Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

PHSCE1

This question paper consists of 19 pages including a 3-page data sheet.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Give brief motivations and discussions where required.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Start EACH question on a NEW page.
11. All diagrams are NOT necessarily drawn according to scale.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following quantities is a measure of the inertia of a body?

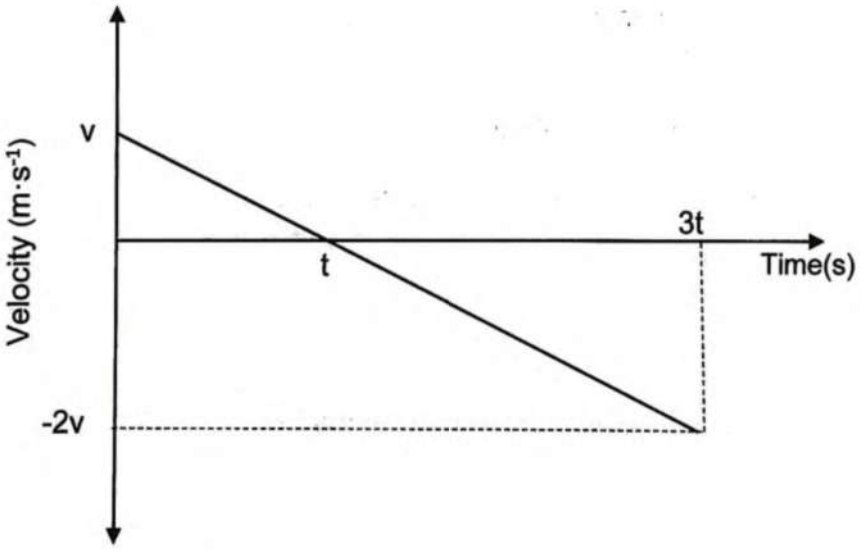
A Acceleration

B Energy

C Velocity

D Mass (2)

1.2 The velocity-time graph below represents the motion of an object under the influence of gravitational force only.



The displacement of the object at time 3t is …

A vt.

B -vt.

C $\frac{-3}{2}$ vt.

D Zero. (2)

1.3 Airbags can protect a driver from serious injury during a collision. Which ONE of the following combinations in the table below best describes the effect that airbags have on the contact time and the net force acting on the driver during the collision and explains why the driver is more protected from injury?

	CONTACT TIME	NET FORCE
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

(2)

1.4 An object is projected vertically upwards from the ground and reaches a maximum height *h*. Which ONE of the following statements regarding the movement of the object from the ground to height *h* is correct? Ignore the effects of air friction.

A The mechanical energy of the object at height *h* is zero.

B The change in kinetic energy of the object is zero.

C The loss in the object's kinetic energy is equal to the gain in the object's gravitational potential energy.

D The work done on the object is equal to zero. (2)

1.5 The force on gravitational attraction on the earth is 6 times greater than on the moon. The reason for this is:

A The moon has no water on its surface.

B The mass and the radius of the earth is greater than that of the moon.

C Only the mass of the earth is greater than the mass of the moon.

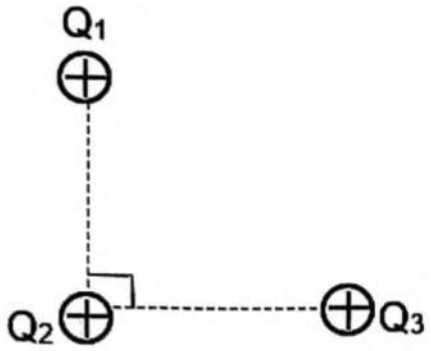
D Only the radius of the earth is greater than the radius of the moon. (2)

1.6 An observer moving at a constant speed away from a stationary sound source, observes that the pitch of the sound waves decreases. This is because the following happens:

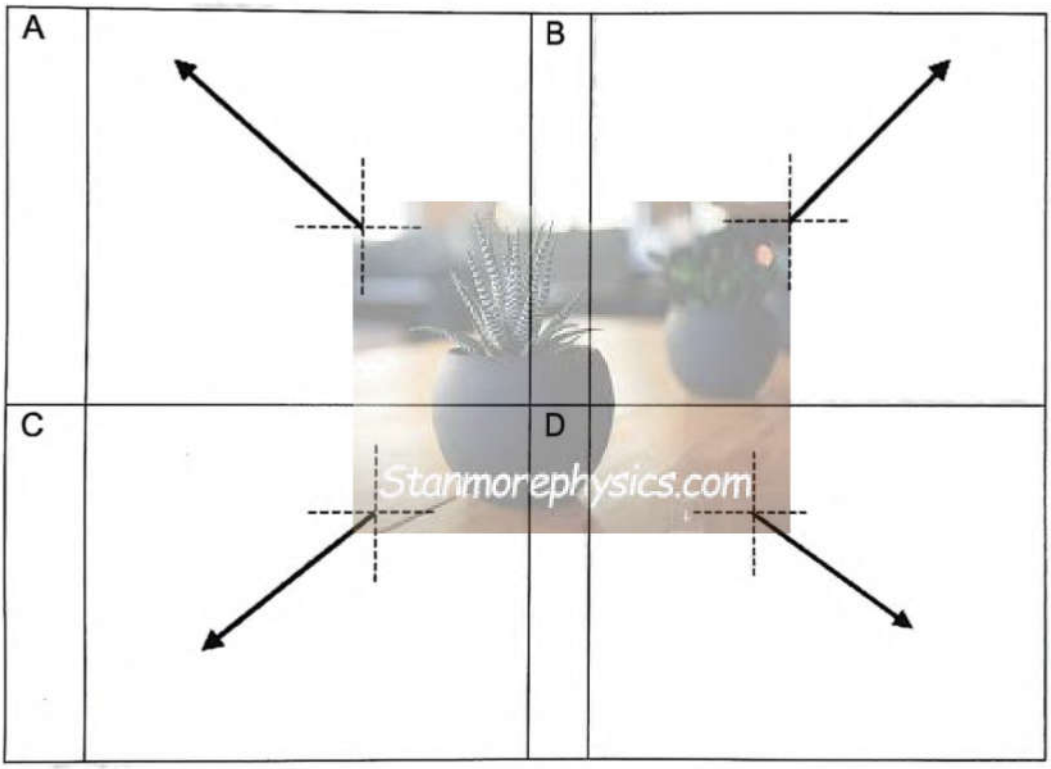
	WAVELENGTH	FREQUENCY
A	Increases	Decreases
B	Decreases	Remains the same
C	Increases	Increases
D	Decreases	Increases

(2)

1.7 Three identical positive point charges, Q_1, Q_2 and Q_3, are arranged as shown in the diagram below.

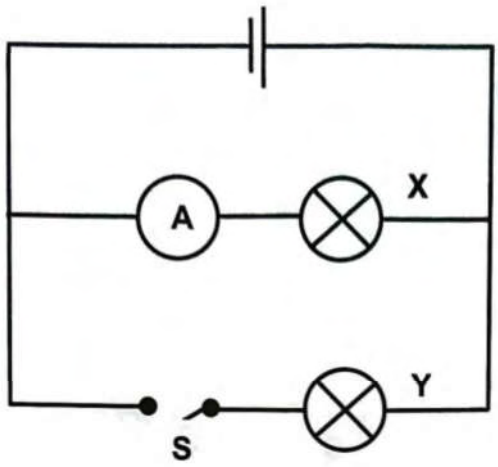


Which ONE of the following diagrams is the correct representation of the NET electrostatic force experienced by charge Q_2?



