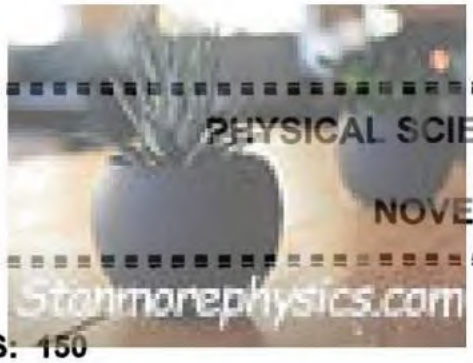
basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12



PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2023

MARKS: 150

TIME: 3 hours

This question paper consists of 19 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

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

The block will move with a ...

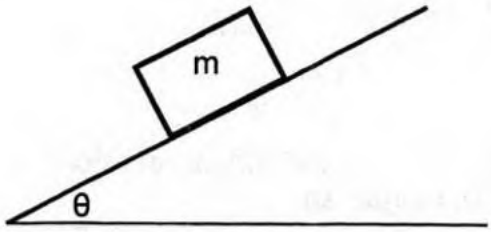
A constant velocity.

B constant acceleration.

C constantly increasing acceleration.

D constantly decreasing acceleration. (2)

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



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

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

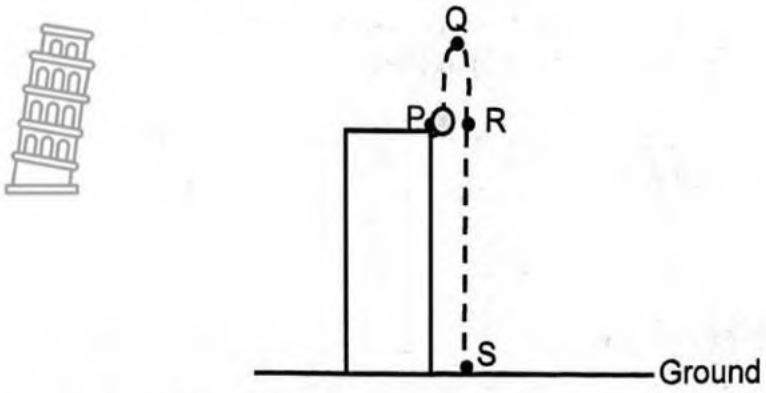
A equal to the component of the weight of the crate which is parallel to the plane.

B larger than the component of the weight of the crate which is parallel to the plane.

C equal to the component of the weight of the crate which is perpendicular to the plane.

D larger than the component of the weight of the crate which is perpendicular to the plane. (2)

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



Ignore the effects of air friction.

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

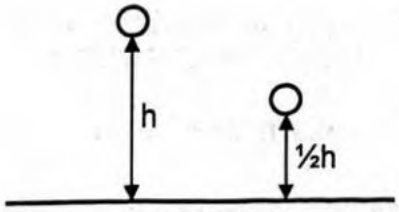
A P and S

B P and R

C R and S

D Q and S (2)

1.4 A ball is dropped from height h and strikes the floor with momentum p. The ball is then dropped from height ½h.



Ignore the effects of air friction.

Which ONE of the following represents the momentum of the ball when it strikes the floor after being dropped from height ½h?

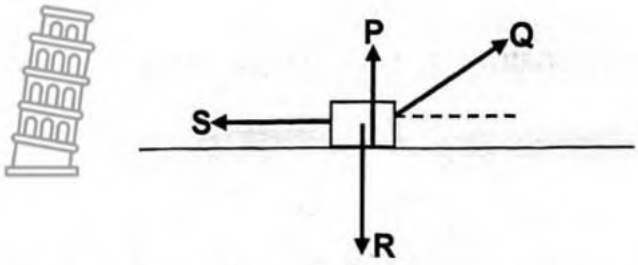
A p

B $\frac{1}{\sqrt{2}}p$

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

D 2p (2)

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



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

A **P** and **R** only

B **Q** and **S** only

C **Q**, **R** and **S** only

D **P**, **Q**, **R** and **S** (2)

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

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

The observed …

A frequency is higher than the emitted frequency.

B wavelength is longer than the emitted wavelength.

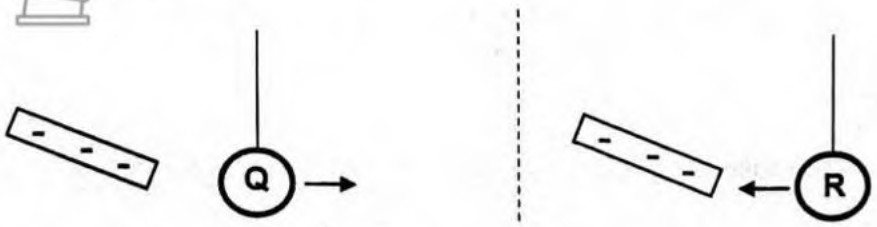
C frequency is lower than the emitted frequency.

D wavelength is equal to the emitted wavelength. (2)

1.7 Refer to the diagram below.

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

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

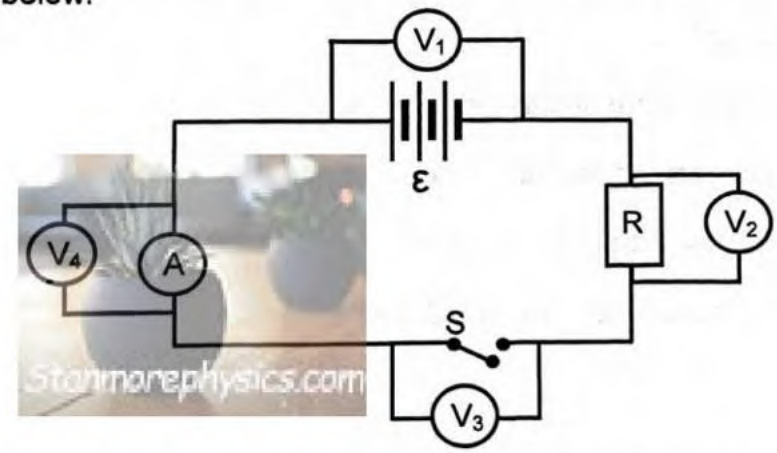


Which ONE of the combinations below can be possible for the nature of the charges on spheres **Q** and **R**?

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

(2)

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



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

A V_2 only

B V_3 only

C V_4 only

D V_2 and V_4

(2)

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

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

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

(2)

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

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

A Planck's constant

B The inverse of Planck's constant

C The energy of the incident photons

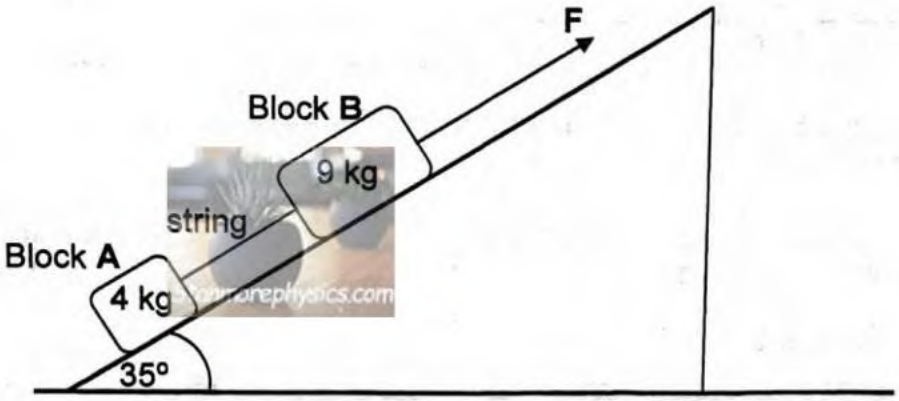
D The maximum kinetic energy of the ejected electrons

(2)
[20]

QUESTION 2 (Start on a new page.)

