basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2025

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

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

A in the direction of motion of the object.

B in the direction of acceleration of the object.

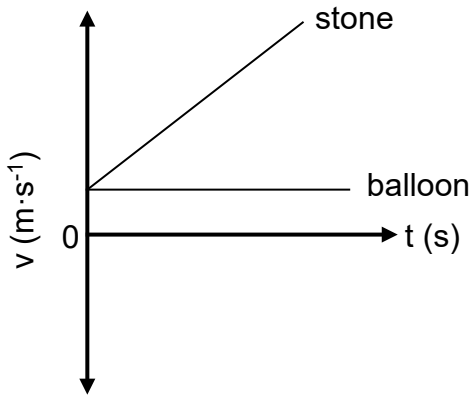
C zero when the object moves at constant acceleration.

D increasing when the object moves at constant acceleration. (2)

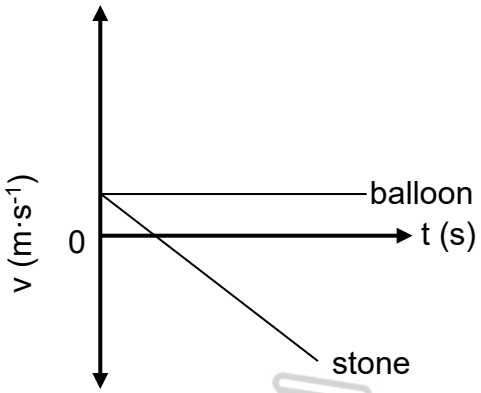
1.2 A hot-air balloon is moving upwards at a constant velocity. A small stone is dropped from THE BALLOON. Which ONE of the following graphs represents the motions of the balloon and the stone?

Ignore the effects of friction on the stone.

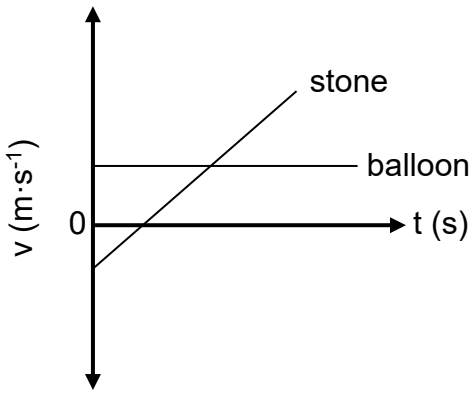
A



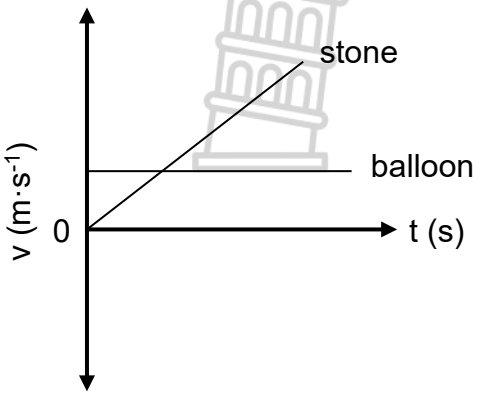
B



C

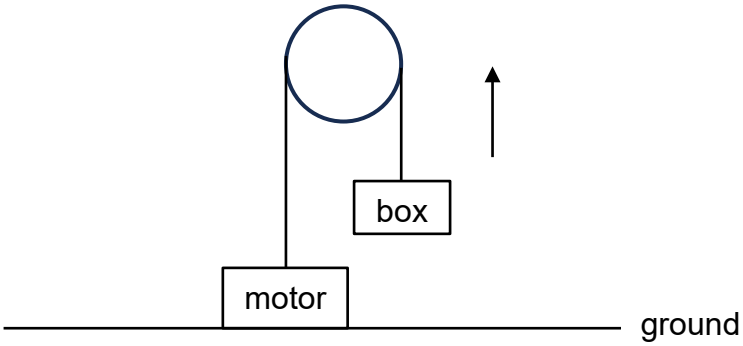


D



(2)

1.3 A motor fixed to the ground is used to lift a box vertically upwards at a CONSTANT VELOCITY.



Consider the statements below for the upward motion of the box.

(i) The rate at which work is done by the motor on the box increases.
(ii) The rate at which work is done by the motor on the box is constant.
(iii) The mechanical energy of the box increases.
(iv) The mechanical energy of the box is constant.

Which of the statements above are CORRECT?

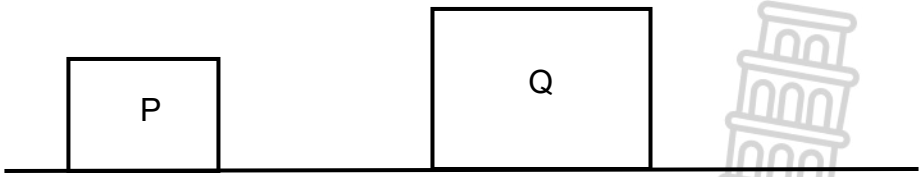
A (i) and (iii) only

B (ii) and (iv) only

C (ii) and (iii) only

D (i) and (iv) only (2)

1.4 Objects P and Q, with masses m and 2m respectively, have the same momentum.



The velocity of P is …

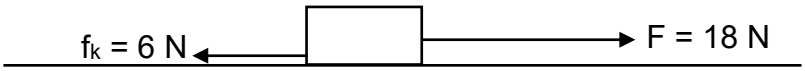
A equal to the velocity of Q.

