education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS P1

SEPTEMBER 2026

MARKS: 150

TIME: 3 HOURS

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

INSTRUCTIONS AND INFORMATION

1. Write your name on the FOLIO PAPERS
2. This question paper consists of ELEVEN questions. Answer ALL the questions on the FOLIO PAPERS!
3. Start EACH question on a NEW page on the FOLIO PAPERS.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, 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 answer 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 correct answer and write only the letter (A–D) next to the question number (1.1 to 1.10) on the FOLIO PAPER, e.g. 1.11 E.

1.1 A car is moving on a horizontal road at constant velocity.
Which ONE of the following statements is true?

A The forces acting on the car are not in equilibrium.

B There are no forces acting on the car.

C The resultant force acting on the car is zero.

D There is no frictional force acting on the car. (2)

1.2 A 3 kg iron sphere and a 1 kg aluminium sphere with the same diameter fall freely from the roof of a tall building. Ignore the effects of friction.

When the spheres are 5 m above the ground, they have the same ...

A momentum.

B acceleration.

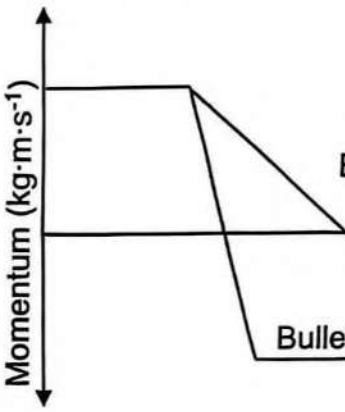
C kinetic energy.

D potential energy. (2)

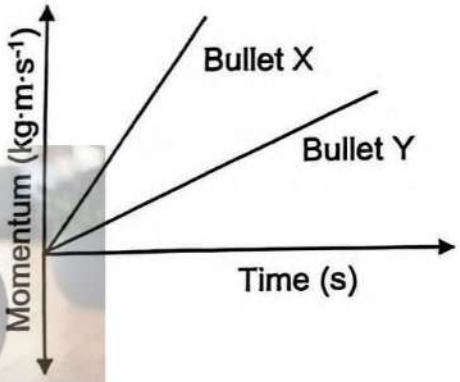
1.3 Two identical bullets, **X** and **Y**, with identical velocities strike a steel block and a wooden block respectively.
Bullet **X** bounces 180° back from the steel block.
Bullet **Y** penetrates and becomes embedded inside the wooden block.

Which ONE of the following momentum vs time graphs represents the above scenario the best?

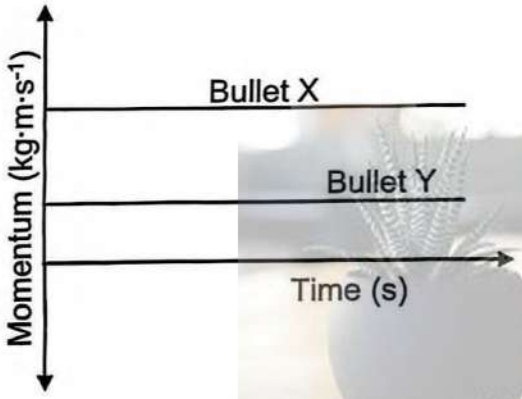
A



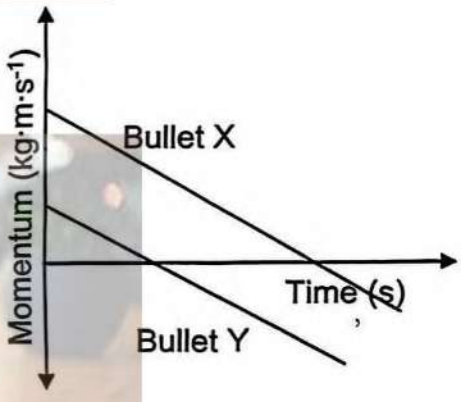
B



C



D



(2)

1.4 Which ONE of the following statements about conservative forces is false?

Conservative forces …

A cannot change the potential energy of a system.

B do not change the mechanical energy of a system.

C can convert potential energy into kinetic energy.

D do work which only depends on the initial and final positions of an objects motion. (2)

1.5 The net work required to bring a moving object to rest is equal to the …

A increase in kinetic energy of that object.

B decrease in potential energy of that object.

C decrease in inertia of that object.

D decrease in kinetic energy of that object. (2)

1.6 The siren of an ambulance, moving in front of a car, emits sound waves of frequency *f*. Both vehicles are travelling at the same constant velocity. The frequency of the sound heard by the driver of the car is….

A *f*.

B zero.

C greater than *f*.

D smaller than *f*. (2)

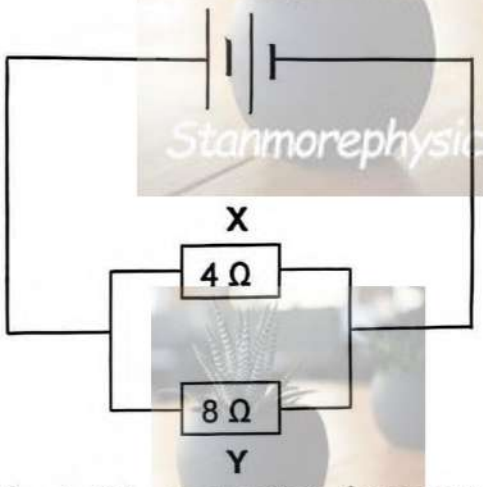
1.7 Two point charges of + 2 nC and - 2 nC, respectively at point **S** and **T**, are located on the same straight line as shown in the diagram below.

Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S .	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T
A	Right	Left
B	Left	Right
C	Left	Left
D	Right	Right

(2)

1.8 Two resistors, **X** and **Y**, are connected in parallel to a battery as shown in the diagram. The battery with emf **V** and negligible internal resistance. How does the power dissipated in resistor **X** compare to the power dissipated in resistor **Y**?



A The power dissipation in **Y** is greater than the power dissipation in **X**.

B The power dissipation in **X** is greater than the power dissipation in **Y**.

C The power dissipation in **X** is the same as the power dissipation in **Y**.