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

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



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

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

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

2.3 Calculate the magnitude of:

2.3.1 The tension in the string (4)

2.3.2 Force **F** (3)

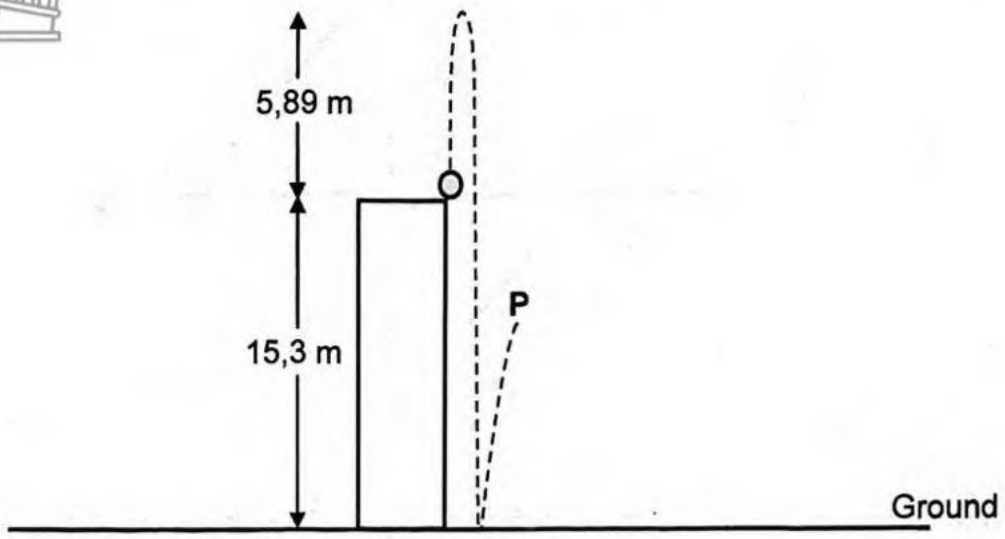
2.4 The angle that the plane makes with the horizontal is now decreased.

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

2.4.2 Explain the answer to QUESTION 2.4.1. (2)
[16]

QUESTION 3 (Start on a new page.)

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



Ignore the effects of air friction.

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

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

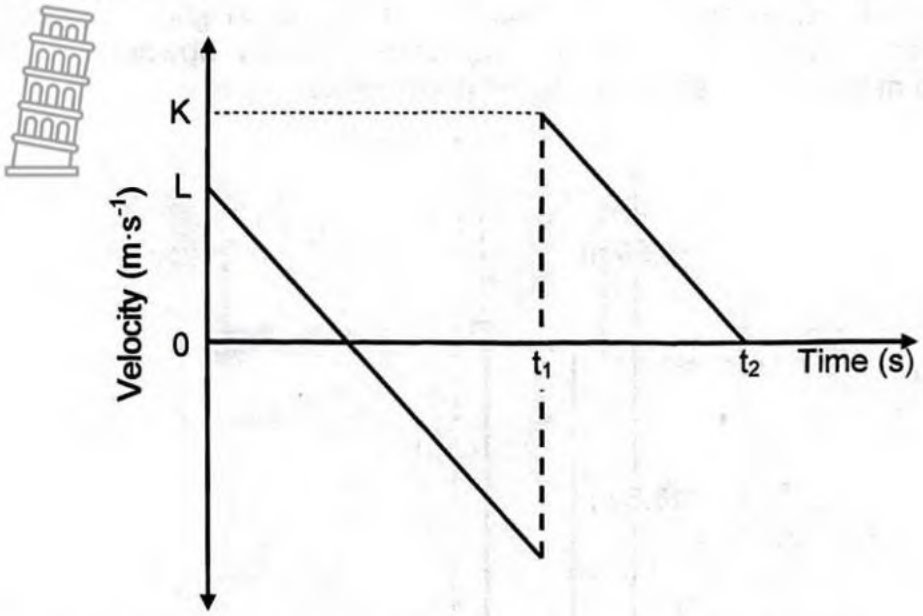
3.3 After the collision with the ground, the ball leaves the ground with a speed of 11,92 $m \cdot s^{-1}$.

Calculate the:

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

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

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



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

3.4.1 K (1)

3.4.2 L (1)

3.4.3 $t_2 - t_1$ (1)

[16]

QUESTION 4 (Start on a new page.)

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

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

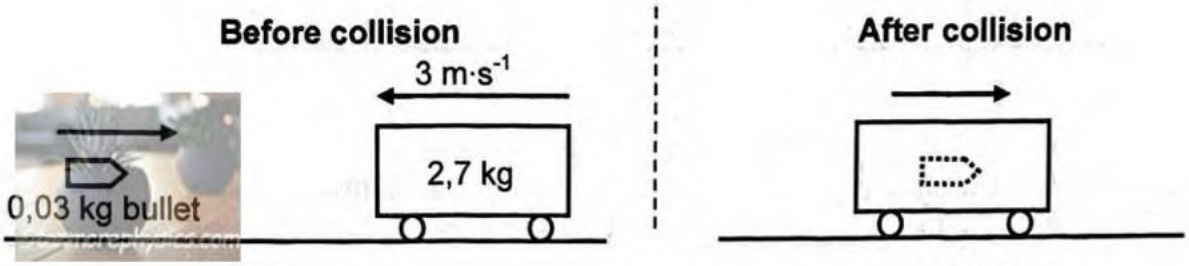


DIAGRAM 1 **DIAGRAM 2**

Ignore all frictional and rotational effects.