B half the velocity of Q.

C twice the velocity of Q.

D four times the velocity of Q. (2)

1.5 A block moves along a rough horizontal surface while a horizontal force F of magnitude 18 N and a constant kinetic frictional force of magnitude 6 N act on it.



Which ONE of the following combinations of ACCELERATION and NET WORK DONE ON THE BLOCK is CORRECT?

	ACCELERATION	NET WORK DONE ON THE BLOCK
A	Constant	Increases
B	Increases	Constant
C	Increases	Increases
D	Constant	Constant

(2)

1.6 A star's spectrum, observed from Earth, is red shifted. Which ONE of the following statements is CORRECT?

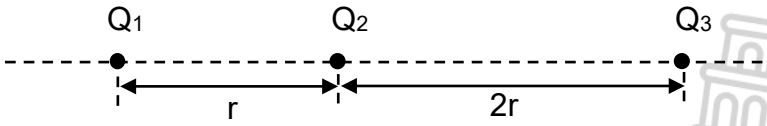
A The speed of light is increasing.

B The star is moving towards Earth.

C The frequency of each spectral line has increased.

D The wavelength of each spectral line has increased. (2)

1.7 Three point charges, Q_1, Q_2 and Q_3, are fixed in a straight line. Q_1 is r metres from Q_2, while Q_3 is 2r metres from Q_2, as shown in the diagram below.



The magnitude of the charge on Q_2 is q. The net electrostatic force on charge Q_1 is zero.

What is the magnitude of charge Q_3 in terms of q?

A $\frac{1}{9}q$

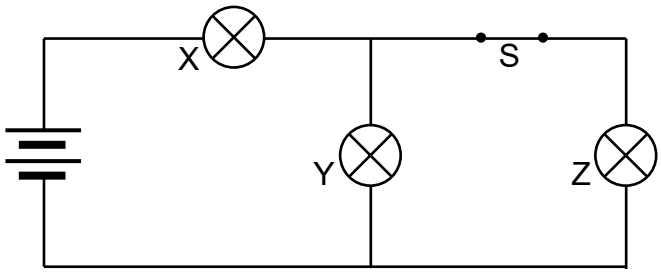
B $\frac{1}{3}q$

C 3q

D 9q (2)

1.8 Three identical light bulbs, X, Y and Z, are connected in a circuit, as shown in the diagram below. Switch S is initially closed.

Ignore the internal resistance of the battery.



Switch S is now opened.

How will the brightness of bulbs X and Y be affected?

	BRIGHTNESS OF BULB X	BRIGHTNESS OF BULB Y
A	Increases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Decreases	Decreases

(2)

1.9 How does the commutator in a DC motor ensure that the coil rotates continuously in ONE direction?

A By reducing friction

B By converting AC to DC

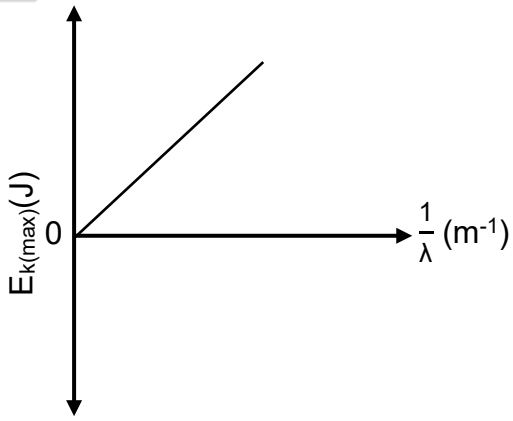
C By reversing the direction of the current in the coil

D By maintaining electrical contact between the external and the internal circuits (2)

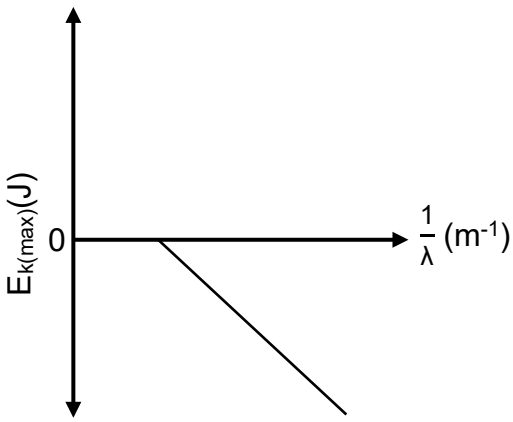
1.10 Light of different wavelengths is incident on a metal surface.

Which ONE of the following graphs shows the CORRECT relationship between the maximum kinetic energy of the photoelectrons, $E_{k(max)}$, and the inverse of the wavelength of the incident light, $\frac{1}{\lambda}$?