(2)

1.8 In the circuit diagram below, light bulbs **X** and **Y** are identical. Switch **S** is open.



Switch **S** is now closed.

Which ONE of the following combinations below best describes the change in the total resistance of the circuit and the ammeter reading when switch **S** is closed?

	TOTAL RESISTANCE	AMMETER READING
A	Increases	Decreases
B	Increases	Remains the same
C	Decreases	Increases
D	Decreases	Remains the same

(2)

1.9 A lamp is connected to an AC generator, and it glows with the same brightness as when it is connected to a DC generator producing a potential difference of **Y** volts. The power dissipated by the lamp when connected to the AC generator is equal to …

A $\frac{Y}{\sqrt{2}}(I_{MAX})$.

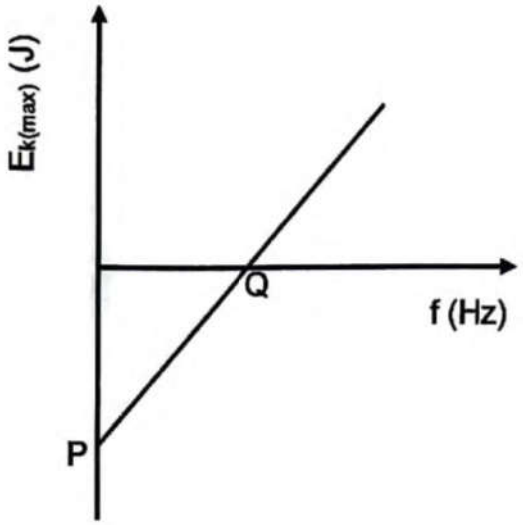
B $\frac{1}{2}I_{max}(Y)$.

C $I_{max}(Y)$.

D $\frac{Y}{\sqrt{2}}(I_{rms})$.

(2)

1.10 The graph below shows the relationship between maximum kinetic energy of ejected photo-electrons and the frequency of the incident photon.



What do the intercepts **P** and **Q** on the graph represent?

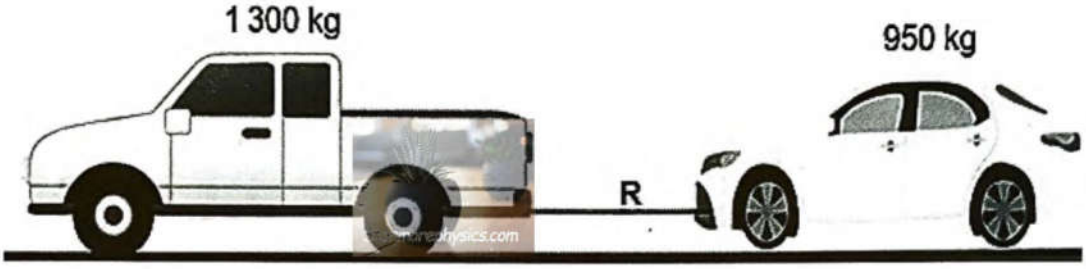
	INTERCEPT P	INTERCEPT Q
A	Planck's constant	Threshold frequency
B	Threshold frequency	Work function
C	Work function	Threshold frequency
D	Threshold frequency	Planck's constant

(2)
[20]

QUESTION 2

A truck of mass 1 300 kg is connected to a car of mass 950 kg by means of an inextensible, massless rope, **R**, and pulls the car along a straight horizontal rough road. The engine of the truck applies a force of 9 000 N to move the truck-car combination to the left as shown in the diagram below. The truck experiences a constant frictional force of 3 500 N. The truck and car move at a CONSTANT VELOCITY.

Ignore the rotational effects of the wheels.



2.1 A learner states that if the truck comes to a sudden stop, the car will continue moving at a constant velocity.

Which physics law did this learner apply to make this statement? (1)

2.2 Draw a labelled free-body diagram of all forces acting on the truck. (5)

2.3 Calculate the:

2.3.1 Tension in the rope connecting the truck and the car (3)

2.3.2 The coefficient of kinetic friction between the car and the road (4)

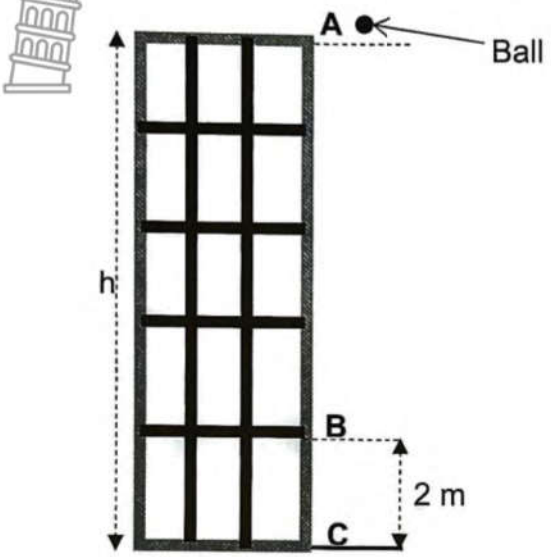
2.4 The rope between the truck and the car suddenly breaks and the car continues to move to the left before coming to rest.

Calculate the magnitude of the acceleration of the car after the rope breaks. (3)
[16]

QUESTION 3

A group of learners set up an experiment to determine the height *h* of their school. They release a tennis ball from point **A** at the edge of the roof of the school building as shown in the diagram below. Point **B** is 2 m above the ground and the ball takes 0,125 s to cover the distance from point **B** to the ground (point **C**).

Ignore the effects of air friction.



3.1 Write down the magnitude of the rate of change of velocity of the ball. (1)

3.2 Calculate the:

3.2.1 Height, *h*, of the school building (5)

3.2.2 Time it takes for the ball to reach the ground (4)

3.2.3 Velocity with which the ball strikes the ground (3)

3.3 Sketch a position versus time graph for the motion of ball from the moment it was released until it strikes the ground. Use the ground as the zero-reference point.