D The power dissipation in both resistors is equal to 0 W. (2)

1.9 Which ONE of the energy conversions below takes place when a DC motor is in operation?

A Kinetic to electrical

B Heat to mechanical

C Electrical to mechanical

D Mechanical to electrical (2)

1.10 The work function of a metal is $W_o = hf_o$. If this metal is illuminated with light of frequency **3f**, the maximum kinetic energy of the photoelectrons will be …

A $3hf + hf_o$

B $3hf - hf_o$

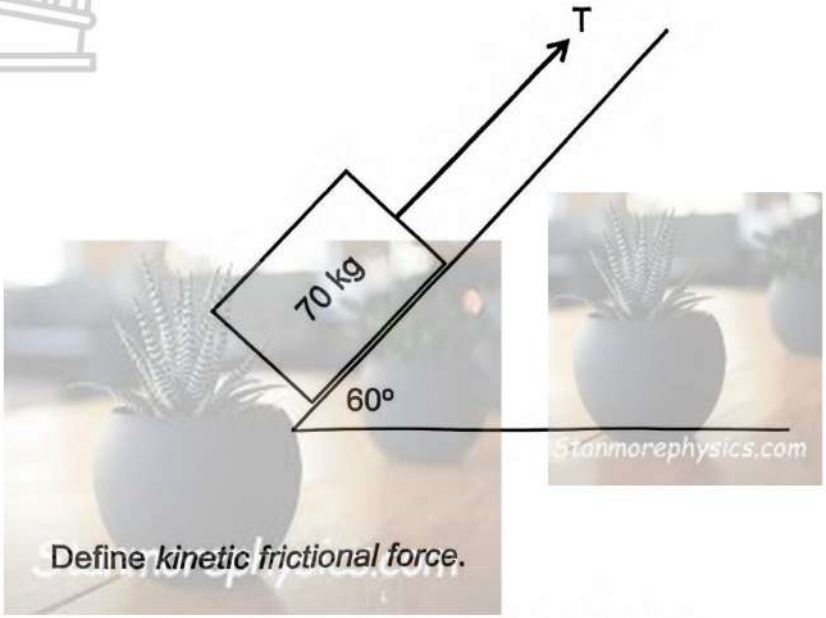
C $3hf + 2hf_o$

D $3hf - 2hf_o$ (2)

[20]

QUESTION 2 (Start on a new page.)

A box with a mass of 70 kg is pulled up an incline at a constant acceleration of 0,5 $m \cdot s^{-2}$. The incline makes an angle of 60° with the horizontal. The rope is parallel to the slope. The kinetic frictional force between the box and the surface is 15 N.



2.1 Define *kinetic frictional force*. (2)

2.2 Draw a labelled free body diagram for the box. (4)

2.3 Calculate the:

2.3.1 Magnitude of the parallel component of gravitational force acting on the box (3)

2.3.2 Tension in the rope (5)

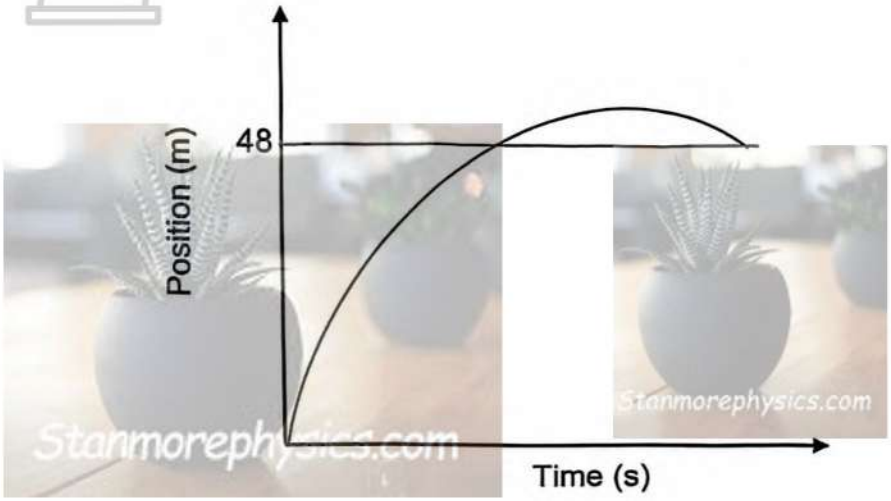
2.4 The slope now becomes less steep and is now at an angle of 40° to the horizontal. What effect will this have on the following?
Choose from INCREASES, DECREASES or REMAINS THE SAME.

2.4.1 Coefficient of kinetic friction (1)

2.4.2 Tension in the rope. Give a reason for the answer. (2)
[17]

QUESTION 3 (Start on a new page.)

Part of the position-time graph for a ball thrown vertically upwards from the ground to the top of a 48 m tall building is shown below. The graph is not drawn to scale.
The ball bounces on the roof of the building and reach a maximum height of 8 m above the building.
Ignore the effect of air resistance.



3.1 Define the term *projectile*. (2)

3.2 Calculate the magnitude of the speed at which the ball:

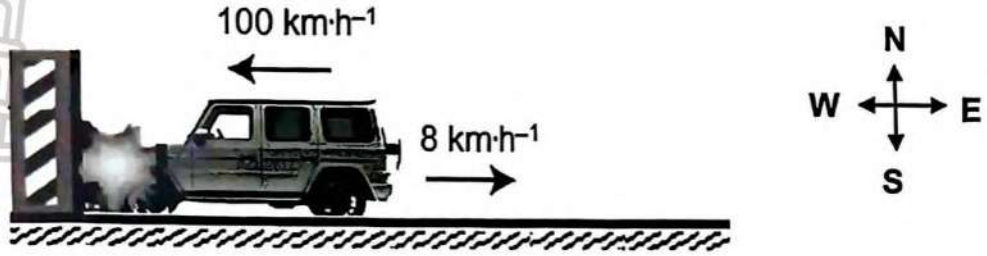
3.2.1 Is thrown upwards (3)

3.2.2 Hits the roof (3)

3.3 Draw a velocity time graph for the whole movement of the ball, show the initial velocity and velocity with which it hits the roof. (3)
[11]

QUESTION 4 (Start on a new page.)

In a crash test, a car of mass 1 500 kg collides with a wall and rebounds. The initial and final velocities of the car are 100 km.h^{-1} west and 8 km.h^{-1} east respectively.