4.1 Write down the magnitude and direction of the average net force that the bullet exerts on the trolley. (1)

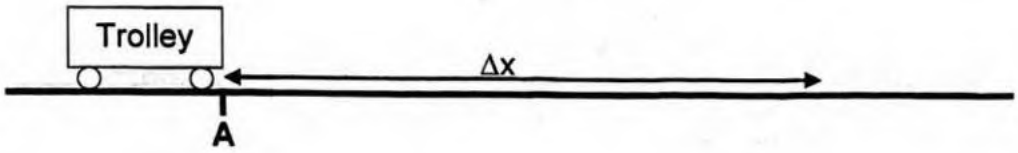
4.2 Calculate the magnitude of the velocity with which the bullet strikes the trolley. (4)

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

4.4 Calculate the magnitude of the velocity of the bullet-trolley combination after the collision. (4)
[11]

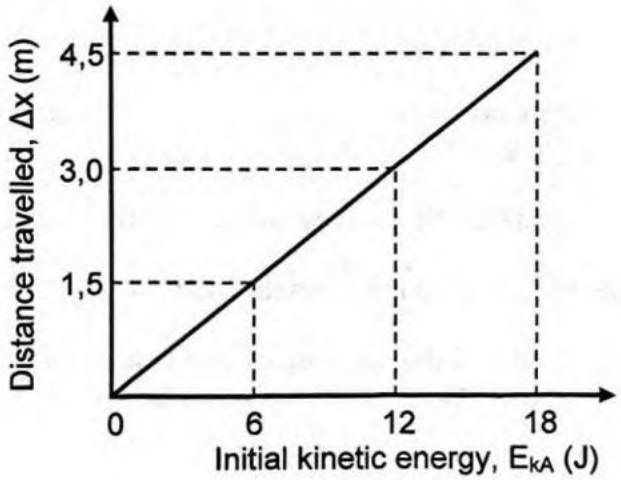
QUESTION 5 (Start on a new page.)

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



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

The results obtained are shown in the graph below.



Ignore the rotational effects of the wheels of the trolley.

5.1 Draw a labelled free-body diagram showing all the forces acting on the trolley during its motion after passing point **A**. (3)

5.2 Name the independent variable in this experiment. (1)

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

5.4 Calculate the mass of the trolley if the coefficient of kinetic friction between the wheels of the trolley and the rough horizontal surface is 0,18. (6)
[12]

QUESTION 6 (Start on a new page.)

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

Ignore the effects of wind.

6.1.1 State the Doppler effect in words. (2)

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

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

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

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

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

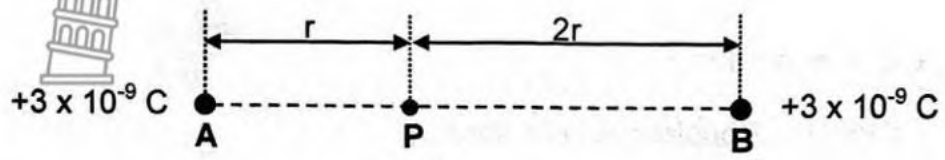
6.2 The spectrum of a distant star when viewed from the Earth is red shifted.

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

6.2.2 Use the Doppler effect to explain the answer to QUESTION 6.2.1. (2)
[13]

QUESTION 7 (Start on a new page.)

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



7.1 Describe an *electric field*. (2)

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

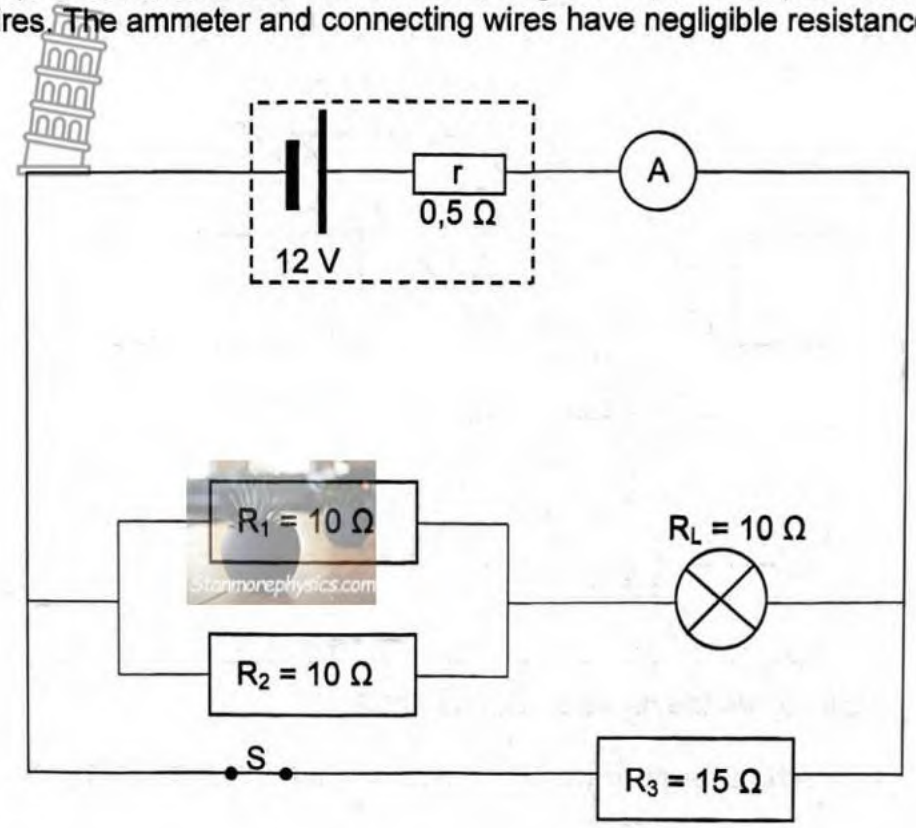
The magnitude of the net electric field at point **P** is 27 N·C^{-1}.

7.3 Calculate the value of r. (5)

7.4 Calculate the magnitude of the net electrostatic force that an electron would experience if placed at point **P**. (3)
[13]

QUESTION 8 (Start on a new page.)

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



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

Switch S is initially CLOSED.

8.2 Calculate the:

8.2.1 Total external resistance of the circuit (5)

8.2.2 Reading on the ammeter (3)

8.2.3 Power dissipated by resistor R_3 (4)

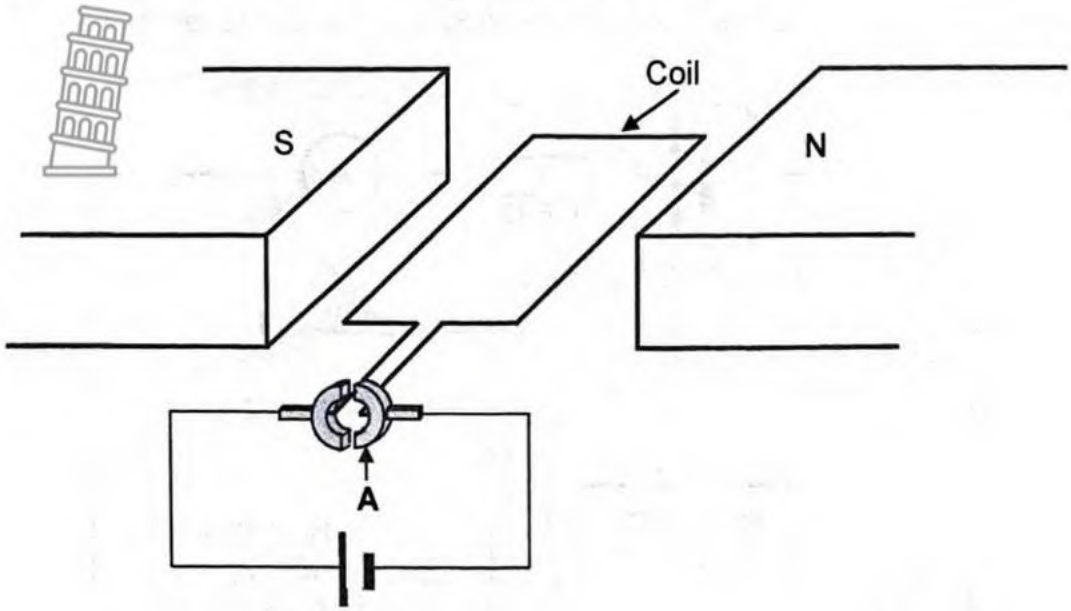
8.3 Switch S is now OPENED.