Indicate the following on the graph:

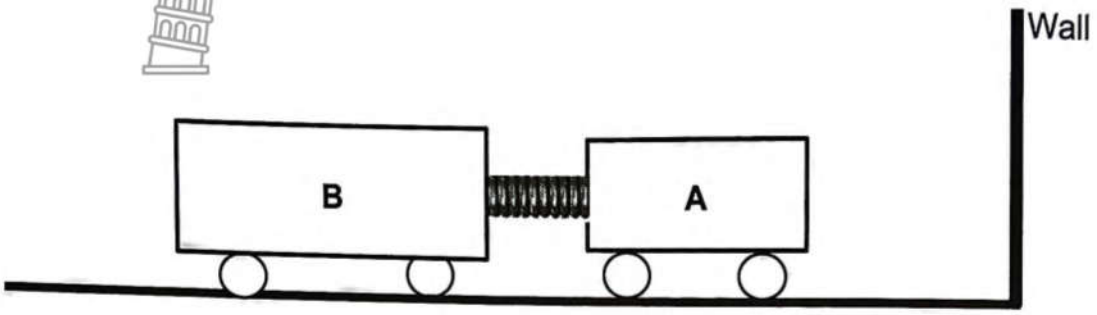
- The height from which the ball was released
- Time when the ball strikes the ground

(3)
[16]

QUESTION 4

Two trolleys, **A** of mass 1 kg, and **B** of mass 2 kg, are held stationary on a smooth horizontal surface with a compressed spring between them, as shown in the diagram below. The spring is released and falls to the ground. Trolley **A** moves to the right at a constant velocity of 5,0 $m \cdot s^{-1}$ and collides with a wall.

Assume this is an isolated system.



4.1 Define an *isolated system*. (2)

4.2 Calculate the velocity of trolley **B** immediately after the spring is released. (4)

4.3 The average force exerted by the wall on trolley **A** is 80 N and the collision of the trolley with the wall lasts 0,5 seconds.

Calculate the velocity with which trolley **A** moves away from the wall. (4)

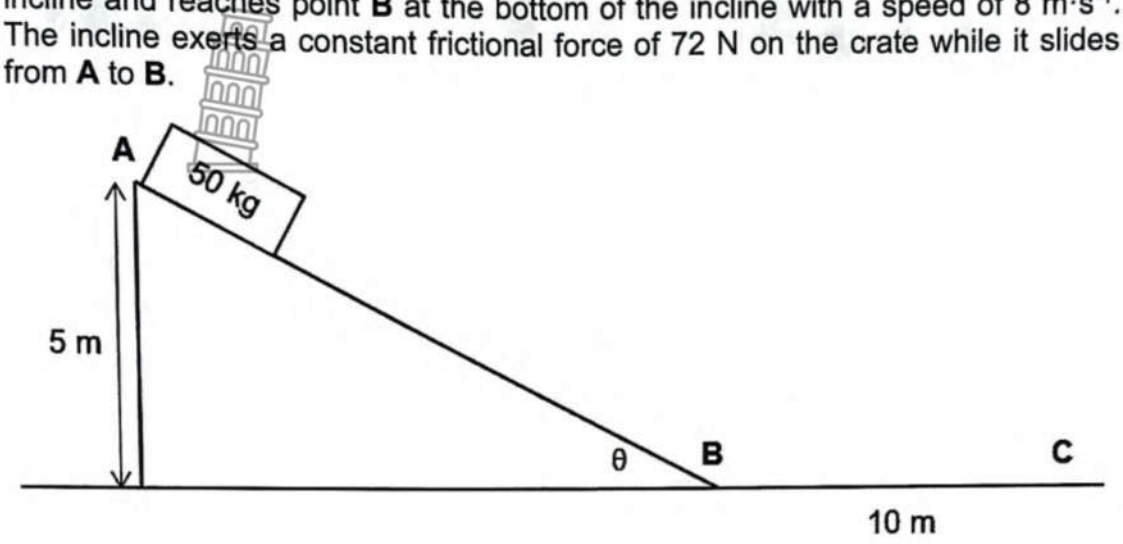
4.4 A learner comments that the collision of trolley **A** with the wall is inelastic.

Briefly explain what is meant by an inelastic collision. (2)

[12]

QUESTION 5

A crate of mass 50 kg is at rest at point **A** which is at a vertical height of 5 m above the horizontal surface. The inclined surface makes an angle θ with the horizontal, as shown in the diagram below. When the crate is released, it slides down the incline and reaches point **B** at the bottom of the incline with a speed of 8 $m \cdot s^{-1}$. The incline exerts a constant frictional force of 72 N on the crate while it slides from **A** to **B**.



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

5.2 Use energy principles to calculate the angle θ. (6)

After passing point **B**, the crate slides along a rough horizontal surface, coming to rest at point **C**, which is 10 m away from point **B**.

5.3 Draw a free body diagram of all forces acting on the crate while it slides from **B** to **C**. (3)

5.4 Calculate the work done by the frictional force to bring the crate to rest. (4)
[15]

QUESTION 6

A police van with its siren on, travels at a constant speed between two observers, **A** and **B**. Observer **A** detects sound with a frequency of 545 Hz from the siren, while observer **B** detects a frequency of 615 Hz.

6.1 State the Doppler effect in words. (2)

6.2 In which direction is the police van moving?

Choose from TOWARDS OBSERVER **A** or TOWARDS OBSERVER **B**.

Give a reason for your answer. (2)

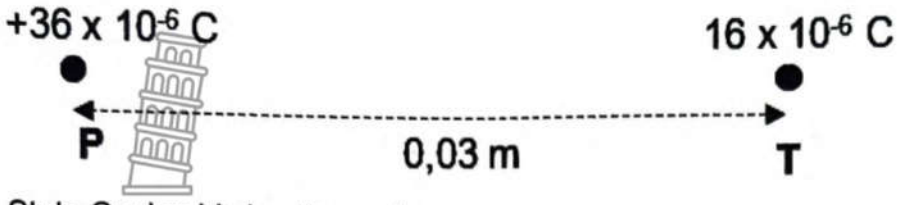
6.3 The speed of sound in air is 343 $m \cdot s^{-1}$. Calculate the frequency of the siren. (7)

6.4 Spectral lines of a certain gas observed from a distant star appear to be red shifted. Explain this observation by referring to the MOTION OF THE STAR and the FREQUENCY of the spectral lines. (2)

[13]

QUESTION 7

Two-point charges, **P** and **T**, are placed 0,03 m apart. The charge on **P** is $+36 \times 10^{-6}$ C while **T** carries a charge of 16×10^{-6} C of UNKNOWN SIGN.



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

7.2 Draw the electric field pattern around a positive charge. (3)

7.3 Calculate the magnitude of the force that charges **P** and **T** exert on each other. (3)

When a test charge is placed at point **X**, a distance **r** m to the right of charge **T** as shown in the diagram below, the test charge remains STATIONARY.

