$R = 2,97\ \Omega$

$R_Y = 2(2,97)$

$= 5,94\ \Omega$ ✓(range 5,92 – 5,95)

OR/*OF*

$R_p = \frac{R_X R_Y}{R_X + R_Y}$ ✓

$1,98 = \left[\frac{(R)(2R)}{R + 2R}\right]$ ✓ ($R_X = R$)

$R = 2,97\ \Omega$

$R_Y = 2(2,97)$

$= 5,94\ \Omega$ ✓

(range 5,92 – 5,95)

OPTION 3/*OPSIE 3*

$\varepsilon = I(R + r)$
$\varepsilon = V_{ext} + Ir$ ✓ Any one/ *Enige een*
$12 = V_{ext} + 5,5(0,2)$ ✓
$V_{ext} = 10,9$ V

$\frac{1}{R_p} = \frac{1}{R_X} + \frac{1}{R_Y}$ ✓

$\frac{1}{R_p} = \left(\frac{1}{R} + \frac{1}{2R}\right)$ ✓ $(R_X = R)$
$R_p = 0,67R$

$R_p = \frac{V_p}{I_T}$
$0,67R = \frac{10,9}{5,5}$
$R = 2,96\ \Omega$
$R_Y = 2(2,96)$
$= 5,92\ \Omega$ ✓(range 5,92 – 5,95)

OR/*OF*

$R_p = \frac{V_p}{I_T}$
$= \frac{10,9}{5,5}$
$= 1,98\ \Omega$
$\frac{1}{R_p} = \frac{1}{R_X} + \frac{1}{R_Y}$ ✓
$\frac{1}{1,98} = \left(\frac{1}{R} + \frac{1}{2R}\right)$ ✓ $(R_X = R)$
$R = 2,97\ \Omega$
$R_Y = 2(2,97)$
$= 5,94\ \Omega$ ✓
(range 5,92 – 5,95)

(5)

8.3 **POSITIVE MARKING FROM QUESTION 8.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.

$V_p = I_T R_p$
$= (5,5)(1,98)$ ✓
$= 10,89$ V

OR/*OF*

$\varepsilon = I(R + r)$
$\varepsilon = V_{ext} + Ir$
$12 = V_{ext} + 5,5(0,2)$ ✓
$V_{ext} = 10,9$ V
$V_p = 10,9$ V

$I_x = \frac{2}{3}(5,5)$ ✓
$= 3,67$ A

OR/*OF*

$I_X = \frac{V_p}{R_X}$
$= \frac{10,9}{2,97}$ ✓
$= 3,67$ A

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$= (3,67)^2(2,97)$ ✓
$= 40$ W ✓

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓
$= \frac{10,9^2}{2,97}$ ✓
$= 40$ W ✓

OPTION 3/*OPSIE 3*

$P = VI$ ✓
$= (10,9)(3,67)$ ✓
$= 40$ W ✓

(4)

8.4 **POSITIVE MARKING FROM QUESTION 8.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.

$V = IR$ ✓

$= 1,3 \times 5,94$ ✓

$= 7,72\ V$ ✓ (3)

8.5 **POSITIVE MARKING FROM QUESTION 8.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.

Marking citeria/*Nasienkriteria:*

Calculation of R_Z/*Berekening van* R_Z:
- Correct formula $\varepsilon = I(R + r)$./*Korrekte formule* $\varepsilon = I(R + r)$. ✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Correct substitution to calculate R_Z./*Korrekte vervanging om* R_Z *te bereken.* ✓

Calculation of I/*Berekening van I*:
- Addition of R_p and R_Z./*Bymekaartel van* R_p *en* R_Z.
- Correct substitution to calculate I./*Korrekte vervanging om I te bereken*.
- Correct final answer/*Korrekte finale antwoord*: (range: 2,26 A – 2,28 A)

S_1 AND S_2 OPEN/*S_1 EN S_2 OOP:*

$\varepsilon = I(R + r)$ ✓

$12 = 1,3(R_T + 0,2)$ ✓

$R_T = 9,03\ \Omega$

$R_T = R_Y + R_z$

$9,03 = 5,95 + R_z$ ✓

$R_z = 3,08\ \Omega$

S_1 OPEN AND S_2 CLOSED/*S_1 OOP EN S_2 GESLUIT:*

$R_p = 0,67R$ $= (0,67)(2,97)$ $= 1,98\ \Omega$	$\varepsilon = I(R + r)$ $12 = 5,5(R + 0,2)$ $R_p = 1,98\ \Omega$	$\frac{1}{R_p} = \frac{1}{R_X} + \frac{1}{R_Y}$ $\frac{1}{R_p} = \frac{1}{2,97} + \frac{1}{5,94}$ $R_p = 1,98\ \Omega$	$R_p = \frac{R_X R_Y}{R_X + R_Y}$ $R_p = \frac{(2,97)(5,94)}{2,97 + 5,94}$ $R_p = 1,98\ \Omega$

✓

$R_T = 1,98 + 3,08$

$R_T = 5,06\ \Omega$

$\varepsilon = I(R + r)$ $12 = I(5,06 + 0,2)$ ✓ $I = 2,28\ A$ ✓	$R = \frac{V}{I}$ $5,26 = \frac{12}{I}$ ✓ $I = 2,28\ A$ ✓

(6)

[19]