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

8.3.2 Explain the answer to QUESTION 8.3.1. (3)
[18]

QUESTION 9 (Start on a new page.)

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



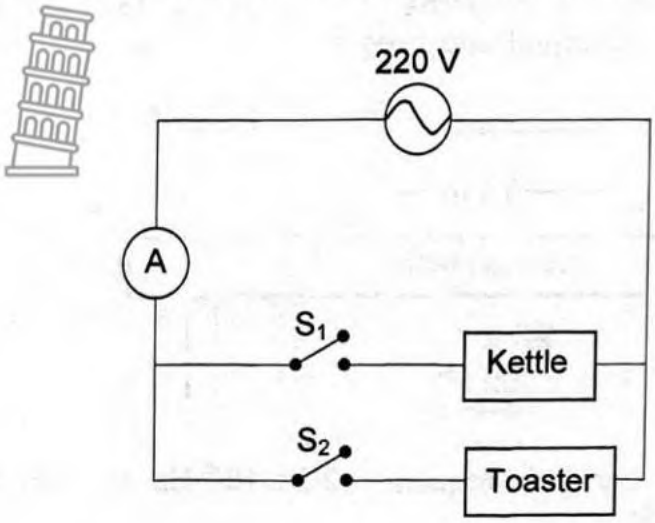
9.1.1 Write down the name of component **A**. (1)

9.1.2 State the energy conversion that takes place in the motor. (1)

9.1.3 In which direction will the coil rotate? Choose from CLOCKWISE or ANTICLOCKWISE. (2)

9.1.4 State TWO changes that can be made to the motor for the coil to rotate faster. (2)

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



9.2.1 Define the term *root mean square current*. (2)

9.2.2 When switch S_1 is CLOSED and switch S_2 is OPEN, the maximum current through the circuit is 3,6 A.

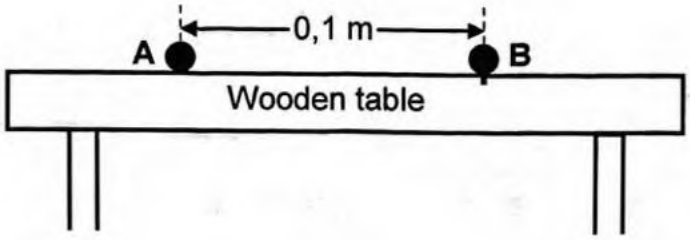
Calculate the root mean square current in the circuit. (3)

9.2.3 When switch S_1 is OPEN and switch S_2 is CLOSED, the root mean square current in the circuit is 2,62 A.

Calculate the energy consumed by the toaster in two minutes. (3)
[14]

QUESTION 10 (Start on a new page.)

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



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

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

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

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

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

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

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

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

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

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

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

DIAGRAM A

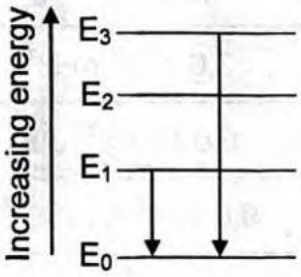
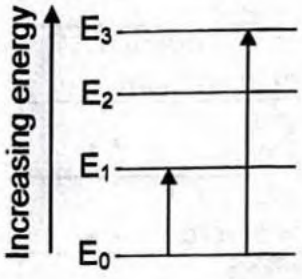


DIAGRAM B



(2)
[17]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR 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	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9\ N\cdot m^2\cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

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

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

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

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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 2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 24 pages.
Hierdie nasienriglyne bestaan uit 24 bladsye.

QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	A ✓✓	(2)
1.3	D ✓✓	(2)
1.4	B✓✓	(2)
1.5	B ✓✓	(2)
1.6	A ✓✓	(2)
1.7	D ✓✓	(2)
1.8	B ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)

[20]

QUESTION 2/*VRAAG 2*

2.1

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

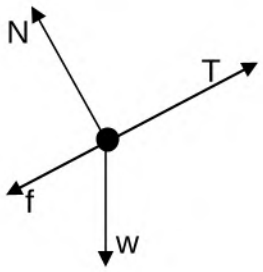
When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp 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.

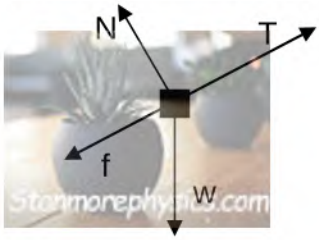
OR/*OF*
The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. (2 or 0)
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum in die rigting van die resulterende/netto krag. (2 of 0)

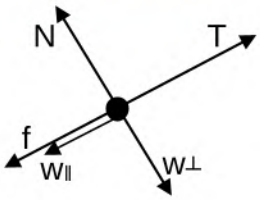
(2)

2.2

ACCEPT/*AANVAAR*







	Accepted labels/*Aanvaarde benoemings*
N	F_N/Normal/F_{normal}/*$F_{normaal}$*/*Normaal*
f	(kinetic) friction/F_f/f_k/*(kinetiese) wrywing*/5,88 N/*F_w*
w	F_g/F_w/weight/mg/39,2 N/gravitational force *F_g*/*F_w*/*gewig*/*mg*/*39,2 N*/*gravitasiekrag*
T	F_T/F_{string}/*F_{tou}*/tension/*spanning*

Notes/*Aantekeninge*
- Mark is awarded for label and arrow./*Punt word toegeken vir byskrif en pyltjie.*
- Do not penalise for length of arrows./*Moenie vir die lengte van die pyltjies penaliseer nie*.
- If w is not shown but $w_{\parallel}$ and $w_{\perp}$ are shown, give 1 mark for both./
Indien w nie getoon is nie maar $w_{\parallel}$ en $w_{\perp}$ is getoon, ken 1 punt toe vir beide.
- If arrows do not touch the dot/*Indien pyle nie die kolletjie raak nie*: Max/*Maks* $\frac{3}{4}$
- Any other additional force(s)/*Enige ander addisionele krag(te): Max/Maks* $\frac{3}{4}$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $\frac{3}{4}$

(4)

2.3.1 **For block A/*Vir blok A:***

$F_{net} = ma$
$T - f_k - w_{\parallel} = ma$ ✓Any one /*Enige een*
$T - f_k - mg\sin\theta = ma$
$T - 5,88 - 4(9,8)\sin35°$ ✓$= 4(2)$ ✓
$T = 36,36$ N ✓ (4)