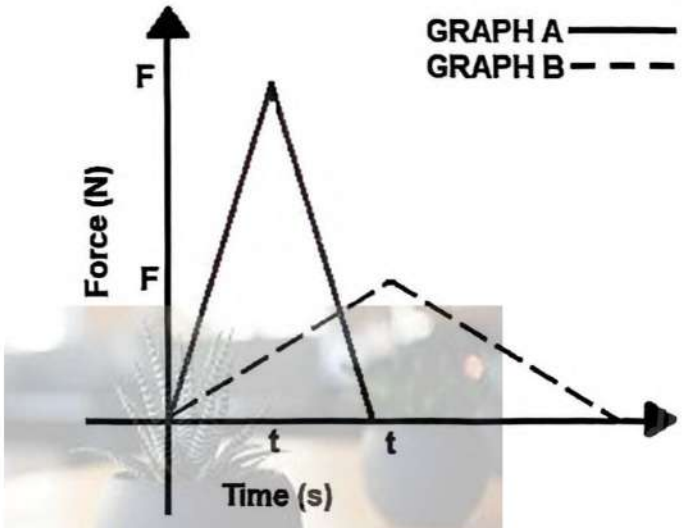
4.1 Define *Newton's second law of motion* in terms of momentum. (2)

4.2 Calculate the force exerted by the wall on the car if the collision last for 0,2 s. (3)

4.3 How will the magnitude of the force exerted on the car be affected if the time interval of the collision remains 0,2 s, but the car does NOT BOUNCE OFF the wall? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

4.4 Is the collision ELASTIC and INELASTIC? Explain the answer. (2)

4.5 Two cars, one WITH and one WITHOUT an airbag, each with a mass of 1 500 kg were used in a car factory, to investigate the injuries on drivers. Graphs **A** and **B** below represent the results obtained from the investigation, as shown below. Study the graphs and answer the questions that follow.



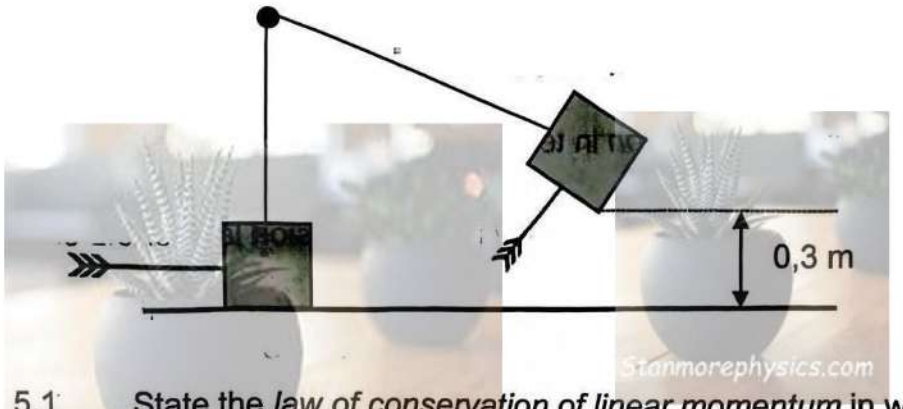
4.5.1 Which graph represent the results of a car WITH an airbag? Write down only GRAPH A or GRAPH B. (1)

4.5.2 Explain the answer in QUESTION 4.6.1. (2)

[11]

QUESTION 5 (Start on a new page.)

A man shoots an arrow, with a mass of 0,15 kg, from a crossbow into a wooden block, of mass 4,85 kg, which hangs from a light inextensible string as shown in the diagram below. After the collision, the arrow is stuck in the wooden block. The block and arrow now swing upwards and reach a vertical height of 0,3 m above the initial position of the block. Ignore air friction on the block and arrow.



5.1 State the *law of conservation of linear momentum* in words. (2)

5.2 Calculate the:

5.2.1 Potential energy of the arrow and block at the height of 0,3 m. (3)

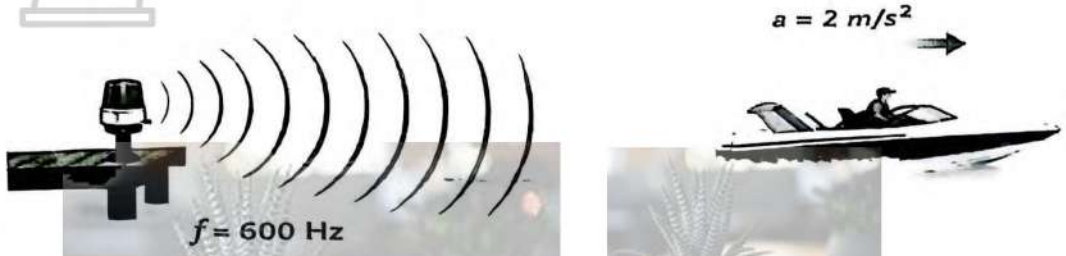
5.2.2 Velocity of the block and arrow immediately after the collision. (5)

5.2.3 Velocity with which the arrow collides with the block. (5)

[15]

QUESTION 6 (Start on a new page.)

A siren on a stationary dock emits a sound of frequency 600 Hz. A speedboat moves away from the dock, starting from rest and accelerates at 2 $m \cdot s^{-2}$ as shown in the diagram below. Take the speed of sound in air as 340 $m \cdot s^{-1}$.
Ignore effects of friction.



6.1 State *Doppler effect* in words. (2)

6.2 Calculate the frequency heard by the person on the boat after 5 seconds when the boat is now moving at a constant velocity. (6)

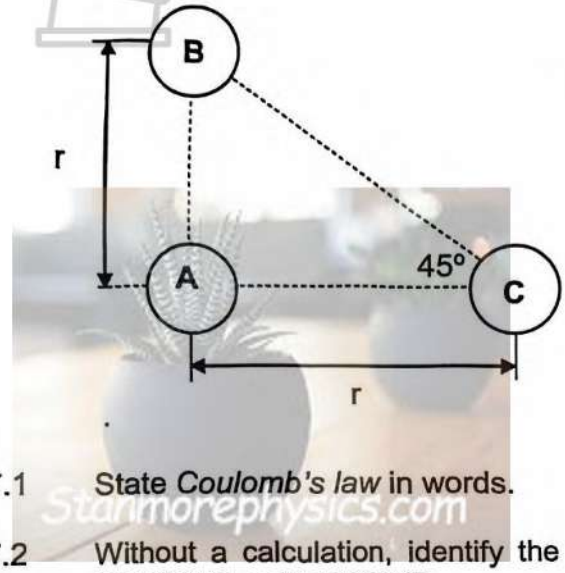
6.3 How is the pitch changing over the time?
Choose from INCREASE, DECREASE or REMAIN THE SAME?
Give a reason for the answer. (2)

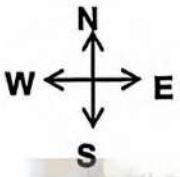
6.4 Spectral lines of star X at an observatory are observed to be red shifted.