A



B



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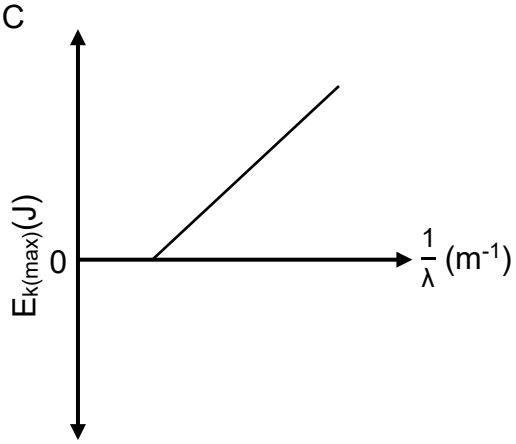

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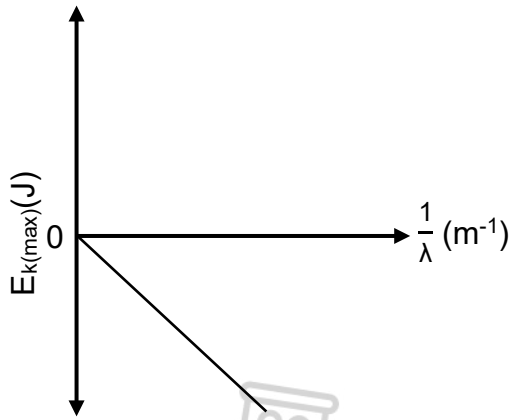
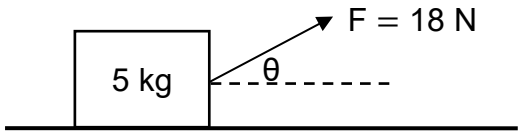


(2)
[20]

QUESTION 2 (Start on a new page.)

A block of mass 5 kg is at rest on a rough horizontal surface. When a constant force F of magnitude 18 N acts on the block at an angle θ to the horizontal, the block experiences maximum static friction. See the diagram below.



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

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

2.3 The horizontal component of force F is 15 N.

Calculate:

2.3.1 θ (2)

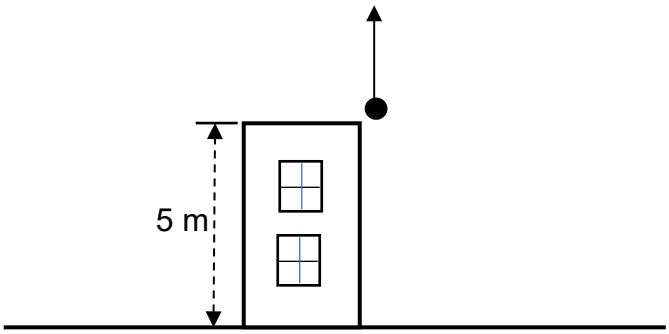
2.3.2 The coefficient of static friction (5)

2.4 Angle θ is decreased while the magnitude of force F remains constant.

How will the friction acting on the block be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (4)
[17]

QUESTION 3 (Start on a new page.)

A ball is projected vertically upwards from the top of a building that is 5 m high. Ignore the effects of friction.



The table below shows the magnitude of the velocity of the ball at THREE different times during its motion.

TIME (s)	MAGNITUDE OF VELOCITY ($m \cdot s^{-1}$)
0	15
p	0
3,36	q

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

3.2 Using EQUATIONS OF MOTION ONLY, calculate the value of p. (3)

The ball strikes the ground 3,36 seconds after it was thrown upwards.

3.3 Calculate q. (3)

The ball bounces to a maximum height of 3 m after it struck the ground.

3.4 Is the collision with the ground ELASTIC or INELASTIC?

Explain the answer WITHOUT the use of calculations. (3)

3.5 Sketch a velocity versus time graph for the motion of the ball from the time it was projected until it reached the maximum height after it bounced.

Show the following NUMERICAL VALUES on the graph:

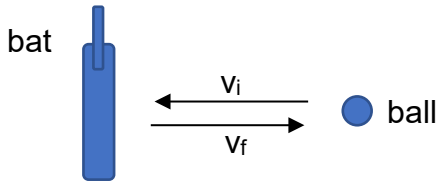
- The initial velocity
- Time p
- Velocity q

(4)
[15]

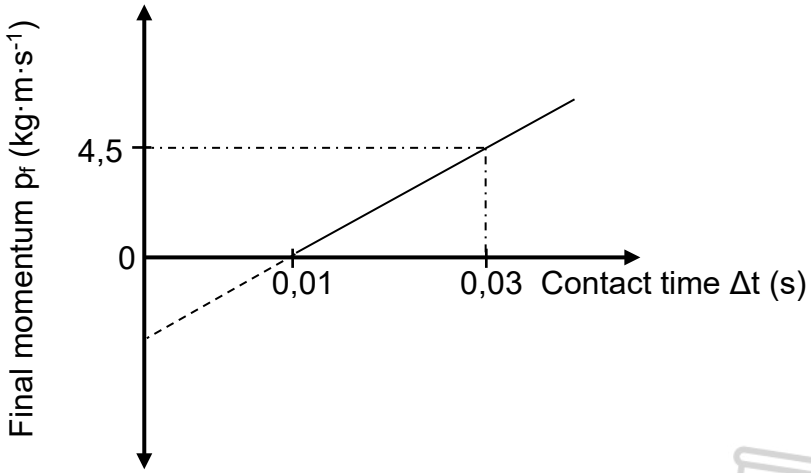
QUESTION 4 (Start on a new page.)