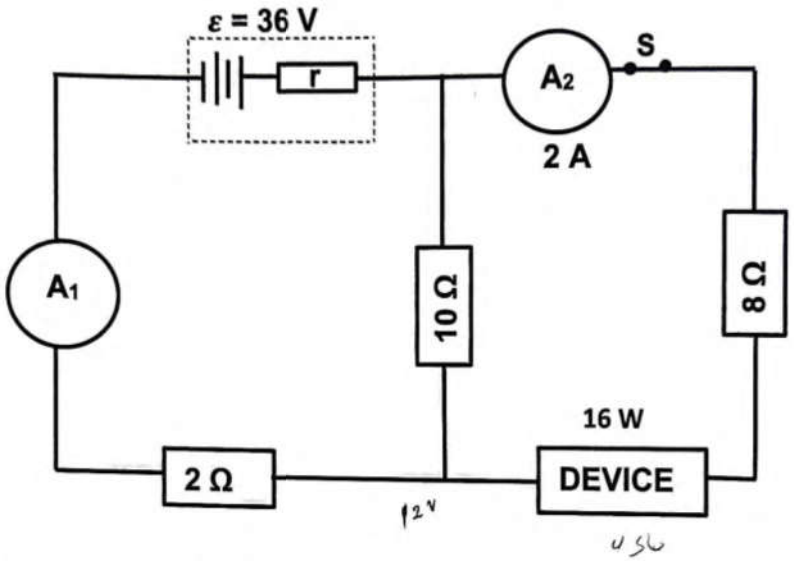
7.4 Write down the sign of the charge (POSITIVE or NEGATIVE) of **T**. Explain your answer. (3)

7.5 Calculate the distance **r**. (5)

[16]

QUESTION 8

Three resistors and an electrical device rated 16 W are connected to a battery of emf 36 V and unknown internal resistance **r**, as shown in the circuit diagram below. Ammeter **A2** reads 2 A when switch **S** is closed.



8.1 Define the term *emf* of a battery in words. (2)

8.2 Calculate the:

8.2.1 Resistance of the electrical device (3)

8.2.2 Current passing through the battery (5)

8.2.3 Internal resistance **r** of the battery (6)

8.3 The switch **S** is now opened. How will this affect the reading on ammeter **A1**?

Choose from INCREASE, DECREASE or REMAIN THE SAME.

Explain your answer.

(2)
[18]

QUESTION 9

A coal power station uses AC generators to produce electricity.

9.1 State the energy conversion that takes place in a generator. (2)

9.2 Draw a sketch graph of emf generated versus time for two complete cycles for an AC generator. (2)

9.3 Alternating current is used for the long-distance transmission of electricity. Give a reason why AC is preferred over DC to transmit electricity over long distances. (1)

9.4 An electrical kettle is marked 220 V. What does the 220 V represent? (1)

9.5 A certain AC generator produces a peak current of 6,25 A when connected to an electrical kettle of resistance 45 Ω.

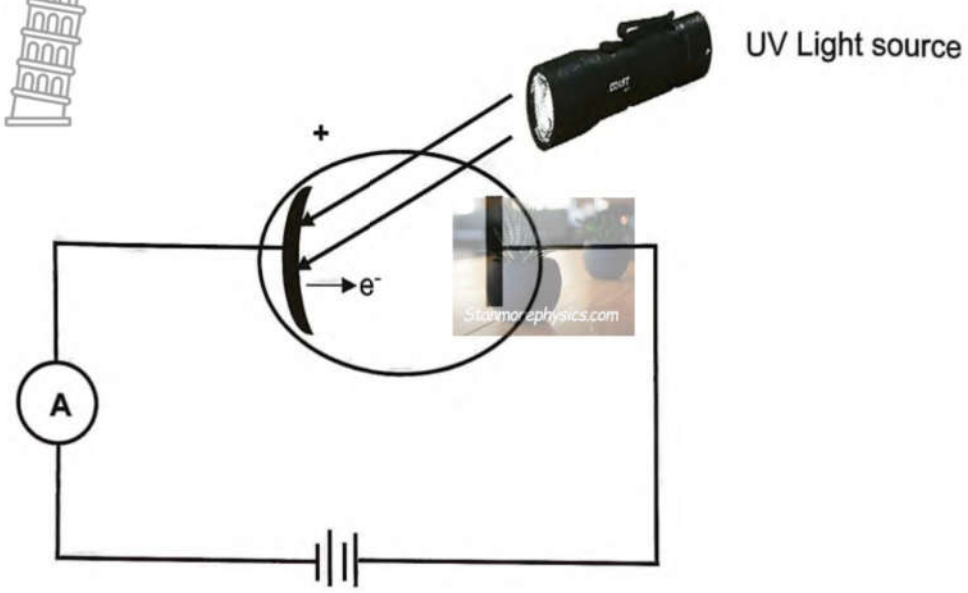
Calculate the:

9.5.1 Root mean square (rms) current (3)

9.5.2 Average power dissipated by the kettle when connected to this generator (3)
[12]

QUESTION 10

An investigation is done to determine the effect of the power of a light bulb on the current which is generated in a photo-electric cell. The apparatus used in this investigation is shown in the simplified diagram below. Ultraviolet light of wavelength 490 nm emitted by two bulbs, **A** and **B**, is shone onto the cathode of the photo-electric cell and the maximum speed of the ejected photo-electrons is measured.



The results of their investigation are shown on the table below.

BULB	POWER OF LIGHT BULB	MAXIMUM SPEED OF PHOTO-ELECTRONS
A	100 W	$7,5 \times 10^5$ m·s^{-1}
B	200 W	$7,5 \times 10^5$ m·s^{-1}

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

10.2 Briefly explain why the power of the light bulbs does not affect the maximum speed of the ejected photo-electrons. (2)

10.3 Which ONE of the light bulbs, **A** or **B**, will produce the highest reading on the ammeter?

Explain your answer. (2)

10.4 Calculate the:

10.4.1 Energy of the ultraviolet photons (3)

10.4.2 Work function of the metal cathode (4)

[13]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12

VRAESTEL 1 (FISIKA)

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

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

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{d^2}$	$g = G\frac{M}{d^2}$

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 $E_k = \frac{1}{2}mv^2$	$W_{nett} = \Delta K$ or/*of* $W_{nett} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv$	

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

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

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + R_3 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$Q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIORSERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2023

PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: **150**

This marking guideline consists of 16 pages./
Hierdie nasienriglyn bestaan uit 16 bladsye.

GENERAL GUIDELINES/*ALGEMENE RIGLYNE*

1. CALCULATIONS/*BEREKENINGE*

1.1 **Marks will be awarded for**: correct formula, correct substitution, correct answer with unit.
Punte sal toegeken word vir: *korrekte formule, korrekte substitusie, korrekte antwoord met eenheid.*

1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there are many relevant symbols and applicable substitutions.
Geen punte *sal toegeken word waar 'n* ***verkeerde of ontoepaslike formule gebruik*** *word nie, selfs al is daar relevante simbole en relevante substitusies.*

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
Wanneer 'n fout gedurende ***substitusie in 'n korrekte formule*** *begaan word, sal 'n punt vir die korrekte formule en vir korrekte substitusies toegeken word, maar* ***geen verdere punte*** *sal toegeken word nie.*

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark.**
Indien ***geen formule*** *gegee is nie, maar* ***al die substitusies is korrek***, ***verloor*** *die kandidaat* ***een punt****.*

1.5 **No penalisation** if **zero substitutions are omitted** in calculations where **correct formula/principle** is correctly given.
Geen penalisering *indien* ***nulwaardes nie getoon*** *word nie in berekeninge waar die* ***formule/beginsel korrek gegee is nie****.*

1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and correct substitutions. The mark for the incorrect numerical answer is forfeited.
Wiskundige manipulasies en verandering van die onderwerp van toepaslike formules tel geen punte nie, maar indien 'n kandidaat met die korrekte formule begin en dan die onderwerp van die formule verkeerd verander, sal die punte vir die formule en korrekte substitusies toegeken word. Die punt vir die verkeerde numeriese antwoord word verbeur.