Explain the term red shifted in terms of wavelength. (2)
[12]

QUESTION 7 (Start on a new page.)

The spheres **A**, **B** and **C** are arranged at the corners of a right-angled triangle, as shown in the diagram below. The charges on **B** and **C** are + 2 µC and – 2 µC respectively and the magnitude of the charge on **A** is 6 µC. The distances **AB** and **AC** are **r** respectively. The charge **A** experiences a resultant electrostatic force of 0,12 N northwest.





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

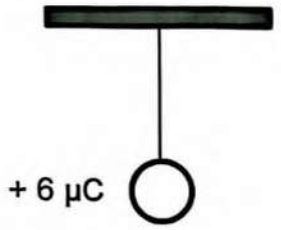
7.2 Without a calculation, identify the nature of the charge on **A**. Choose between POSITIVE or NEGATIVE. (1)

7.3 Draw a free body diagram of the electrostatic forces exerted on **A** due to the charges at **B** and **C**. (2)

7.4 Calculate the value of r. (6)
[11]

QUESTION 8 (Start on a new page.)

8.1 A metal sphere with a charge of +6 µC is suspended from a wooden beam by means of a non-conducting string as shown in the diagram below.

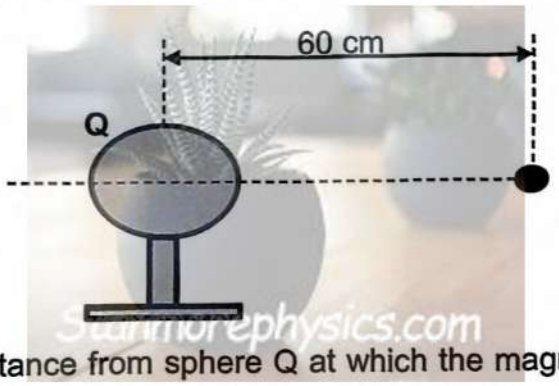


8.1.1 Define the term *electric field at a point* in words. (2)

8.1.2 Draw the electric field pattern around the sphere. (2)

8.1.3 Calculate the number of electrons added to or removed from the sphere. Assume that the sphere was initially neutral. (3)

8.2 The magnitude of the electric field is 100 $N \cdot C^{-1}$ at a point which is 60 cm away from an unknown charge on sphere **Q** as shown in the diagram below.

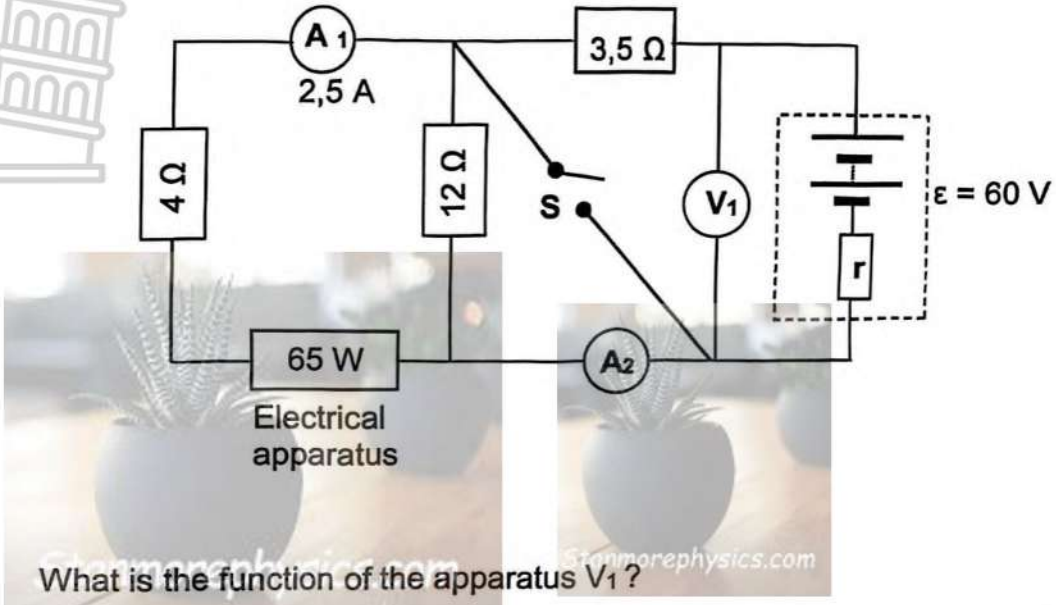


Calculate the distance from sphere Q at which the magnitude of the electric field is 50 $N \cdot C^{-1}$. (5)

[12]

QUESTION 9 (Start on a new page)

Three resistors and a 64 W electrical apparatus are connected to a 60 V battery with an internal resistance **r** as shown in the diagram below. The ammeter A_1 has a reading of 2,5 A. Switch **S** is open.



9.1 What is the function of the apparatus V_1? (1)

9.2 How does the reading on ammeter A_1 compare to the reading on ammeter A_2? Choose from LARGER THAN, SMALLER THAN or THE SAME AS. Explain the answer (2)

9.3 Calculate the:

9.3.1 Resistance of the electrical apparatus. (3)

9.3.2 Current passing through the battery. (4)

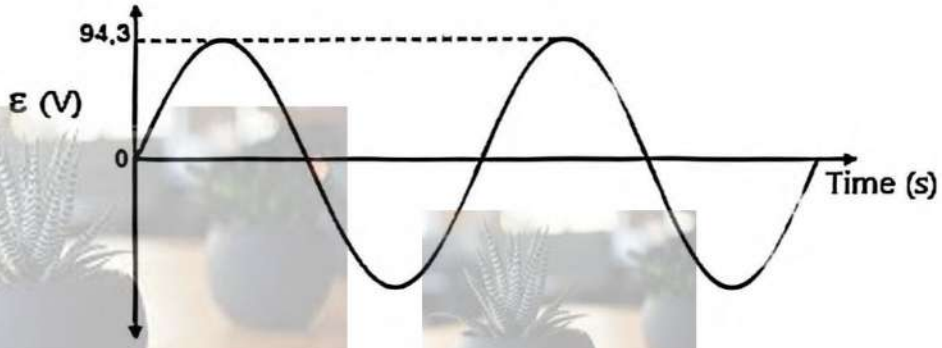
9.3.3 Voltmeter reading V_1. (3)