Cricketers at an academy conduct an experiment to determine the relationship between the contact time and the final momentum of a ball for a constant average net force.

A cricket ball of mass 150 g is thrown horizontally with a certain initial velocity and is struck by a bat so that the ball moves in the opposite direction, as shown in the diagram below. The average net force acting on the ball is horizontal.



The experiment is repeated using the same ball. The average net force and the initial velocity of the ball are kept constant. The contact time between the bat and the ball is changed EACH time. The results obtained are shown in the sketch graph below.



4.1 Define the term *impulse*. (2)

4.2 Calculate the:

4.2.1 Average net force acting on the ball (3)

4.2.2 Magnitude of the initial velocity of the ball (4)

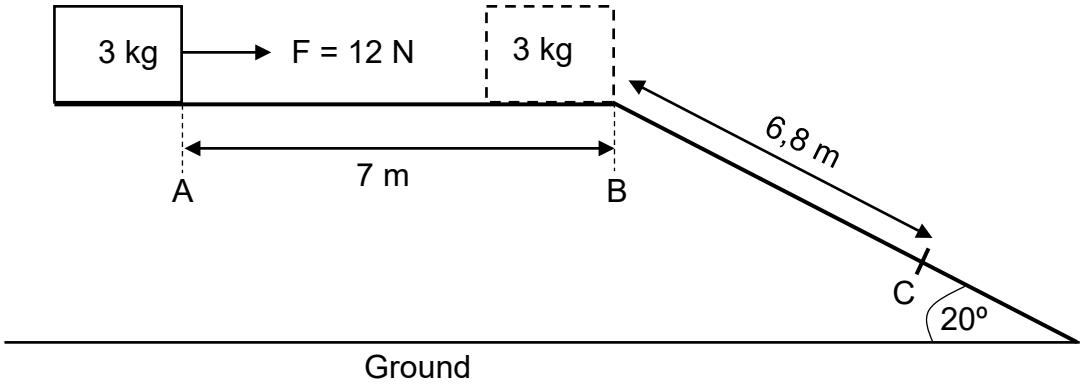
4.3 Redraw the graph in the ANSWER BOOK and label it as A.

On the same set of axes, draw the graph that will be obtained when a ball with a bigger mass is used, without changing the initial velocity and average net force. Label this as B. (2)

[11]

QUESTION 5 (Start on a new page)

A crate of mass 3 kg is at rest at point A on a frictionless horizontal surface. A constant horizontal force F of 12 N acts on the crate and moves it from point A to point B. The crate then moves down a rough plane, inclined at 20° to the horizontal. The distance from point A to point B is 7 m and from point B to point C is 6,8 m, as shown in the diagram below.



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

5.2 Using ENERGY PRINCIPLES ONLY, calculate the kinetic energy of the crate at point B. (3)

Force F is removed when the crate reaches point B. The crate then experiences a constant frictional force of 21 N as it moves down the incline.

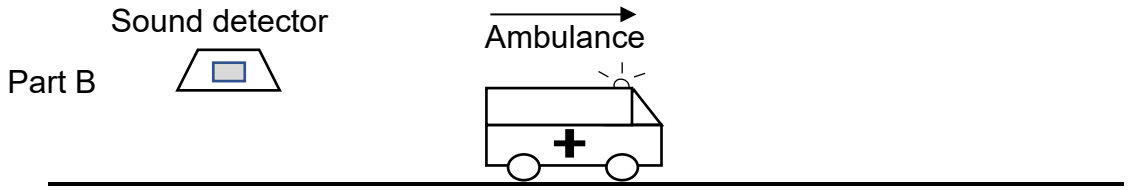
5.3 Draw a free-body diagram showing ALL the forces acting on the crate as it moves down the incline. (3)