1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
Punte word slegs vir 'n formule toegeken indien ***'n poging tot berekening aangewend*** *is, d.w.s. substitusies is gedoen of 'n numeriese antwoord is gegee.*

1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
Punte kan slegs toegeken word vir substitusies wanneer waardes in formules ingestel word en nie vir waardes wat voor 'n berekening gelys is nie.

1.9 All calculations, when not specified in the question, must be done to a minimum of two decimal places.
Alle berekenings, wanneer nie in die vraag gespesifiseer word nie, moet tot 'n minimum van twee desimale plekke gedoen word.

1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
Indien 'n finale antwoord van 'n berekening korrek is, sal volpunte nie outomaties toegeken word nie. Nasieners sal altyd verseker dat die korrekte/toepaslike formule gebruik word en dat bewerkings, insluitende substitusies korrek is.

1.11 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.
Vrae waar 'n reeks berekeninge gedoen moet word (bv. 'n stroombaan-diagramvraag) hoef nie noodwendig dieselfde volgorde te hê nie. VOLPUNTE sal toegeken word op voorwaarde dat dit 'n geldige oplossing vir die probleem is. Enige berekening wat egter nie die kandidaat nader aan die antwoord as die oorspronklike data bring nie, sal geen punte tel nie.

2. UNITS/*EENHEDE*

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
*Kandidate sal slegs een keer gepenaliseer word vir die herhaaldelike gebruik van 'n verkeerde eenheid **in 'n vraag**.*

2.2 Units are only required in the final answer to a calculation.
Eenhede word slegs in die finale antwoord op 'n vraag verlang.

2.3 Marks are only awarded for an answer, and not for a unit *per se*. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

Punte sal slegs vir 'n antwoord en nie vir 'n eenheid per se toegeken word nie. Kandidate sal die punt vir die antwoord in die volgende gevalle verbeur:

- *Korrekte antwoord + verkeerde eenheid*
- *Verkeerde antwoord + korrekte eenheid*
- *Korrekte antwoord + geen eenheid*

2.4 SI units must be used except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \bullet s^{-1}$ or $km \bullet h^{-1}$ instead of $m \bullet s^{-1}$ where the question warrants this.
SI-eenhede moet gebruik word, behalwe in sekere gevalle, bv. $V \bullet m^{-1}$ in plaas van $N \bullet C^{-1}$, en $cm \bullet s^{-1}$ of $km \bullet h^{-1}$ in plaas van $m \bullet s^{-1}$ waar die vraag dit regverdig.

3. GENERAL/*ALGEMEEN*

3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.

3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.
Vir nasiendoeleindes sal alternatiewe simbole (s, u, t, ens.) ook aanvaar word.

3.3 Separate compound units with a multiplication dot, not a full stop, for example, $m•s^{-1}$.
For marking purposes, $m•s^{-1}$ and m/s will also be accepted.
Skei saamgestelde eenhede met 'n vermenigvuldigingspunt en nie met 'n punt nie, byvoorbeeld $m•s^{-1}$. Vir nasiendoeleindes sal $m•s^{-1}$ en m/s ook aanvaar word.

4. POSITIVE MARKING/*POSITIEWE NASIEN*

Positive marking regarding calculations will be followed in the following cases:
Positiewe nasien met betrekking tot berekeninge sal in die volgende gevalle geld:

4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. 3.1) and needs to be substituted in another (3.2 of 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent subquestions.
***Subvraag na subvraag**: Wanneer 'n sekere veranderlike in een subvraag (bv. 3.1) bereken word en dan in 'n ander vervang moet word (3.2 of 3.3), bv. indien die antwoord vir 3.1 verkeerd is en word korrek in 3.2 of 3.3 vervang, word **volpunte** vir die daaropvolgende subvraag toegeken.*

4.2 **A multistep question in a subquestion**: If the candidate has to calculate, for example, current in die first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.
*'n **Vraag met veelvuldige stappe in 'n subvraag**: Indien 'n kandidaat bv. die stroom verkeerd bereken in 'n eerste stap as gevolg van 'n substitusiefout, verloor die kandidaat die punt vir die substitusie sowel as die finale antwoord.*

5. NEGATIVE MARKING/*NEGATIEWE NASIEN*

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given in QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for e.g. QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer could be considered.
'n Verkeerde antwoord, indien dit op 'n konsepsuele fout gebaseer is, kan normaalweg nie korrek gemotiveer word nie. Indien 'n kandidaat gevra word om in VRAAG 3.2 die antwoord op VRAAG 3.1 te motiveer en VRAAG 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op bv. VRAAG 3.1 egter op 'n berekening gebaseer is, kan die motivering vir die verkeerde antwoord in VRAAG 3.2 oorweeg word.

QUESTION 1/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS
MEERVOUDIGEKEUSE-VRAE

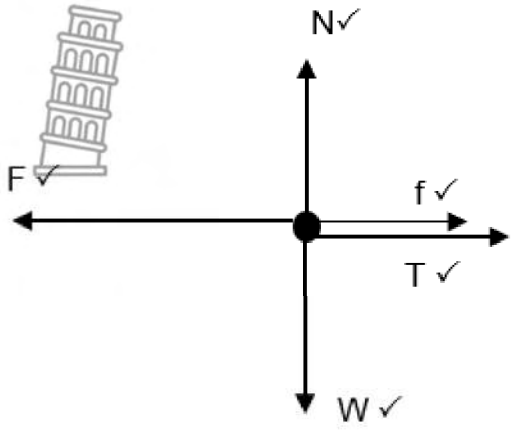
1.1	D ✓✓	(2)
1.2	C ✓✓	(2)
1.3	B ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	A ✓✓	(2)
1.7	C ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	C ✓✓	(2)

[20]

QUESTION 2/*VRAAG 2*

2.1 Newton's third law ✓
Newton se derde wet (1)

2.2



Notes
Mark awarded for arrow and label.
Do not penalise for length of arrows since drawing is not drawn to scale,
Any other additional force(s). Max. $^4/_5$
If force(s) do not make contact with body. Max. $^4/_5$

Aantekeninge
Punt word toegeken vir byskrif en pyltjie.
Moenie vir die lengte van die pyltjie penaliseer nie
Enige addisionele krag(te). Maks. $^4/_5$
As krag(te) nie kontak maak met liggaam nie. Maks. $^4/_5$ (5)

2.3.1 $F_{net} = ma$ / $F - T - f = ma$ } Any one / *Enige een* ✓
$9\,000 - T - 3\,500 = 0$ ✓
$T = 5\,500$ N ✓ (3)

POSITIVE MARKING FROM / *POSITIEWE NASIEN VANAF* 2.3.1

2.3.2 $F_{net} = ma$
$T - f = ma$
$T - \mu_k N = ma$
$T - \mu_k mg = ma$ } Any one / *Enige een* ✓
$\underline{5\,500 - \mu_k \times 950 \times 9{,}8 = 0}$ ✓
$\therefore \mu_k = 0{,}59$ (0,591) ✓ (4)