9.4 Switch **S** is now closed. How does the reading on the ammeter A_1 compare to the reading on ammeter A_2? Choose from LARGER THAN, SMALLER THAN or THE SAME AS. Explain the answer. (2)

[15]

QUESTION 10 (Start on a new page)

10.1 An alternating current (AC) generator is installed on a farm and the following emf versus time graph can be drawn from results obtained. The root mean square of the current is 5 % of the root mean square of the voltage.



10.1.1 What is represented by the 94,3 V on the graph? (1)

10.1.2 What changes must be made to the above AC generator to change it to a DC generator? (1)

10.1.3 Calculate the average power of this generator. (4)

10.2 A search light with an ohmic bulb is marked 90 V: 56 W.

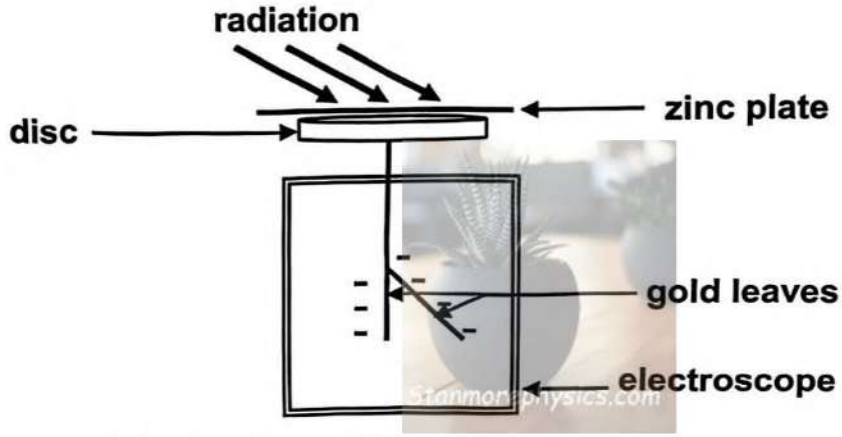
10.2.1 Calculate the resistance of the bulb. (3)

10.2.2 The search light is now connected to the AC generator described above in QUESTION 10.1. How will the brightness of the bulb be influenced? Choose from MORE BRIGHT, LESS BRIGHT or THE SAME. Explain the answer. (2)

[11]

QUESTION 11 (Start on a new page)

11.1 A group of learners performs an investigation to compare the effect of two types of radiation on the emission of photoelectrons from zinc in order to explain the photo electric effect. They place a zinc plate on top of the disc of a negatively charged electroscope. Ultraviolet and red light are shone alternately onto the zinc plate as shown below, with the electroscope fully charged in each case.



They record the following observations:

RADIATION	OBSERVATION
Ultraviolet light	Gold leaves collapse
Red light	No effect on the movement of gold leaves

11.1.1 Define the term *photoelectric effect* in words. (2)

11.1.2 What conclusion can be drawn from this investigation? (2)

11.1.3 Write down the energy conversion in the photo electric effect. (2)

11.2 The learners have access to the following information:

Work function of zinc	$6{,}88 \times 10^{-19}$ J
Wavelength of ultraviolet light	$2{,}7 \times 10^{-7}$ m
Wavelength of red light	$6{,}99 \times 10^{-7}$ m

11.2.1 Use a calculation to explain why red light fails to emit photoelectrons from the surface of the zinc plate. (4)

11.2.2 Calculate the momentum of a photoelectron of ultraviolet light just after it leaves the zinc surface. (5)

[15]

TOTAL:150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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	$9,11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^{6}\ m$

TABLE 2: FORMULAE / *TABEL 2: FORMULES*

MOTION / *BEWEGING*

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

FORCE / *KRAG*

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

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

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

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

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

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

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NASIONALE SENIOR SERTIFIKAAT

GRADE/GRAAD 12

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

SEPTEMBER 2026

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/*PUNTE*: 150

These marking guidelines consists of 14 pages
Hierdie nasienriglyne bestaan uit 14 bladsye

QUESTION 1 / *VRAAG 1*

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 A ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (2)

1.6 A ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

1.9 C ✓✓ (2)

1.10 B ✓✓ (2)

[20]

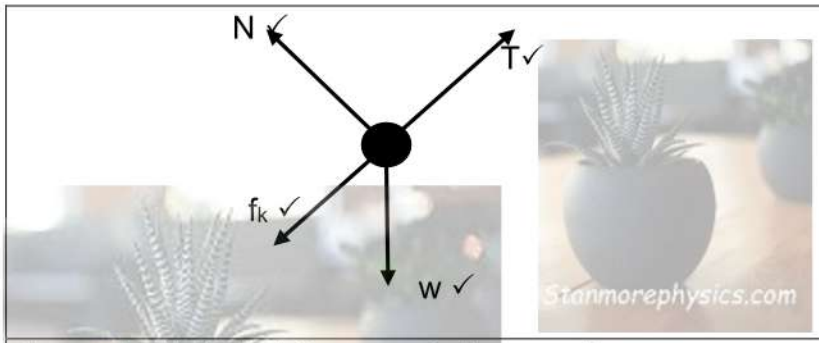
QUESTION 2 / *VRAAG 2*

2.1

Marking criteria/*Nasienkriteria*
If any one 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 force that opposes the motion of a moving object relative to a surface. ✓✓ *Die krag wat die beweging van 'n bewegende voorwerp relatief tot 'n oppervlak teenwerk.*

(2)

2.3



(4)

Accepted labels / Aanvaarde benoemings	
w	F_g / F_w / force of earth on block / weight / mg / gravitational force / VALUE / gravitasiekrag
T	Tension in rope / F_T /F/$F_{applied}$ / spankrag
f_k	f/$F_{friction}$ / F_f / frictional force / wrywing
N	Normal force / F_N / Normaalkrag

Notes/Aantekeninge:
- Mark awarded for label and arrow/ *Punt toegeken vir benoeming en pyltjie..*
- Any additional forces/Enige addisionele kragte: deduct 1 mark/trek 1 punt af: max/maks $^3/_4$
- No labels/*Nie benoem nie*: deduct 1 mark/*trek 1 punt af*: max/maks $^3/_4$
- If everything correct, but no arrows *Indien alles korrek is, maar geen pyltjies* /: deduct 1 mark/trek 1 punt af: max/maks $^3/_4$
- Force(s) not touching object/*Krag(te) nie die voorwerp raak nie: deduct 1 mark/trek 1 punt af*: max/maks $^3/_4$
- Ignore relative sizes of the vectors/Ignoreer die relatiewe groottes van die vektore.