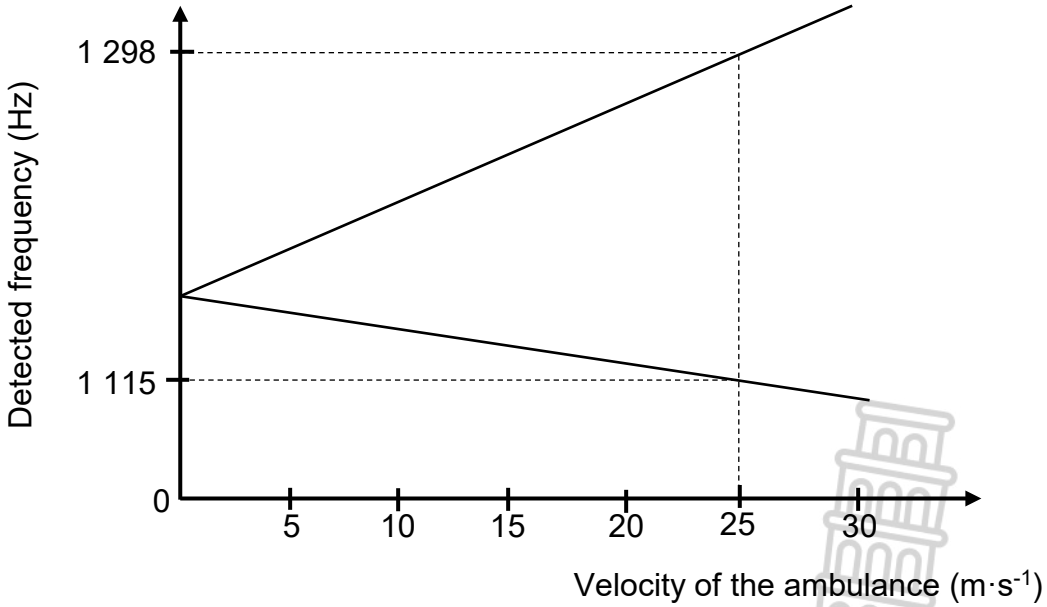
5.4 Using ENERGY PRINCIPLES ONLY, determine whether the crate will pass point C. (5)
[13]

QUESTION 6 (Start on a new page.)

An investigation is performed to determine the relationship between the velocity of a moving sound source and the frequency of the sound detected.

The siren of an ambulance produces sound with a constant frequency. The ambulance, with its siren on, moves towards a stationary sound detector (Part A) and away from the stationary sound detector (Part B) at constant velocities. The experiment is repeated for different velocities of the ambulance. The detected frequency is measured for EACH velocity. The results obtained are shown in the graph below.





6.1 STATE the Doppler effect. (2)

6.2 For this experiment, write down:

6.2.1 The independent variable (1)

6.2.2 A controlled variable (1)

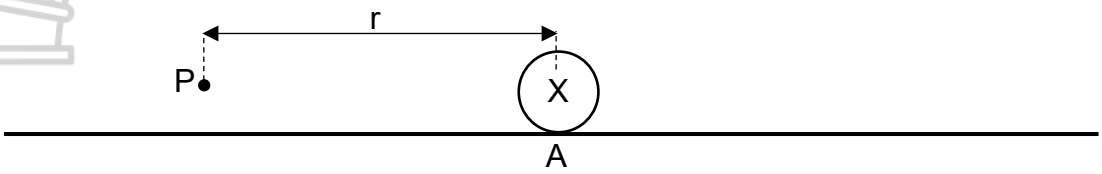
6.3 What conclusion can be made for Part B of this experiment? (2)

6.4 Calculate the speed of sound in air. (6)

[12]

QUESTION 7 (Start on a new page.)

A sphere X is placed at point A on a horizontal surface. X carries a charge of $+3 \times 10^{-7}$ C. Point P is r metres to the left of point A.



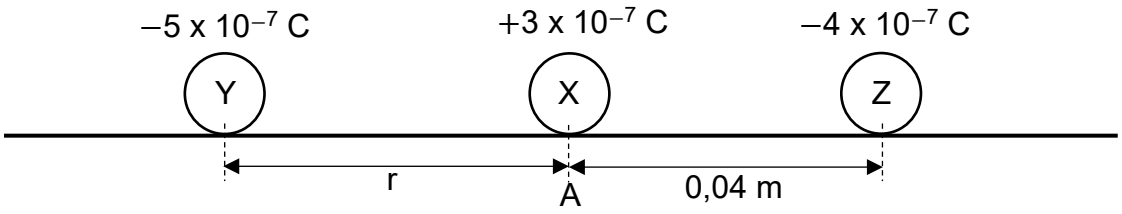
The magnitude of the electric field at point P is $1,08 \times 10^{6}$ N·C^{-1}.

7.1 Describe an *electric field*. (2)

7.2 Draw the electric field pattern due to the charge on sphere X. (2)

7.3 Show, by means of a calculation, that r = 0,05 m. (3)

Sphere Y, carrying a charge of -5×10^{-7} C, is now fixed at point P and sphere Z, carrying a charge of -4×10^{-7} C, is fixed 0,04 m to the right of sphere X.



7.4 The NET FORCE acting on sphere X is 0,0427 N at point A.

Is the surface frictionless? Choose from YES or NO. Explain the answer by means of a calculation. (6)