2.4 $F_{net} = ma$
$-f = ma$
$-(\mu_k N) = ma$
$-(\mu_k mg) = ma$
Any one / *Enige een* ✓

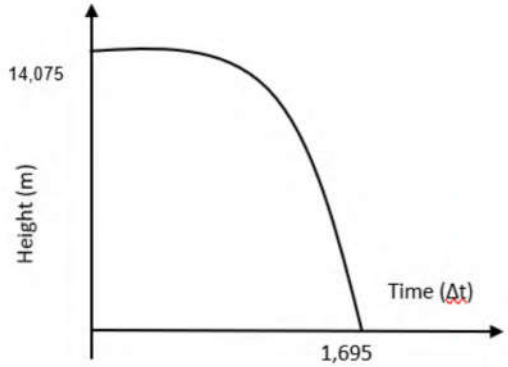
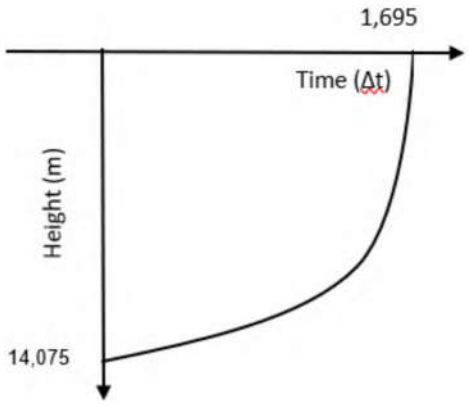
$\underline{-(0,59 \times 950 \times 9,8) = 950a}$ ✓
$\therefore a = -5,78\ m.s^{-2}$
$\therefore a = 5,78\ m.s^{-2}$ (to the right / *na regs*) ✓ (3)
[16]

QUESTION 3/*VRAAG 4*

3.1 $9,8\ m.s^{-2}$ ✓ (1)

3.2.1	**UPWARD POSITIVE/*OPWAARTS AS POSITIEF***	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\underline{-2 = v_i \times 0,125 + \frac{1}{2} \times (-9,8)(0,125)^2}$ ✓ $v_i = -15,388\ m.s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{-15,388^2 = 0^2 + 2(-9,8)\ \Delta y}$ ✓ $\therefore \Delta y = 12,08\ m$ Height / *Hoogte* = 12,08 + 2 ✓ Height / *Hoogte* = 14,08 m ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\underline{2 = v_i \times 0,125 + \frac{1}{2} (9,8)(0,125)}$ ✓ $v_i = 15,388\ m.s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{15,388^2 = 0^2 + 2(9,8)\ \Delta y}$ ✓ $\therefore \Delta y = 12,08\ m$ Height / *Hoogte* = 12,08 + 2 ✓ Height / *Hoogte* = 14,08 m ✓	Any one/ *Enige een* ✓ (5)
3.2.2	**UPWARD POSITIVE/*OPWAARTS AS POSITIEF***	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
	$v_f = v_i + a\Delta t$ ✓ $\underline{-15,388 = 0 + (-9,8)(\Delta t)}$ ✓ $\therefore \Delta t = 1,57\ s$ $\Delta t = 1,57 + 0,125$ ✓ $\Delta t = 1,70\ s$ ✓	$v_f = v_i + a\Delta t$ ✓ $\underline{15,388 = 0 + (9,8)(\Delta t)}$ ✓ $\therefore \Delta t = 1,57\ s$ $\Delta t = 1,57 + 0,125$ ✓ $\Delta t = 1,70\ s$ ✓	(4)
	OPTION 1/*OPSIE 1*		
3.2.3	**UPWARD POSITIVE/*OPWAARTS AS POSITIEF***	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{-15,388^2 + 2(-9,8)(-2)}$ ✓ $\therefore v_f = 16,61\ m.s^{-1}$ downwards / *afwaarts* ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{15,388^2 + 2(9,8)(2)}$ ✓ $\therefore v_f = 16,61\ m.s^{-1}$ downwards/*afwaarts* ✓	
	OPTION 2/*OPSIE 2*		
	UPWARD POSITIVE/*OPWAARTS AS POSITIEF*	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
	$v_f = v_i + a\Delta t$ ✓ $v_f = \underline{-15,388 + (-9,8)(0,125)}$ ✓ $v_f = -16,61$ $\therefore v_f = 16,61\ m.s^{-1}$ downwards / *afwaarts* ✓	$v_f = v_i + a\Delta t$ ✓ $v_f = \underline{15,388 + (9,8)(0,125)}$ ✓ $\therefore v_f = 16,61\ m.s^{-1}$ downwards/*afwaarts* ✓	

	OPTION 3/*OPSIE 3*		
	UPWARD POSITIVE/*OPWAARTS AS POSITIEF*	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
	$\Delta x = \frac{v_f + v_i}{2}\Delta t$ ✓ $-2 = (\frac{v_f + (-15{,}388)}{2}) \times 0{,}125$ ✓ $\therefore v_f = 16{,}61$ m.s^{-1} downwards /*afwaarts* ✓	$\Delta x = \frac{v_f + v_i}{2}\Delta t$ ✓ $2 = (\frac{v_f + 15{,}388}{2}) \times 0{,}125$ ✓ $\therefore v_f = 16{,}61$ m.s^{-1} downwards /*afwaarts* ✓	(3)

	UPWARD POSITIVE/*OPWAARTS AS POSITIEF*	**UPWARD NEGATIVE/*OPWAARTS AS NEGATIEF***	
			

CRITERIA FOR MARKING / *NASIENKRITERIA*	
Correct shape / *Korrekte vorm*	✓
Initial position indicated / Aanvanklike posisie aangedui	✓
Time when ball hits the ground / *Tyd wanneer bal die grond tref*	✓

(3)
[16]

QUESTION 4/*VRAAG 4*

4.1 A system on which the net external force is zero. ✓✓
'n Sisteem waar die netto eksterne krag nul is. (2)

4.2 $\sum p_i = \sum p_f$
$m_A v_i + m_B v_i = m_A v_f + m_B v_f$ ✓ Any one / *Enige een*
$(m_A + m_B)v_i = m_A v_f + m_B v_f$
$\underline{(2 + 1) \times 0}$ ✓ $= \underline{1 \times 5 + 2v_f}$ ✓
$v_f = 2{,}5\ m.s^{-1}$ left / *links* (west / *wes*) ✓ (4)

4.3

OPTION 1 / *OPSIE 1*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = mv_f - mv_i$ ✓ Any one / *Enige een*
$\underline{-80 \times 0{,}05}$ ✓ $= \underline{1 \times v_f - 1 \times 5}$ ✓
$v_f = 1\ m.s^{-1}$ left / *links* (west / *wes*) ✓

OPTION 2 / *OPSIE 2*

$F_{net} = ma$
$\underline{-80 = 1 \times a}$ ✓
$a = -80\ m.s^{-2}$
$v_f = v_i + a\Delta t$ ✓
$v_f = 5 + \underline{(-80) \times 0{,}05}$ ✓
$v_f = 1\ m.s^{-1}$ left / *links* (west / *wes*) ✓ (4)