2.3.1

$F_{\parallel} = mg\sin\theta$ ✓
$F_{\parallel} = (70)(9,8)\sin 60^o$ ✓
$F_{\parallel} = 594,09$ N ✓

(3)

2.3.2

$F_{net} = ma$
$T + (-f) + (-Fg_{\parallel}) = ma$ } Any one ✓
$T - 15$ ✓ $- 594,09$ ✓ $= (70)(0,5)$ ✓
$T = 644,09$ N ✓

(5)

2.4.1 REMAINS THE SAME / BLY DIESELFDE ✓ (1)

2.4.2 DECREASES / NEEM AF ✓
Fgll decreases/neem af ✓ (2)
[17]

QUESTION 3 / VRAAG 3

3.1 An object (which has been given an initial velocity and) then it moves under the influence of the gravitational force only. ✓✓ **(2 or 0)**

'n Voorwerp (waaraan 'n beginsnelheid gegee is en) wat dan slegs onder die invloed van die gravitasiekrag beweeg. (2)

3.2.1

Upwards positive/Opwaarts positief	**Downwards positive/Afwaarts positief**
$\Delta y = 48 + 8 = 56$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(-9,8)(56)$ ✓ $v_i = 33,13\ m\cdot s^{-1}$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9,8)(-56)$ ✓ $v_i = 33,13\ m\cdot s^{-1}$ ✓

(3)

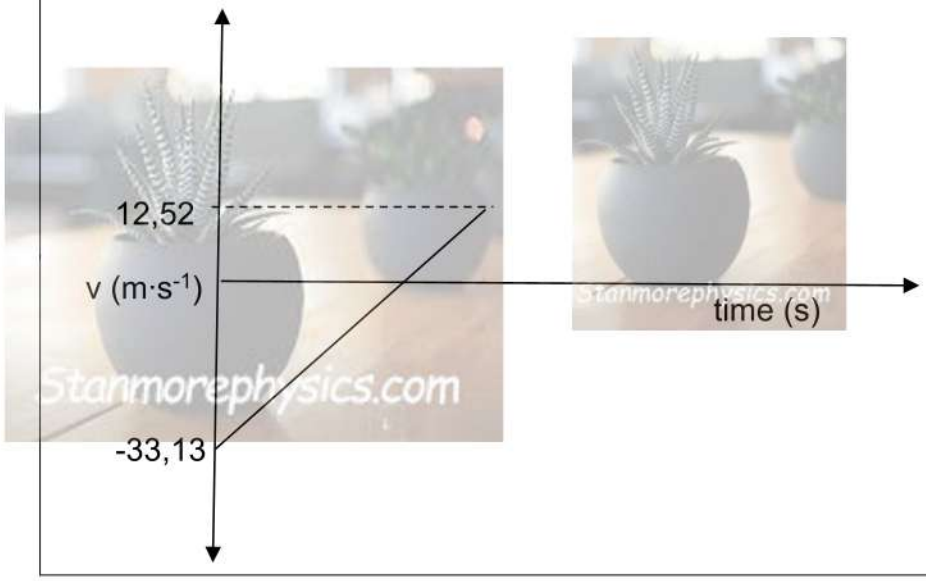
3.2.2

POSITIVE MARKING FROM/POSITIEWE MERK VANAF 3.2.1	
OPTION/OPSIE 1 **Upwards positive/Opwaarts positief** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (33,13)^2 + 2(-9,8)(48)$ ✓ $v_i = 12,52\ m\cdot s^{-1}$ ✓	**OPTION/OPSIE 1** **Downwards positive/Afwaarts positief** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (-33,13)^2 + 2(9,8)(-48)$ ✓ $v_i = 12,52\ m\cdot s^{-1}$ ✓
OPTION/OPSIE 2 **Upwards positive/Opwaarts positief** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + 2(-9,8)(-8)$ ✓ $v_i = 12,52\ m\cdot s^{-1}$ ✓	**OPTION/OPSIE 2** **Downwards positive/Afwaarts positief** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + 2(9,8)(8)$ ✓ $v_i = 12,52\ m\cdot s^{-1}$ ✓

(3)

3.3 **POSITIVE MARKING FROM/POSITIEWE MERK VANAF 3.2.1 & 3.2.2**
UPWARDS POSITIVE/OPWAARTS POSITIEF

Criteria/Kriteria	Marks/Punte
Correct shape – straight line cutting through x-axis / Korrekte vorm – reguitlyn wat die x-as kruis	✓
Initial velocity / aanvanklike snelheid (3.2.1)	✓
Velocity it hits the roof with / snelheid waarmee dit die dak tref (3.2.2)	✓



(3)
[11]

QUESTION 4 / VRAAG 4

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

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

4.2
$F_{net} \cdot \Delta t = \Delta p$ ✓
F_{net} (0,2) ✓ = (1 500)(-2,22) – (1 500)(27,78) ✓
F_{net} = -225 000 N
F_{net} = 225 000 N east/oos✓ (4)

4.3 DECREASES/ AFNEEM ✓ (1)

4.4 INELASTIC✓, kinetic energy is not conserved/velocity changed.✓

ONELASTIES, kinetiese energie bly nie behoue nie /snelheid het verander. (2)

4.5.1 GRAPH/GRAFIEK **B** ✓

4.5.2 An airbag extends the contact time ✓ during the collision and therefore he driver experiences a smaller net force for the same change in momentum/$F_{net} \propto \frac{1}{\Delta t}$. ✓

'n Lugsak verleng die kontaktyd tydens die botsing en ervaar die bestuurder dus 'n kleiner netto krag vir dieselfde verandering in momentum.