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

OPTION 1: For block B/*Vir blok B:*

$F_{net} = ma$
$F - T - f_k - w_{\parallel} = ma$
$F - T - f_k - mg\sin\theta = ma$
$F - 36,36 - 13,23 - 9(9,8)\sin35°$ ✓$= (9)(2)$ ✓
$F = 118,18$ N ✓

OPTION 2: For blocks A and B combined/*Vir blokke A en B te same*

$F_{net} = ma$
$F - f_k - w_{\parallel} = ma$
$F - f_k + mg\sin\theta = ma$
$F - 19,11 - 13(9,8)\sin35°$ ✓$= (13)(2)$ ✓
$F = 118,18$ N ✓ (3)

2.4.1 INCREASE/*TOENEEM* ✓ (1)

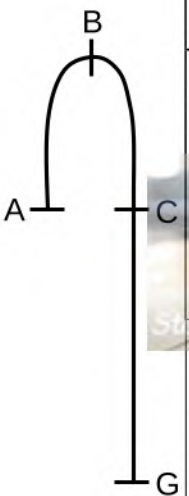
2.4.2 As θ decreases, normal force will increase./*Soos* θ *afneem sal normaalkrag toeneem*. ✓ **OR/*OF*** $N = mg\cos\theta$
Frictional force is directly proportional to normal force/*wrywing is direk eweredig aan normaalkrag* ✓ **OR/OF** $f \alpha N$ / $f = \mu_k N$ (2)
[16]

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)

NOTE: If projectile is defined 0/2 **NOTA: Indien projektiel gedefinieer is 0/2**

3.2



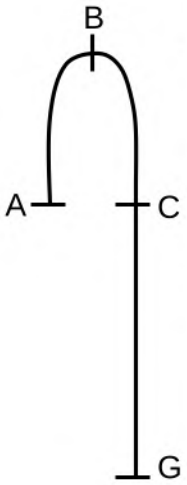
Marking criteria/*Nasienkriteria*	
• Correct formula for v_i./*Korrekte formule vir* v_i.✓ • Correct substitution into formula./*Korrekte vervanging in formule*. ✓ • Final answer/*Finale antwoord*: 10,74 m·s^{-1} ✓ • If energy principles are used./Indien energiebeginsels gebruik word: max/maks $^1/_3$ for correct answer/ vir korrekte antwoord	
OPTION 1/*OPSIE 1* **A-B:**	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(-9,8)(5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9,8)(-5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓
OPTION 2/*OPSIE 2* **B-C:**	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(-9,8)(-5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(9,8)(5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓

(3)

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

Marking criteria/*Nasienkriteria*

- Any one of the correct equations leading to the velocity at which the ball strikes the ground./*Enige een van die korrekte vergelykings wat lei tot die snelheid waarmee die bal die grond tref..* ✓
- Correct substitution leading to the velocity at which the ball strikes the ground./*Korrekte vervanging wat lei tot die snelheid waarmee die bal die grond tref.* ✓
- Correct equation for ΔE_k./*Korrekte vergelyking vir* ΔE_k. ✓
- Correct substitution into ΔE_k *equation./Korrekte vervanging in* ΔE_k *vergelyking.* ✓
- Correct answer / *Korrekte antwoord* 68,31 J ✓
  Range / *Gebied* (67,91 – 69,34)



OPTION 1/*OPSIE 1*
A-G:
UPWARDS AS POSITIVE/
***OPWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(10,74)^2 + 2(-9,8)(-15,3)}$ ✓
$v_f = 20,38\ m\cdot s^{-1}$

OPTION 2/*OPSIE 2*
B-G:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0^2 + \underline{2(-9,8)(-21,19)}$ ✓
$v_f = 20,38\ m\cdot s^{-1}$

OPTION 3/OPSIE 3
C-G:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(-10,74)^2 + 2(-9,8)(-15,3)}$ ✓
$v_f = 20,38\ m\cdot s^{-1}$

OPTION 4/*OPSIE 4*
A-G:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-15,3 = (10,74)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
$t = 3,18\ s$

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15,3 = \left(\frac{10,74 + v_f}{2}\right)3,18$ ✓
$v_f = -20,38\ m\cdot s^{-1}$

DURING COLLISION/
TYDENS BbotsING
$\Delta E_k = E_{kf} - E_{ki}$
$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$
✓Any one/ *Enige een*
$\Delta E_k = \underline{\frac{1}{2}(0,5)(11,92^2 - (20,38)^2)}$ ✓
$\Delta E_k = -68,31\ J$ ✓

OPTION 5/*OPSIE 5*

B-G:

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

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

$t = 2,08$ s

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

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

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

OPTION 6/*OPSIE 6*

C-G:

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

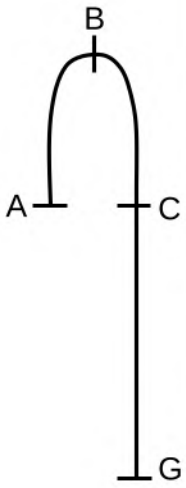
$-15,3 = (-10,74)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$\Delta t = 0,98$ s

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

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

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



OPTION 7/*OPSIE 7*

A-G:

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

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

$t = 3,18$ s

$v_f = v_i + a\Delta t$ ✓

$v_f = 10,74 + \underline{(-9,8)(3,18)}$ ✓

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

OPTION 8/*OPSIE 8*

B-G:

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

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

$t = 2,08$ s

$v_f = v_i + a\Delta t$ ✓

$v_f = 0 + \underline{(-9,8)(2,08)}$ ✓

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

OPTION 9/*OPSIE 9*

C-G:

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

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

$t = 0,98$ s

$v_f = v_i + a\Delta t$ ✓

$v_f = \underline{-10,74 + (-9,8)(0,98)}$ ✓

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

DURING COLLISION/*TYDENS BOTSING*

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

$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

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

✓Any one/ *Enige een*

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

$\Delta E_k = -68,31$ J ✓

OPTION 10/*OPSIE 10*

A-G:

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

$(9,8)(0,5)(15,3)\cos0° = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓

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

OPTION 11/*OPSIE 11*

B-G:

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

$(9,8)(0,5)(21,19)\cos0° = \frac{1}{2}(0,5)v_f^2 - 0$ ✓

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

OPTION 12/*OPSIE 12*

C-G:

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

$(9,8)(0,5)(15,3)\cos0° = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓

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

OPTION 13/*OPSIE 13*

A-G OR/*OF* C-G:

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = [\frac{1}{2}m(v_f^2 - v_f^2)] + [mg(h_f - h_i)]$ ✓Any one/*Enige een*

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

$0 = [\frac{1}{2}(0,5)v_f^2 - (10,74)^2] + [0 - (0,5)(9,8)(15,3)]$ ✓

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

OPTION 14/*OPSIE 14*

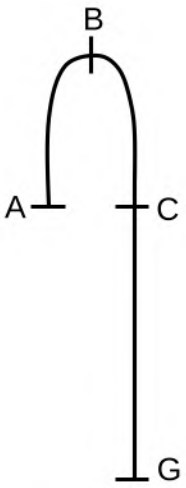
B-G:

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = [\frac{1}{2}m(v_f^2 - v_f^2)] + [mg(h_f - h_i)]$ ✓Any one/*Enige een*

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

$0 = [\frac{1}{2}(0,5)v_f^2 - 0] + [0 - (0,5)(9,8)(21,19)]$ ✓

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



DURING COLLISION/*TYDENS BOTSING*

$\Delta E_k = E_{kf} - E_{ki}$
$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓Any one/*Enige een*

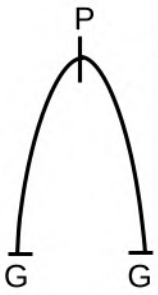
$\Delta E_k = \frac{1}{2}(0,5)(11,92^2 - (20,38)^2)$ ✓

$\Delta E_k = -68,31\ J$ ✓

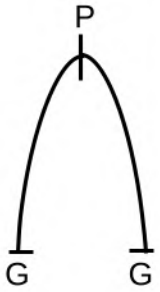
(5)

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

Marking criteria/*Nasienkriteria*
- Correct equation to calculate Δt./*Korrekte vergelyking om Δt te bereken.* ✓
- Correct substitution to calculate Δt./*Korrekte vervanging om Δt te bereken.* ✓
- Correct final answer./*Korrekte finale antwoord:*
  1,22 s ✓



OPTION 1/*OPSIE 1*	
G-P:	**G-P:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = 11{,}92 + (-9{,}8)\,\Delta t$ ✓	$0 = (-11{,}92) + (9{,}8)\Delta t$ ✓
$\Delta t = 1{,}22$ s ✓	$\Delta t = 1{,}22$ s ✓
OPTION 2/*OPSIE 2*	
P-G:	**P-G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-11{,}92 = 0 + (-9{,}8)\,\Delta t$ ✓	$11{,}92 = 0 + (9{,}8)\Delta t$ ✓
$\Delta t = 1{,}22$ s ✓	$\Delta t = 1{,}22$ s ✓
OPTION 3/*OPSIE 3*	
G - G:	**G - G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-11{,}92 = 11{,}92 + (-9{,}8)\,\Delta t$ ✓	$11{,}92 = -11{,}92 + (9{,}8)\,\Delta t$ ✓
$\Delta t = 2{,}43$ s	$\Delta t = 2{,}43$ s
Time to reach $h_{max} = \frac{2{,}43}{2}$	Time to reach $h_{max} = \frac{2{,}43}{2}$
$= 1{,}22$ s ✓	$= 1{,}22$ s ✓



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

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (11,92)^2 + 2(-9,8)\Delta y$
$\Delta y = 7,25$ m

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

OR/*OF*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$7,25 = \left(\frac{11,92 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

G-P:
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (-11,92)^2 + 2(9,8)\Delta y$
$\Delta y = -7,25$ m

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

OR/*OF*

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

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

$v_f^2 = v_i^2 + 2a\Delta y$
$(-11,92)^2 = 0 + 2(-9,8)\Delta y$
$\Delta y = -7,25$ m

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-7,25 = \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 1,22$ s ✓

OR/*OF*

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

P-G:
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$
$(11,92)^2 = 0 + 2(9,8)\Delta y$
$\Delta y = 7,25$ m

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$7,25 = (11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 1,22$ s ✓

OR/*OF*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$7,25 = \left(\frac{0 + 11,92}{2}\right)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta E_k$

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

$(0,5)(9,8)\Delta y\cos 180^\circ = \frac{1}{2}(0,5)(0 - (11,92)^2)$

$\Delta y = 7,25$ m

OR/*OF*

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

$W_{nc} = [\frac{1}{2}m(v_f^2 - v_f^2)] + [mg(h_f - h_i)]$

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

$0 = \frac{1}{2}(0,5)[(0 - (11,92)^2] + (0,5)(9,8)\Delta h$

$\Delta h = 7,25$ m

OR/*OF*

$\sum E_{Mi} = \sum E_{Mf}$

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

$\frac{1}{2}(0,5)(11,92)^2 + 0 = 0 + (0,5)(9,8)(h_f)$

$\Delta h = 7,25$ m

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

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

$\Delta t = 1,22$ s ✓

OR/*OF*

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

$7,25 = \left(\frac{11,92 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

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

$\Delta t = 1,22$ s ✓

OR/*OF*

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

$-7,25 = \left(\frac{-11,92 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 1,22$ s ✓

(3)

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

3.4.1 11,92 ($m\cdot s^{-1}$) ✓ (1)

3.4.2 10,74 ($m\cdot s^{-1}$) ✓ (1)

3.4.3 1,22 (s) ✓ (1)
[16]

QUESTION 4/*VRAAG 4*

4.1 591 N to the right/*na regs* ✓ (1)

4.2

RIGHT AS POSITIVE/ *REGS AS POSITIEF:*	**LEFT AS POSITIVE/ LINKS *AS POSITIEF:***
OPTION 1/*OPSIE 1*	
$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ $ma\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $-591(0,02)$✓ $= (0,03)(0 - v_i)$ ✓ $v_i = 394\ m\cdot s^{-1}$ ✓	$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ $ma\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $591(0,02)$✓ $= (0,03)(0 - v_i)$ ✓ $v_i = -394\ m\cdot s^{-1}$ $v_i = 394\ m\cdot s^{-1}$ ✓
OPTION 2/*OPSIE 2*	
$F_{net} = ma$ $-591 = (0,03)a$ ✓ $a = -19\ 700\ m\cdot s^{-1}$ $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (-19\ 700)(0,02)$ ✓ $v_i = 394\ m\cdot s^{-1}$ ✓	$F_{net} = ma$ $591 = (0,03)a$ ✓ $a = 19\ 700\ m\cdot s^{-1}$ $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (19\ 700)(0,02)$ ✓ $v_i = -394\ m\cdot s^{-1}$ $v_i = 394\ m\cdot s^{-1}$ ✓

(4)

4.3

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

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)

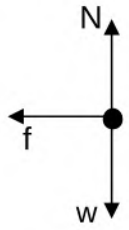
4.4

POSITIVE MARKING FROM QUESTION 4.2. *POSITIEWE NASIEN VANAF VRAAG 4.2.*
RIGHT AS POSITIVE/*REGS AS POSITIEF*
$\sum p_i = \sum p_f$ $m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ ✓Any one/*Enige een* $(0,03)(394) + (2,7)(-3)$ ✓ $= v_f(0,03 + 2,7)$✓ $\therefore v_f = 1,36\ m\cdot s^{-1}$ ✓
LEFT AS POSITIVE/*LINKS AS POSITIEF*
$\sum p_i = \sum p_f$ $m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ ✓Any one/*Enige een* $(0,03)(-394) + (2,7)(3)$ ✓ $= v_f(0,03 + 2,7)$✓ $\therefore v_f = -1,36\ m\cdot s^{-1}$ $\therefore v_f = 1,36\ m\cdot s^{-1}$ ✓

(4)
[11]