7.5 Sphere Y is brought into contact with sphere X, and is placed back in its original position.

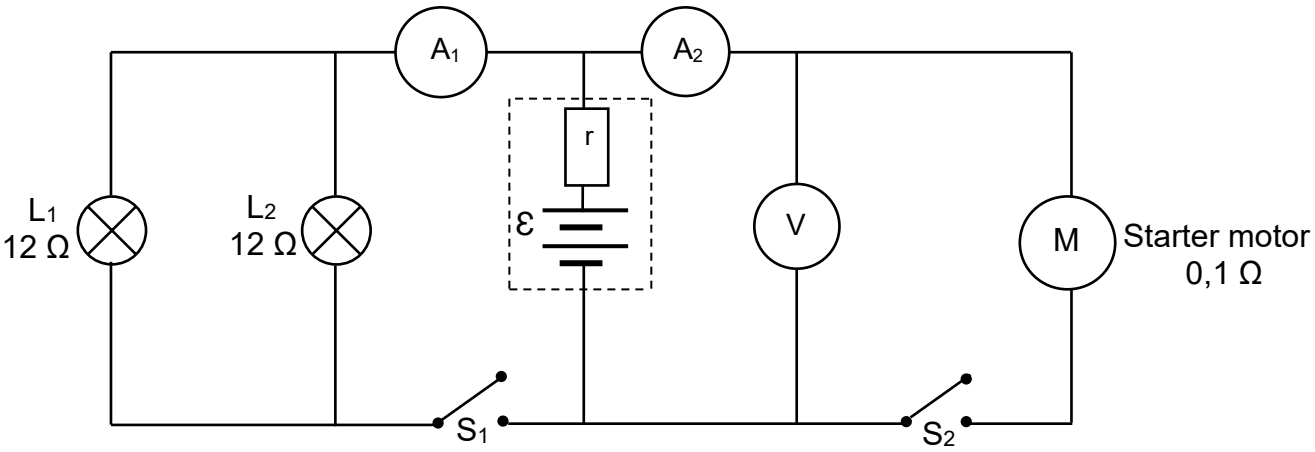
How will the magnitude of the force that sphere X now exerts on sphere Y be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. (2)

[15]

QUESTION 8 (Start on a new page.)

Two identical headlights, L_1 and L_2, and a starter motor, M, of a car are connected to a battery, as shown in the circuit diagram below. The resistance of each headlight is 12 Ω, while the resistance of the starter motor is 0,1 Ω. The emf (Ɛ) and internal resistance (r) of the battery are unknown.

The ammeters and the connecting wires have negligible resistance, while the voltmeter has a high resistance. Switches S_1 and S_2 are initially open.



8.1 Define the term *emf*. (2)

8.2 Switch S_1 remains open while switch S_2 is closed.
The reading on ammeter A_2 is 120 A.

Calculate the reading on the voltmeter. (3)

8.3 Switch S_1 is now closed and switch S_2 is opened. The power dissipated by each headlight is 15 W.

8.3.1 Calculate the current passing through L_1. (3)

8.3.2 Write down the reading on ammeter A_1. (1)

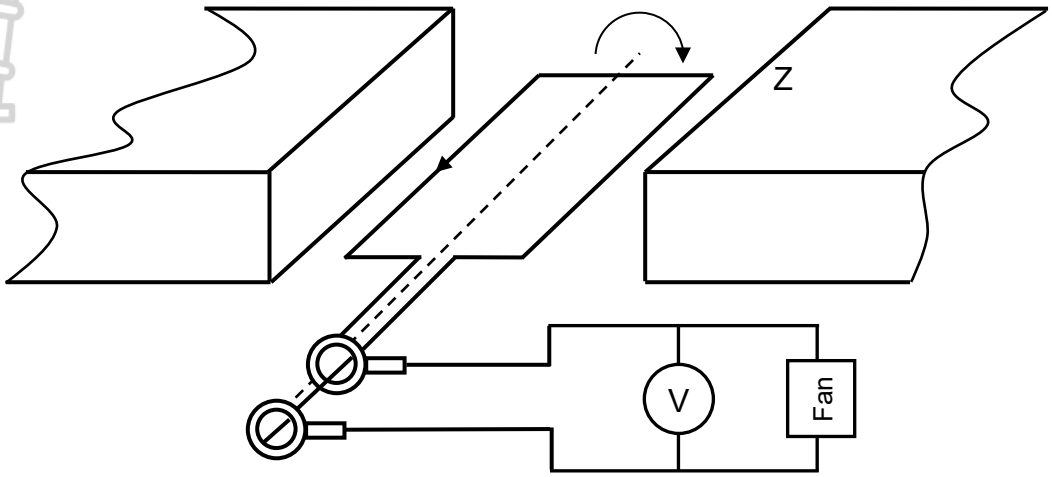
8.4 Calculate the emf of the battery. (6)

8.5 Both switches are now closed.
How will the reading on ammeter A_1 be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer WITHOUT the use of a calculation. (5)
[20]

QUESTION 9 (Start on a new page.)

An AC generator operates a fan. The directions of the rotation of the coil and the induced current are shown in the simplified diagram below.