(2)
[11]

QUESTION 5 / VRAAG 5

5.1 The total linear momentum in an isolated system remains constant. ✓✓ **(2 or 0)**

Die totale liniêre momentum in 'n geisoleerde sisteem bly konstant. (2)

5.2.1
$E_p = mgh$ ✓
$E_p = (5)(9,8)(0,3)$ ✓
$E_p = 14,7$ J ✓ (3)

5.2.2
$E_{ki} + E_{pi} = E_{kf} + E_{pf}$✓
0 + 14,7 ✓ = $\frac{1}{2}(5)v^2 + 0$ ✓
v = 2,42 m·s^{-1} ✓right/regs✓ (5)

5.2.3	**POSITIVE MARKING FROM/POSITIEWE MERK VANAF 5.2.2**
	TAKE TO THE RIGHT AS POSITIVE/NEEM REGS AS POSITIEF $\Sigma p_i = \Sigma p_f$ $(mv_i)_A + (mv_i)_B = (mv_f)_1 + (mv_f)_2$ ✓ Any one/enige een $\underline{(0,15)(v_{iA})}$ ✓ $+ 4,85(0) = \underline{(5)(2,42)}$ ✓ $v_{iA} = \underline{80,67\ m\cdot s^{-1}}$ ✓right/regs✓

(5)
[15]

QUESTION 6 / VRAAG 6

6.1	**Marking criteria/*Nasienkriteria*** If any one 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 <u>change in frequency/pitch/wavelength</u> of the sound detected by a listener because the sound <u>source and the listener have different velocities relative to the medium of sound propagation</u>. ✓✓ *Die <u>verandering van frekwensie/toonhoogte/golflengte</u> van die klank waargeneem deur 'n luisteraar omdat die klank<u>bron en die luisteraar verskillende snelhede relatief tot die medium van klankvoorplanting</u> het.* **OR/*OF*** An (apparent) <u>change</u> in observed <u>frequency/pitch/wavelength</u> as the result of the <u>relative motion</u> between a <u>source and an observer/listener</u>. ✓✓ *'n (Skynbare) <u>verandering</u> in waargenome <u>frekwensie/toonhoogte/golflengte</u> as gevolg van die <u>relatiewe beweging</u> tussen die <u>bron en 'n waarnemer/luisteraar</u>.*

(2)

6.2	$v_f = v_i + a\Delta t$ ✓ $= 0 + 2\ (5)$ ✓ $= 10\ m\cdot s^{-1}$ $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓ OR $f_L = \frac{v - v_L}{v} f_S$ $f_L = \frac{340 - 10}{340}$ ✓ 600 ✓ $f_L = 582,35\ Hz$ ✓

(6)

6.3 Pitch keeps DECREASING ✓ over time
Frequency decreases./ Pitch and frequency are directly proportional. ✓

Toonhoogte bly AFNEEM oor tyd. Frekwensie neem af. / Toonhoogte en frekwensie is direk eweredig. (2)

6.4 Wavelength INCREASES. ✓
The source is MOVING AWAY from the observer. ✓

Golflengte NEEM TOE.
Die bron BEWEEG WEG van die waarnemer. (2)
[12]

QUESTION 7 / VRAAG 7

7.1 **Marking criteria/Nasienkriteria**

If any one 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.*

Note/Nota: If **masses** used ($^{0}/_{2}$)

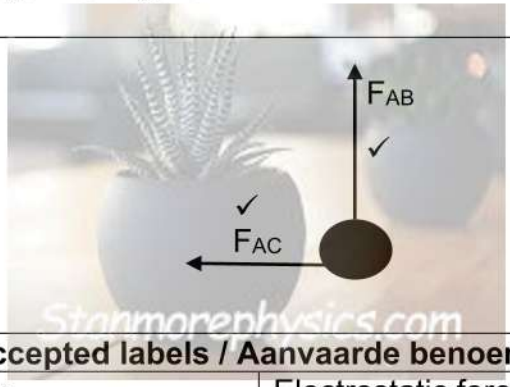
As massagebruik is

The magnitude of the electrostatic force exerted by one point charge (Q1) on another point charge (Q2) is directly proportional to the product of the magnitudes of the charges ✓ and inversely proportional to the square of the distance (r) between them ✓

Die grootte van die elektrostatiese krag wat een puntlading (Q1) op 'n ander puntlading (Q2) uitoefen, is direk eweredig aan die produk van die groottes van die ladings ✓ en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. ✓ (2)

7.2 Negative/negatief ✓ (1)

7.3



(2)

Accepted labels / Aanvaarde benoemings	
F_{AB}	Electrostatic force on charge **A** due to charge **B** Elektrostatiese krag op lading **A** as gevolg van lading **B**
F_{AC}	Electrostatic force on charge **A** due to charge **C** Elektrostatiese krag op lading **A** as gevolg van lading **C**

Notes/Aantekeninge:

- Any additional forces/enige addisionele kragte: deduct 1 mark/trek 1 punt af: max/maks $^1/_2$
- No labels/geen benoemings: deduct 1 mark/trek 1 punt af: max/maks $^1/_2$
- No arrows/geen pyltjies: $0/2$
- Force(s) not touching object/krag(te) raak nie die voorwerp nie: deduct 1 mark/trek 1 punt af: max/maks $^1/_2$
- **Ignore relative sizes of the vectors/Ignoreer relatiewe groottes van die vektore**

7.4

$$F_{AB} = \frac{kQ_1Q_2}{r^2} \checkmark = \frac{(9\times10^9)(2\times10^{-6})(6\times10^{-6})}{(r)^2} \checkmark$$

$$F_{AC} = \frac{(9\times10^9)(2\times10^{-6})(6\times10^{-6})}{(r)^2} \checkmark$$

$$(F_{net})^2 = (F_{AB})^2 + (F_{AC})^2 \checkmark \text{ (Pythagoras)}$$

$$(0{,}12)^2 \checkmark = \left(\frac{0{,}108}{r^2}\right)^2 + \left(\frac{0{,}108}{r^2}\right)^2$$

$$r = 1{,}128 \text{ m} \checkmark$$

(6)
[11]

QUESTION 8 /VRAAG 8

8.1.1

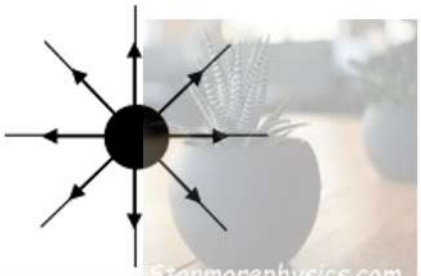
Marking criteria/Nasienriglyne:
-1 mark for each of the 5 key words omitted in the correct context.
-1 punt vir elk van die 5 sleutelwoorde weggelaat in die korrekte konteks.