QUESTION 5/*VRAAG 5*

5.1



Accepted labels/*Aanvaarde benoemings*	
w	F_w /F_g /mg /gravitational force/*gravitasiekrag*/weight/*gewig*
f	F_f /f_k/(kinetic) Friction/*(kinetiese) wrywing*/F_w
N	F_N /Normal/*Normaal*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows./*Moenie vir die lengte van die pyltjies penaliseer nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max*/*Maks* ⅔
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* ⅔
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks ⅔

(3)

5.2 Initial kinetic energy/*Oorspronklike kinetiese energie* ✓ (1)

5.3

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

The net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓
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 in voorwerp deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

5.4

Marking criteria/*Nasienkriteria*

- OPTION 1/*OPSIE 1*: Relating frictional force to gradient/*Verband tussen wrywingskrag en helling* ✓
  OPTION 2 and 3/*OPSIE 2 en 3*: Correct formulae for work / *Korrekte verfgelyking vir arbeid* ✓
- Correct subtitution of two values or ratio from the graph/*korrekte invervanging van twee waardes of verhouding vanaf die grafiek* ✓✓
- Formula to calculate mass/*formule om massa te bereken* ✓
- Correct substitution of μ and 9,8/*korrekte invervanging van μ en 9,8* ✓
- Final answer/*finale antwoord* ✓

OPTION 1/*OPSIE 1*

$m = \frac{\Delta y}{\Delta x}$

$f = \frac{E_{ki}}{\Delta x}$

$\frac{1}{f} = \frac{\Delta x}{E_{ki}}$

$\boxed{\frac{1}{f} = \text{gradient}}$ ✓

$\frac{1,5}{6} = \frac{3}{12} = \frac{4,5}{18} = \frac{1}{4}$ ✓

$f = 4\ N$

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta K + \Delta U$
$W_{net} = \Delta E_k$
$W_{net} = E_{kf} - E_{ki}$
$W_f = \Delta E_k$
$W_f = E_{kf} - E_{ki}$
$f\Delta x \cos 180° = E_{kf} - E_{ki}$

✓Any one/ *Enige een*

$-f(1,5)$ ✓ $= 0 - 6$ ✓

OR/*OF*

$-f(3) = 0 - 12$

OR/*OF*

$-f(4,5) = 0 - 18$

$f = 4\ N$

OPTION 3/OPSIE 3

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

-6 ✓ $= f(1,5)\cos 180°$ ✓ **OR/*OF***

$-12 = f(3)\cos 180°$ **OR/*OF***

$-18 = f(4,5)\cos 180°$

$f = 4\ N$

$f_k = \mu_k F_N$ ✓

$4 = (0,18)(m)(9,8)$ ✓

$m = 2,27\ kg$ ✓

(6)
[12]

QUESTION 6/*VRAAG 6*

6.1.1

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

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

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

6.1.2

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S \quad \textbf{OR/OF} \quad f_L = \frac{v}{v + v_S} f_S \quad ✓$$

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

$$v = 343{,}04 \text{ m·s}^{-1} ✓$$

(5)

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

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

c) Increases/*Toeneem* ✓ (1)

6.2.1 AWAY FROM/*WEG VAN* ✓ (1)

6.2.2
- A lower frequency/longer wavelength ✓ is detected.
- This lower frequency/longer wavelength corresponds to the red end of the spectrum. ✓

- *'n Laer frekwensie/langer golflengte word waargeneem*
- *Hierdie laer frekwensie/langer golflengte stem ooreen met die rooi ent van die spektrum*

(2)
[13]

QUESTION 7/*VRAAG 7*

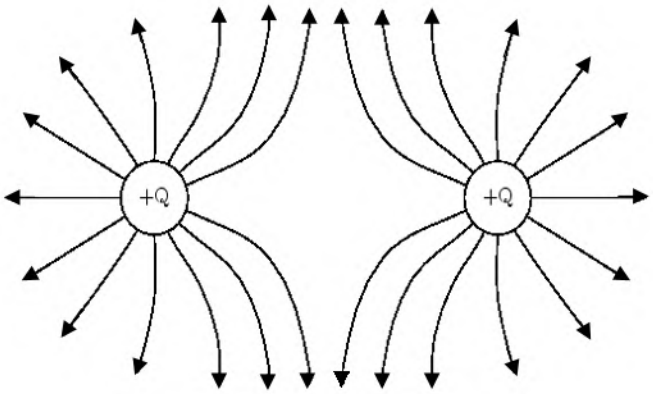
7.1.

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

Electric field is a region in space in which an electric charge experiences a force.✓✓
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

NOTE: If electric field at a point is defined 0/2 **NOTA: Indien elektiese veld by 'n punt gedefinieer is 0/2**

7.2



Criteria for sketch/Kriteria vir skets	Marks/*Punte*
Correct direction of field lines/ *Korrekte rigting van veldlyne*	✓
Correct shape of the electric field lines/ *Korrekte vorm van elektrieseveld*	✓
No field lines crossing each other. Field lines must touch the sphere, but not go inside the sphere/ *Geen veldlyne wat mekaar kruis nie. Veldlyne moet die sfeer raak, maar nie die sfeer binnegaan nie.*	✓

(3)

7.3

Marking criteria/*Nasienkriteria*

- Formula/*Vergelyking* $E = \frac{kQ}{r^2}$. ✓
- Correct substitution for each A ✓and B ✓/*Korrekte vervanging vir elkeen A en B.*
- Subtraction/*Aftrek van* ($E_A - E_B$) ✓
- Final answer/*Finale antwoord*: 0,87 (m) ✓

NOTE: If $E_B - E_A$ is used in the subtraction, mark for final answer must be forfeited.

OPTION 1/*OPSIE 1*

$E = \frac{kQ}{r^2}$ ✓

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

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

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

$r = 0,87$ (m) ✓

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*

- Equation for Coulomb's law./Vergelyking vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's equation for F_A. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_A.
- Correct substitution into Coulomb's equation for F_B. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_B.
- Subtraction/*Aftrek van* ($F_A - F_B$) ✓
- Final answer/*Finale antwoord*: 0,87 m ✓

NOTE: If $F_B - F_A$ is used in the subtraction, mark for final answer must be forfeited.