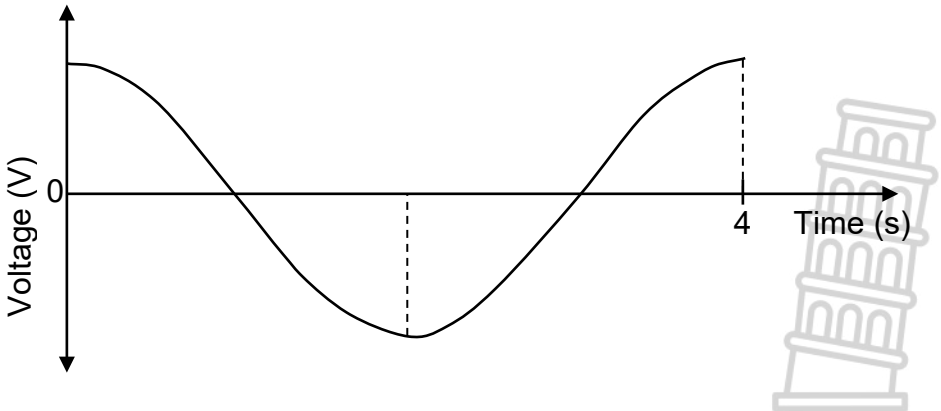


9.1 Define the term *rms potential difference*. (2)

9.2 What is the polarity of the magnet at Z? (2)

9.3 The resistance of the fan is 60 Ω and the maximum potential difference produced by the generator is 311,11 V. Calculate the cost of operating the fan for 1,5 hours if the cost of electricity is R3,33 per kWh. (5)

The voltage versus time graph for this generator is given below.



9.4 Redraw this graph in the ANSWER BOOK and label it as A. On the same set of axes, draw the graph for ONE rotation of the coil when the speed of rotation is doubled. Label this as graph B. (3)

9.5 State ONE way in which this generator can be changed to a DC generator. (1)
[13]

QUESTION 10 (Start on a new page.)

10.1 Learners conduct an experiment to determine whether electrons will be emitted from the surface of different metals when light with a single frequency is incident on the metal. The maximum kinetic energy of emitted electrons are measured when light of frequency $1,045 \times 10^{15}$ Hz is used.

The results obtained are shown in the table below.

METALS	ELECTRONS EMITTED	MAXIMUM KINETIC ENERGY (J)
Zinc	Yes	0
Sodium	Yes	$2,53 \times 10^{-19}$
Caesium	Yes	$3,50 \times 10^{-19}$
Metal M	No	–

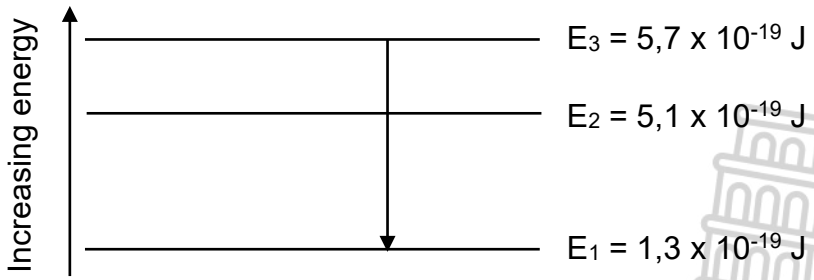
10.1.1 Define the term *work function*. (2)

10.1.2 Write down the threshold frequency of zinc. (1)

10.1.3 How does the work function of sodium compare to that of caesium? Choose from SMALLER THAN, GREATER THAN or EQUAL TO. Explain the answer. (3)

10.1.4 Light of the same frequency, but with a higher intensity, is now incident on metal M. Will electrons now be ejected? Choose from YES or NO. Give a reason for the answer. (2)

10.2 The energy diagram below (NOT drawn to scale) shows the electron energies in different energy levels, E_1, E_2 and E_3, of a certain atom.



10.2.1 An electron of this atom moves from E_3 to E_1. Photon X is emitted. Calculate the frequency of photon X. (4)

10.2.2 Is it possible for a photon with an energy of $2,5 \times 10^{-19}$ J to be emitted from this atom? Choose from YES or NO. Give a reason for the answer. (2)

[14]

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	$3 \times 10^8\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9 \times 10^9\ N\cdot m^2\cdot C^{-2}$
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) = $I(R + r)$ emf (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 2025

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

QUESTION 1/*VRAAG 1*

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

[20]

QUESTION 2/*VRAAG 2*

2.1

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

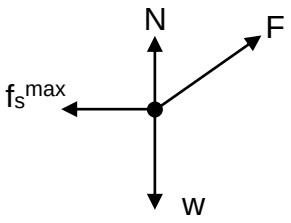
When the net/resultant force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp

OR/*OF*

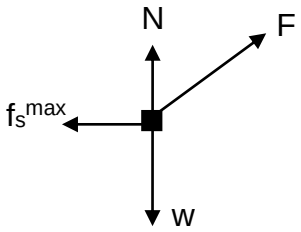
The net/resultant force acting on an object is equal to the rate of change of momentum of the object (in the direction of the net force). **(2 or 0)**
Die netto/resulterende krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die netto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

(2)

2.2



Accept force diagram/
Aanvaar kragtediagram:



Accepted labels/*Aanvaarde byskrifte*	
w	F_g /F_w /$F_{earth\ on\ P}$ /weight /mg /49 N /gravitational force *F_g /F_w /$F_{aarde\ op\ P}$ /gewig /mg /49 N /gravitasiekrag*
F	F_A /18 N / Applied force / *Toegepaste krag*
f_s^{max}	F_f / f_s /f /Friction (force) / (static) friction / *(statiese) wrywingskrag*
N	F_N /Normal (force) /F_{normal} /*$F_{normaal}$ /Normaal(krag)*