The electric field at a point is the electrostatic **force** experienced by a **positive unit charge.** ✓ ✓

Die elektriese veld by 'n punt is die elektrostatiese **krag** wat deur 'n **positiewe eenheidslading** ervaar word.

(2)

8.1.2



Criteria for sketch/Kriteria vir skets	Marks/Punte
Correct shape as shown.Field lines start on sphere. *Korrekte vorm soos getoon.Veldlyne begin op sfeer.*	✓
Direction away from charge. *Rigting weg van lading.*	✓

(2)

8.1.3

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

$$n = \frac{6 \times 10^{-6}}{1{,}60 \times 10^{-19}} \checkmark$$

$n = 3{,}75 \times 10^{13}$ electrons/elektrone ✓

(3)

8.2

At/by E = 100 N. C^{-1} $E = \frac{kQ}{r^2}$ ✓

$$100 \checkmark = \frac{(9 \times 10^9)Q}{(0{,}6)^2} \checkmark$$

$Q = 4 \times 10^{-9}$ C

At/by E = 50 N.C^{-1} $E = \frac{kQ}{r^2}$

$$50 = \frac{(9 \times 10^9)(4 \times 10^{-9})}{r^2} \checkmark$$

$r = 0{,}85$ m (0,845m) ✓

(5)

[12]

QUESTION 9 / VRAAG 9

9.1 To measure potential difference ✓

Om potensiaalverskil te meet (1)

9.2 SMALLER THAN/*KLEINER AS* ✓

A_1 is in a parallel connection, A_2 is the total current ✓

A_1 is in 'n parallelle verbinding, A_2 is die totale stroom (2)

9.3.1

$P = I^2R$ ✓
$65 = 2{,}5^2 R$ ✓
$R = 10{,}4\ \Omega$ ✓ (3)

9.3.2 **POSITIVE MARKING FROM/POSITIEWE MERK VANAF 9.3.1**

$V = I \times R$ ✓
$= 2{,}5 \times (4 + 10{,}4)$ ✓
$= 36$ V

$I_{12\Omega} = V / R$
$= 36 / 12$ ✓
$= 3$ A

Total current/*Totale stroom* = 2,5 + 3 = 5,5 A ✓ (4)

9.3.3 **POSITIVE MARKING FROM/POSITIEWE MERK VANAF 9.3.1 & 9.3.2**

$V_{3,5\Omega} = I \times R$
$= 5{,}5 \times 3{,}5$ ✓
$= 19{,}25$ V

$V_1 = 19{,}25 + 36$ ✓
$= 55{,}25$ V ✓ (3)

9.4 THE SAME AS ✓ No current in both, the readings will be 0 A ✓

BLY DIESELFDE Geen stroom in beide nie, die lesings sal 0 A wees (2)
[15]

QUESTION 10 / VRAAG 10

10.1.1 Maximum voltage / peak voltage ✓

Maksimum spanning / Piekspanning (1)

10.1.2 Replace slip rings by split ring/commutator ✓ (1)

Vervang die glyringe deur splitring/kommutator

10.1.3

$P_{ave} = V_{rms} \cdot I_{rms}$ ✓

$= 66,68 \times 3,33$

$= 222,04$ W ✓

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

$= \frac{94,3}{\sqrt{2}}$ ✓

$= 66,68$ V

$I_{rms} = 66,68 \times 0,05$ ✓

$= 3,33$ A

(4)

10.2.1

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$56 = \frac{90^2}{R}$ ✓

$R = 144,64\ \Omega$ ✓

(3)

10.2.2 LESS BRIGHT, ✓ Current less ✓

MINDER HELDER Die stroom is minder (2)

[11]

QUESTION 11 / VRAAG 11

11.1.1 **Marking criteria/*Nasienkriteria***
If any one 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 emitted from a (metal) surface when light of suitable frequency is incident on that surface. ✓✓
Die proses waardeur elektrone uit 'n (metaal)oppervlak vrygestel word wanneer lig van 'n geskikte frekwensie daarop inval/skyn.

(2)

11.1.2 Only ultraviolet light releases (photo) electrons (from the surface of the zinc). ✓✓ OR
Red light does not release (photo) electrons (from the surface of the zinc)

ACCEPT/AANVAAR
$f (UV) \geq f_o$/ $f (Red) < f_o$

Slegs ultravioletlig /straling sal (foto)elektrone vrystel (vanuit die oppervlak van sink). *OF*
Rooi lig stel geen (foto)elektrone (uit die oppervlak van sink) vry nie. (2)

11.1.3 Light energy ✓ to kinetic / electrical energy ✓ (2)

Ligenergie na kinetiese/ elektriese energie

11.2.1
E of red light $= h\frac{c}{\lambda}$ ✓
$= (6,63 \times 10^{-34}) \left(\frac{3 \times 10^8}{6,99 \times 10^{-7}}\right)$ ✓
$= 2,845 \times 10^{-19}$ J ✓

$E < W_o$ ✓ - no electrons released / geen elektrone vrygestel nie. (4)

11.2.2
$E = W_o + E_{k(max)}$ ✓

$h\frac{c}{\lambda} = (6,63 \times 10^{-34}) \left(\frac{3 \times 10^8}{2,7 \times 10^{-7}}\right)$ ✓ $= 6,88 \times 10^{-19} + \frac{1}{2} mv^2$ ✓

$v = 3,27 \times 10^5$ m·s^{-1}

$p = mv$ ✓

$= 9,11 \times 10^{-31} \times 3,27 \times 10^5$ m·s^{-1}

$= 2,978 \times 10^{-25}$ kg m·s^{-1} ✓

(5)

[15]

TOTAL/*TOTAAL*: 150