$F = \frac{kQ_1Q_2}{r^2}$ ✓

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

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

$F_{net} = F_A - F_B$

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

$r = 0,87$ m ✓

(5)

7.4

OPTION 1/*OPSIE 1*

$F = Eq$ ✓

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

$= 4,32 \times 10^{-18}$ N ✓

OPTION 2/*OPSIE 2*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = F_A - F_B$

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

$= 4,28 \times 10^{-18}$ N ✓

(3)

[13]

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*

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

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

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

OR/*OF*

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

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is. (2)

8.2.1

Marking criteria/*Nasienkriteria*

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

OPTION 1/*OPSIE 1*

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

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

$$= 15\ \Omega$$

✓ Any one/ enige een

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

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

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

OPTION 2/*OPSIE 2*

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

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

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

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

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

$$= 15\ \Omega$$

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

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

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

(5)

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

OPTION 1/*OPSIE 1*

$\varepsilon = I(R + r)$ ✓

$\underline{12 = I(7{,}5 + 0{,}5)}$ ✓

$I = 1{,}5\ A$ ✓

OPTION 2/*OPSIE 2*

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

$$(7{,}5 + 0{,}5) = \frac{12}{I} \checkmark$$

$I = 1{,}5\ A$ ✓

(3)

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

Marking criteria/*Nasienkriteria*

- Substitution of the correct current for R_3./*Invervanging van die korrekte stroom vir R_3.*✓
- Correct equation for power, leading to the answer./*Korrekte vergelyking vir drywing wat lei tot die antwoord*. ✓
- Correct substitution to calculate power./*Korrekte invervanging om drywing te bereken.*✓
- Correct final answer/*Korrekte finale antwoord*: 8,44 W.✓

$1,5 = 2I_{R3}$
$I = 0,75$ A

$R_{ext} = \frac{V_{ext}}{I}$
$V = (7,5)(1,5)$
$V = 11,25$ V

$R_3 = \frac{V_{ext}}{I}$
$15 = \frac{11,25}{I}$
$I = 0,75$ A

OPTION 1/*OPSIE 1*

$P = I^2R$✓
$= (0,75)^2 15$✓
$= 8,44$ W✓

OPTION 2/*OPSIE 2*

$V = IR$
$= (0,75)(15)$✓
$= 11,25$ V

$P = \frac{V^2}{R}$✓
$= \frac{(11,25)^2}{15}$ ✓
$= 8,44$ W✓

OPTION 3/*OPSIE 3*

$V = IR$
$= (0,75)(15)$✓
$= 11,25$ V

$P = VI$✓
$= (11,25)(0,75)$ ✓
$= 8,44$ W✓

(4)

8.3.1 INCREASES/*NEEM TOE* ✓ (1)

8.3.2
- Total resistance of the circuit increases and current in circuit decreases.✓
- $V_{internal}$/internal volts/V_{lost} decreases. and $V_{external}$/external volts /V_{RL} increases. ✓
- V_L increases and Power output increases ✓ therefore brightness increases.

- *Totale weerstand van die stroombaan neem toe en die stroom neem af.*
- *V_{intern}/interne volts/$V_{verlore}$ neem af. and $V_{ekstern}$/externe volts /V_{RL} neem toe.* ✓
- *V_L neem toe en Drywing neem toe ✓daarom sal die herlderheid toeneem* (3)

[18]

QUESTION 9/*VRAAG 9*

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

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

9.1.3 Clockwise/*Kloksgewys* ✓✓ (2)

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

Increase the strength of the magnetic field e. g. use stronger magnets or bring magnets closer /*Toename in die sterkte van die magneetveld bv. Gebruik sterker magnete of bring magnete nader aan mekaar* ✓
Increase the current /*Verhoog die stroom*. ✓
Increase the area of the coil. /*Vergroot die oppervlakte van die spoel.*
Increase the number of turns in the coil./*Vermeerder die aantal windings in die spoel.*
Use battery with higher potential difference / *Gebruik battery met hoër potensiaalverskil* (2)

9.2.1

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

Root-mean-square current is the alternating current that dissipates the same amount of energy as an equivalent DC current. ✓✓
Die wortelgemiddeldekwadraat-stroom is die wisselstroom wat dieselfde hoeveelheid energie verbruik as 'n ekwivalente gelykstroom. (2)

9.2.2

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{3,6}{\sqrt{2}} \checkmark$$
$$= 2,55 \text{ A} \checkmark$$ (3)

9.2.3

Marking criteria/*Nasienkriteria*

- Formula for W./*Formule vir W.* ✓
- Correct substitution for W./*Korrekte vervanging vir W.* ✓
- Correct final answer./*Korrekte finale antwoord*:
- 69 168 J ($6,92 \times 10^3$) (range/*gebied* 69 167,56 J – 69 168,44 J)✓

OPTION 1/*OPSIE 1*

$W = VI\Delta t$ ✓

$= \underline{(220)(2,62)(120)}$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

OPTION 2/*OPSIE 2*

$V = IR$

$220 = 2,62R$

$R = 83,97\ \Omega$

$W = I_{rms}^2 R\Delta t$✓

$= \underline{(2,62)^2(83,97)(120)}$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

$W = \frac{V_{rms}^2}{R}\Delta t$ ✓

$= \underline{\left(\frac{220^2}{83,97}\right)(120)}$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

OPTION 3/*OPSIE 3*

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

$= (220)(2,62)$

$= 576,4$ W

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

$= (2,62)^2(83,97)$

$= 576,4$ W

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

$= \frac{(220)^2}{83,97}$

$= 576,4$ W

$W = P\Delta t$ ✓

$= (576,4)(120)$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

(3)
[14]

QUESTION 10/*VRAAG 10*

10.1.1

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

The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓
Die minimum energie (van invallende fotone) wat elektrone kan vrystel vanuit 'n metaal/oppervlak.

(2)

NOTE: If reference to frequency 0/2
NOTA: Indien na frekwensie verwys word 0/2

10.1.2

OPTION 1/*OPSIE 1*

$E = hf$ ✓
$E = (6,63 \times 10^{-34})(2,8 \times 10^{16})$ ✓
$E = 1,86 \times 10^{-17}$ J ✓

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

OPTION 2/*OPSIE 2*

$W_0 = hf_0$ ✓
$6,63 \times 10^{-19} = (6,63 \times 10^{-34})f_0$ ✓
$f_0 = 1 \times 10^{15}$ Hz ✓

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

OPTION 3/*OPSIE 3*

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

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

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

✓ any one/ *enige een*

✓ any one/ *enige een*

$v = f\lambda$
$3 \times 10^{8} = 2,8 \times 10^{16}\lambda$
$\lambda = 1,07 \times 10^{-8}$ m

✓ both/*beide*

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

OPTION 4/*OPSIE 4*

$E = W_0 + E_{k(max)}$
$hf = W_0 + E_{k(max)}$
} ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(2,8 \times 10^{16}) = 6,63 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 1,79 \times 10^{-17}$ J ✓

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

(4)

10.1.3

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

$$0{,}027 \checkmark = \frac{(9 \times 10^{9})(5{,}4 \times 10^{-6})Q_2}{(0{,}1)^2} \checkmark$$

$$Q_2 = 5{,}56 \times 10^{-9}\ C$$

$$n = \frac{Q}{e} \checkmark$$

$$n = \frac{5{,}56 \times 10^{-9}}{1{,}6 \times 10^{-19}} \checkmark$$

$n = 3{,}47 \times 10^{10}$ (electrons/*elektrone*)

number of photons/*aantal fotone* = n = $3{,}47 \times 10^{10}$✓ ($3{,}475 \times 10^{10}$) (6)

10.2.1 (Line) Absorption/*(Lyn) Absorbsie*✓ (1)

10.2.2 Continuous spectrum of white light/rainbow of colours✓ with dark/black lines✓ (replacing specific frequencies)./Kontinue *spektrum van wit lig/reënboog van kleure met donker/swart lyne (wat spesifieke frekwensies vervang)* (2)

10.2.3 Diagram B ✓✓ (2)
[17]

TOTAL/*TOTAAL*: 150