4.4 Collision in which kinetic energy is not conserved. ✓✓
Collision where total kinetic energy before the collision is not equal to the total kinetic energy after the collision. ✓✓
Botsing waarin die kinetiese energie nie behoue is nie.
Botsing waar die totale kinetiese energie voor die botsing nie gelyk is aan die totale kinetiese energie na die botsing nie. (2)
[12]

QUESTION 5/*VRAAG 5*

5.1 The work done on an object by a net force is equal to the change in kinetic energy of the object. ✓✓
Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

OPTION 1 / *OPSIE 1*

5.2 $W_{net} = \Delta E_k$
$W_{Fg} + W_f = \Delta E_k$
$-\Delta E_p + W_f = \Delta E_k$
$[-mg(h_2 - h_1)] + f.\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } *Any one / Enige een* ✓

$\underline{- 50 \times 9{,}8\ (0 - 5)}$ ✓ + $\underline{72\Delta x\cos 180^\circ}$ ✓ = $\underline{\frac{1}{2} \times 50 \times 8^2 - 0}$ ✓

$\Delta x = 11{,}81$ m
$\theta = \sin^{-1}\left(\frac{5}{11{,}81}\right)$ ✓
$\theta = 25{,}05^\circ$ ✓

OPTION 2 / *OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$
$W_{nc} = [mg(h_2 - h_1)] + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$W_f = [mg(h_2 - h_1)] + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one / *Enige een* ✓

$\underline{72\Delta x\cos 180^\circ}$ ✓ = $\underline{50 \times 9{,}8\ (0 - 5)}$ ✓ + $\underline{\frac{1}{2} \times 50 \times 8^2 - 0}$ ✓

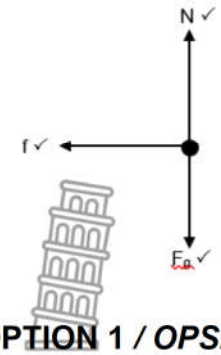
$\Delta x = 11{,}81$ m
$\theta = \sin^{-1}\frac{5}{11{,}81}$ ✓
$\theta = 25{,}05^\circ$ ✓

OPTION 3 / *OPSIE 3*

$W_{net} = \Delta E_k$
$(F_g - F_f).\Delta x.\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one / *Enige een* ✓
$(mg\sin\theta - 72).\Delta x.(1) = \underline{\frac{1}{2}(50)(8^2 - 0^2)}$ ✓
$\frac{50(9{,}8)(5)\,\Delta x}{\Delta x}$ ✓ $- \underline{72\Delta x}$ ✓ $= 1\,600$

$\Delta x = 11{,}81$ m
$\theta = \sin^{-1}\frac{5}{11{,}81}$ ✓
$\theta = 25{,}05^\circ$ ✓ (6)

5.3



(3)

5.4 **OPTION 1 / *OPSIE 1***

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

$W_f = 0$ ✓ $- \frac{1}{2} \times 50 \times 8^2$ ✓
$W_f = 1\ 600$ J ✓

OPTION 2 / *OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$
$W_f = \Delta E_p + \Delta E_k$
} Any one / *Enige een* ✓

$W_f = 0$ ✓ $- \frac{1}{2} \times 50 \times 8^2$ ✓
$W_f = 1\ 600$ J ✓

OPTION 3 / *OPSIE 3*

$v_f^2 = v_f^2 + 2a\Delta x$
$0^2 = 8^2 + 2a(10)$ ✓
$\therefore a = -3{,}2\ m \cdot s^{-1}$

$F_{nett} = ma$
$= 50 \times (-3{,}2)$ ✓
$= -160$ N $(= F_f)$

(Any ONE / *Enige EEN* ✓)

$W_f = F_f \cdot \Delta x \cdot \cos\theta$
$= (160)(10)(\cos 180^\circ)$
$= 1\ 600$ J ✓

(4)
[15]

QUESTION 6/*VRAAG 6*

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

The (apparent) change in frequency observed by a listener due to relative motion between the sound source and the listener. ✓ ✓

Die verandering in die (waargenome) frekwensie waargeneem deur 'n luisteraar omdat daar relatiewe beweging is tussen die luisteraar en die klankbron. (2)

6.2 Towards observer **B**. ✓ Frequency detected by observer B is higher than the frequency detected by observer **A**. ✓

*Na waarnemer **B**. Die frekwensie wat waargeneem word deur luisteraar **B** is hoër as die waargenome frekwensie deur luisteraar **A**.* (2)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

545 ✓ $= \frac{343}{343 + v_s}$ ✓ x f_s .....(1)

615 ✓ $= \frac{343}{343 - v_s}$ ✓ x f_s .....(2)

$v_s = 20{,}70\ m{\cdot}s^{-1}$ $(20{,}69827586\ m{\cdot}s^{-1})$

$f_s = \frac{545(343 + 27{,}70)}{343}$ ✓ **OR/OF** $f_s = \frac{615(343 - 27{,}70)}{343}$

$f_s = 577{,}91$ Hz ✓ (range / *gebied* 577,89 Hz to 577,91 Hz) (7)

6.4 The star is moving away. ✓
The spectral lines show a decrease in frequency (towards red). ✓

OR/OF

The spectral lines show an increase in wavelength (towards red). ✓

Die ster beweeg weg.
Die spektralelyne toon 'n afname in frekwensie (na rooi).

OR/OF

Die spektralelyne toon 'n toename in golflengte (na rooi). (2)

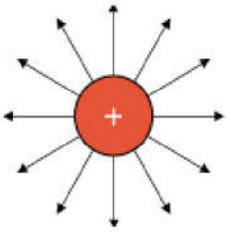
[13]

QUESTION 7/*VRAAG 7*

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

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

7.2



Marking criteria / *Nasienkriteria*
- ✓ Direction / *Rigting*
- ✓ Straight lines / *Reguitlyne*
- ✓ Touching and vertically from charge./ *Raak en is loodreg vanaf die lading*

(3)

7.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9 \times 10^9)(36 \times 10^{-6})(16 \times 10^{-6})}{(0,03)^2}$ ✓

$F = 5\ 760$ N ✓ (3)

7.4 Negative. ✓ For the test charge to experience a net force of zero, the electric field due to **P** and **T** should be in opposite (directions). ✓ The electric field of **P** is to the right, for the electric field of **T** to move to the left, (away) from point **X**, it must be a negative charge. ✓

*Negatief. Vir die puntlading om 'n netto krag van nul te ervaar moet die elektrieseveld a.g.v. **P** en **T** in teenoorgestelde (rigtings) wees. Die elektrieseveld van **P** is regs sodat die elektrieseveld van **T** na links beweeg (weg) vanaf punt **X**. so dit moet 'n negatiewe lading wees.* (3)

7.5 $E = \frac{kQ}{r^2}$ ✓

$E_1 = \frac{(9 \times 10^9)(36 \times 10^{-6})}{(0,03 + r)^2}$ ✓ right / *regs* (Note distance to be correct / *Let wel die afstand moet korrek wees*)