QUESTION 9/*VRAAG 9*

9.1 Y to/*na X* ✓✓ (2)

9.2 Mechanical/Kinetic to electrical energy.✓
Meganiese/Kineties na elektriese energie. (1)

9.3

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 rms potential difference is the alternating current potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference.✓✓
Die wgk-potensiaalverskil is die wisselstroom potensiaalverskil wat dieselfde hoeveelheid energie verbruik/vervaardig as die ekwivalente GS-potensiaalverskil. (2)

9.4
$$V_{rms} = \frac{V_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{125}{\sqrt{2}} \checkmark$$
$$= 88{,}39 \text{ V} \checkmark$$ (3)

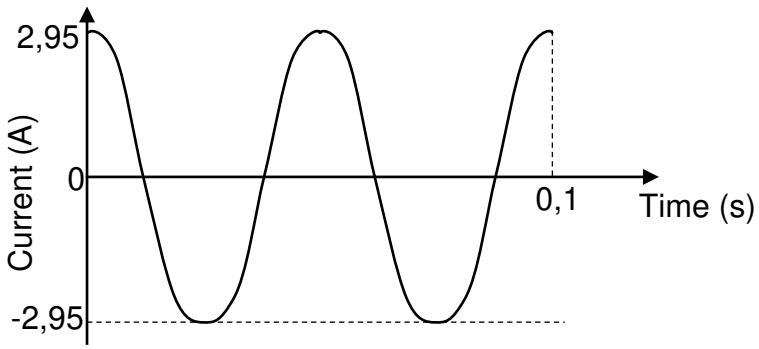
9.5

OPTION 1/*OPSIE 1*
$$I_{max} = \frac{V_{max}}{R} \checkmark$$
$$= \frac{125}{42{,}4} \checkmark$$
$$= 2{,}95 \text{ A} \checkmark$$

OPTION 2/*OPSIE 2*
$$I_{rms} = \frac{V_{rms}}{R}$$
$$= \frac{88{,}39}{42{,}4}$$
$$= 2{,}08 \text{ A}$$
$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \checkmark$$
$$2{,}08 = \frac{I_{max}}{\sqrt{2}} \checkmark$$
$$I_{max} = 2{,}94 \text{ A} \checkmark$$

Notes/*Aantekeninge:*
Do not deduct a mark if subscripts are ommited from V = IR formula./*Moenie penaliseer indien onderskrifte uitgelaat is uit die formule V = IR nie.* (3)

9.6



Criteria for graph/*Kriteria vir grafiek*	
Two complete cycles indicated./*Twee volledige siklusse aangedui.*	✓
Graph stops at 0,1 s **OR** one cycle in 0,05 s./ *Grafiek stop by 0,1 s **OF** een siklus in 0,05 s*	✓
Maximum current (2,95 A) correctly indicated./ *Maksimum stroom (2,95 A) korrek aangedui.*	✓
Correct shape (cosine graph)./Korrekte vorm (cosinus grafiek)	✓

(4)
[15]

QUESTION 10/*VRAAG 10*

10.1

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 process whereby electrons are ejected from a (metal) surface when light of suitable frequency is incident on that surface. ✓✓
Die proses waartydens elektrone vrygestel word vanaf 'n (metaal) oppervlak wanneer lig van geskikte frekwensie invallend is op die oppervlak.

(2)

10.2

OPTION 1/*OPSIE 1*

$$E = W_0 + K_{max}$$
$$\frac{hc}{\lambda} = hf_0 + \frac{1}{2}mv_{max}^2$$
✓ Any one/ Enige een

$$\frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{4,7 \times 10^{-7}} \checkmark = (6,63 \times 10^{-34})(4,37 \times 10^{14}) \checkmark + \tfrac{1}{2}(9,11 \times 10^{-31})v_{max}^2 \checkmark$$

$$v_{max} = 5,41 \times 10^{5}\ m \cdot s^{-1} \checkmark \quad (541\,292,69\ m \cdot s^{-1})$$

OPTION 2/*OPSIE 2*

$$c = f\lambda$$
$$3 \times 10^{8} = f\,(4,7 \times 10^{-7})$$
$$f = 6,38 \times 10^{14}\ Hz$$

$$E = W_0 + K_{max}$$
$$hf = hf_0 + \frac{1}{2}mv_{max}^2$$
✓ Any one/ Enige een

$$(6,63 \times 10^{-34})(6,38 \times 10^{14}) \checkmark = (6,63 \times 10^{-34})(4,37 \times 10^{14}) \checkmark + \tfrac{1}{2}(9,11 \times 10^{-31})v_{max}^2 \checkmark$$

$$v_{max} = 5,41 \times 10^{5}\ m \cdot s^{-1} \checkmark \quad (541\,292,69\ m \cdot s^{-1})$$

(5)

10.3.1 Higher than/*Hoër as* ✓ (1)

10.3.2
- Photons of (UV light) eject electrons (from the disc/Zn). ✓
- The negative charge on the electroscope decreases/becomes zero✓
- The electrostatic/repulsive force on the foil decreases/becomes zero. ✓
- *Fotone van (UV lig) stel elektrone vry (vanaf die skyf/Zn).*
- *Die negatiewe lading op die elektroskoop verlaag/word nul*
- *Die elektrostatiese/afstotende krag op die foelie verlaag/word nul.*

(3)

10.3.3 No/*Nee* ✓
Photons will still have the same energy **OR** increasing the intensity does not increase the energy of the photon(s) ✓
*Fotone sal nog steeds dieselfde enegie besit **OF** verhoging van intensiteit verhoog nie die energie van die foton(e) nie.*

(2)
[13]

TOTAL/*TOTAAL*: 150