(Any 1 of Top substitutions / *Enige van die vervangings*)

$E_2 = \frac{(9 \times 10^9)(16 \times 10^{-6})}{r^2}$ ✓ left/*links*

$E_{net} = E_1 + E_2$

$0 = \frac{(9 \times 10^9)(36 \times 10^{-6})}{(0,03 + r)^2} + \frac{(-(0,03 + r)^2)}{r^2}$ ✓ (Correct addition / *Korrekte addisie*)

$r = 0,06$ m ✓ (5)

[16]

QUESTION 8/*VRAAG 8*

8.1 The total energy per coulomb of charge that a battery can supply. ✓✓
Die totale energie per coulomb lading wat 'n battery kan verskaf. (2)

8.2.1 $P = I^2 R$ ✓
$16 = 2^2 \times R$ ✓
$R = 4\ \Omega$ ✓ (3)

8.2.2 **Positive marking from / *Positiewe nasien vanaf* 8.2.1**

OPTION 1 / *OPSIE 1*

$R = \frac{V}{I}$ ✓
$12 = \frac{V_p}{2}$ ✓
$V = 24$ V
$I_{10} = \frac{24}{10}$ ✓
$I_{10} = 2,4$ A
$I = I_{10} + I_2$
$I = 2,4 + 2$ ✓
$I = 4,4$ A ✓

OPTION 2 / *OPSIE 2*

$I_{10} = \frac{12}{10} \times 2$ ✓✓✓
$I_{10} = 2,4$ A
$I = I_{10} + I_2$
$I = 2,4 + 2$ ✓
$I = 4,4$ A ✓

(5)

8.2.3 **Positive marking from 8.2.1 and 8.2.2. / *Positiewe nasien vanaf 8.2.1 en 8.2.2***

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓
$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{12}$ ✓
$R_p = 5,4545\ \Omega$

$R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓
$R_p = \frac{10 \times 12}{10 + 12}$ ✓
$R_p = 5,4545\ \Omega$

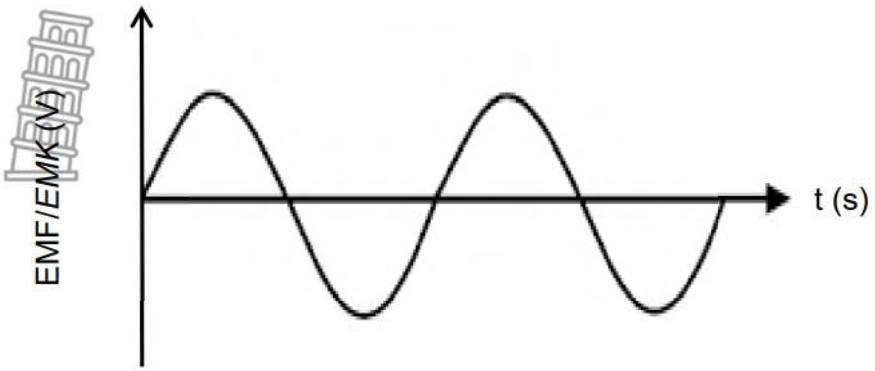
$R_{ext} = 7,4545\ \Omega$
Emf / *Emk* $= I(R_{ext} + r)$ ✓
$[36 = 4,4\ (\underline{7,4545}$ ✓$+ r)]$ ✓
$R = 0,73\ \Omega$ ✓ (6)

8.3 Decrease. ✓ The total external resistance will increase, and the current will decrease. ✓
Afneem. Die totale eksterne weerstand sal toeneem en die stroom sal afneem. (2)
[18]

QUESTION 9/*VRAAG 9*

9.1 Mechanical energy ✓ to electrical energy. ✓
Meganiese energie na elektriese energie. (2)

9.2



Marking criteria / *Nasienkriteria*	
Correct shape/ *Korrekte vorm*	✓
Two complete waves / *Twee volledige golwe*	✓

(2)

9.3 AC can be transmitted over long-distances because it causes minor energy loss. ✓

OR/*OF*

The potential difference can be increased or decreased.
WS kan oor lang afstande met minimale energie verlies oorgedra word.

OR/*OF*

Die potensiaalverskil can verhoog of verlaag word. (1)

9.4 $V_{rms/\ wgk}$ **OR** Root mean square voltage/*wortel gemiddelde kwadraat spanning* (1)

9.5.1 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{6,25}{\sqrt{2}}$ ✓

$I_{rms} = 4,42\ A$ ✓ (3)

9.5.2 **Positive marking from / *Positiewe nasien vanaf* 9.3.1**
OPTION 1 / *OPSIE 1*
$P_{average\ /\ gemiddeld} = I_{rms}^2 R$ ✓
$= 4,42^2 \times 45$ ✓
$= 879,14\ W$ ✓ (3)
[12]

QUESTION 10/*VRAAG 10*

10.1 The process whereby electrons are ejected from a (metal) surface, when light of suitable frequency is incident on that surface. ✓✓
Die proses waardeur elektrone uit 'n (metaal)oppervlakte vrygestel word, wanneer lig van geskikte frekwensie invallend op die oppervlak is. (2)

10.2 Increasing the power rating of the light bulb increases the intensity of the photons. ✓ Increase in intensity does not affect the maximum kinetic energy or maximum speed of the photo-electrons. ✓
Toename in die drywinggradering van die gloeilampies verhoog die intensiteit van die fotone. Toename in die intensiteit affekteer nie die maksimum kinetiese energie nie of maksimum spoed van die fotoëlektrone nie. (2)

10.3 Light **B**. ✓ It has the higher intensity. More photo-electrons will be ejected and therefore more current. ✓ (Ammeter reading will be higher.)

*Lig **B**. Dit het 'n hoër intensiteit. Meer foto-elektrone word vrygestel en daarom meer stroom. (Ammeterlesing sal hoër wees).* (2)

10.4.1

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
$E = \frac{hc}{\lambda}$ ✓ $E = \frac{6{,}63\times10^{-34}\times3\times10^{8}}{490\times10^{-9}}$ ✓ $E = 4{,}06 \times 10^{-19}$ J ✓	$c = f\lambda$ $f = \frac{3\times10^{8}}{490\times10^{-9}}$ $f = 6{,}12244898$ Hz $E = hf$ ✓ $E = \underline{6{,}63 \times 10^{-34} \times 6{,}12244898 \times 10^{14}}$ ✓ $E = 4{,}06 \times 10^{-19}$ J ✓

(3)

10.4.2 **Positive marking from / *Positiewe nasien vanaf* 10.4.1.**
$E = W_0 + E_{k(max/\ maks.)}$ ✓
$4{,}06 \times 10^{-19}$ ✓ $= W_o + \underline{\frac{1}{2} \times 9{,}11 \times 10^{-31} \times (7{,}5 \times 10^{5})^2}$ ✓
$W_0 = 1{,}50 \times 10^{-19}$ J ✓ (4)
[13]

TOTAL / *TOTAAL*: 150