Notes/*Aantekeninge*

- Mark awarded for label and arrow./*Punt toegeken vir byskrif en pyltjie.*
- f_k not accepted as label/*f_k word nie aanvaar nie*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks:* $^3/_4$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks:* $^3/_4$
- If force(s) do not make contact with the dot /*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks:* $^3/_4$

(4)

2.3.1

$F_x = F\cos\theta$ $15 = 18\cos\theta$ ✓ $\theta = 33{,}56^\circ$ ✓	**OR/*OF*** $9{,}95 = 15\tan\theta$ ✓ $\theta = 33{,}56^\circ$ ✓	**OR/*OF*** $9{,}95 = 18\sin\theta$ ✓ $\theta = 33{,}56^\circ$ ✓
NOTE/*NOTA:* If answer only/*Indien slegs antwoord* 1/2		

(2)

2.3.2

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

Marking criteria/*Nasienkriteria*

- Formula / *Formule* $f_s^{max} = \mu_s N$ ✓
- Correct substitution of f_s^{max} / *Korrekte vervanging van* f_s^{max} ✓
- Correct calculation of F_y / *Korrekte berekening van* F_y ✓
- Subtraction for the calculation of N from F_g thus: $(5)(9{,}8) - (18\sin 33{,}56°)$ ✓
  Aftrek *vir die berekening van N van* F_g
- Correct final answer/ *Korrekte finale antwoord*: 0,38 ✓

OPTION 1/*OPSIE 1*

$f_s^{max} = \mu_s N$
$f_s^{max} = \mu_s(mg - F\sin\theta)$ ✓ Anyone/*Enigeen*

15 ✓ $= \mu_s[(5)(9{,}8)$ ✓ $- 18\sin 33{,}56°]$ ✓

$\mu_s = 0{,}38$ ✓

OPTION 2/*OPSIE 2*

$F_{net} = 0$
$F_N + F_y - F_g = 0$
$F_N + F_y = F_g$

$F_N = (5)(9{,}8)$ ✓ $- (18\sin 33{,}56°)$ ✓

$F_N = 39{,}05$ N

$f_s^{max} = \mu_s N$ ✓
15 ✓ $= \mu_s(39{,}05)$
$\mu_s = 0{,}38$ ✓

OPTION 3/*OPSIE 3*

$F_y = \sqrt{(18)^2 - (15)^2}$ ✓
$= 9{,}95$ N

$F_{net} = 0$
$F_N + F_y - F_g = 0$
$F_N = F_g - F_y$

$F_N = (5)(9{,}8)$ ✓ $- (9{,}95)$

$F_N = 39{,}05$ N

$f_s^{max} = \mu_s N$ ✓
15 ✓ $= \mu_s(39{,}05)$
$\mu_s = 0{,}38$ ✓

NOTE: If N calculation NOT shown ($^3/_5$)
NOTA: Indien berekening van N nie getoon ($^3/_5$)

(5)

2.4

Increases ✓ • Vertical component of F decreases ✓ • Normal force increases ✓ • μ_s remains constant, f_s^{max} is directly proportional to N✓	*Neem toe* • *Vertikale component van F neem af* • *Normaalkrag neem toe* • μ_s *bly konstant,* f_s^{max} *direk eweredig aan N*
OR Decreases ✓ • Horizontal component of F increases ✓ • The block will move (F_{net} will increase)✓ • $f_k < f_s^{max}$ ✓	***OF*** *Neem af* • *Horisontale komponent van F neem toe* • *Die blok sal beweeg (*F_{net} *sal toeneem)* • $f_k < f_s^{maks}$
OR Remains the same ✓ • Explain using relevant calculation NB: In the calculation, candidates must choose a $\mu_k < \mu_s$ value and θ that together with the μ_k value will give an answer of 15 N for f_k	***OF*** *Bly dieselfde* ✓ • *Verduidelik deur van 'n gepaste berekening gebruik te maak* *NB: In die berekening moet die kandidaat 'n waarde* $\mu_k < \mu_s$ *en θ wat saam met* μ_k *waarde 'n antwoord van 15 N gee vir* f_k

(4)
[17]

QUESTION 3/*VRAAG 3*

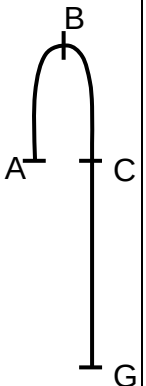
3.1 Motion under the influence of weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gewig/gravitasiekrag.
(2 or/of 0)

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

3.2

Marking criteria/*Nasienkriteria*
- Formula with Δt/*Formule met Δt* ✓
- Correct substitution into formula/*Korrekte vervanging in formule* ✓
- Correct final answer / *Korrekte finale antwoord*: 1,53 s ✓

NOTE for 3.2 and 3.3: If energy principles used ($^1/_3$) for the final answer
NOTA vir 3.2 en 3.2: *Indien energiebeginsels gebuik* ($^1/_3$) *vir finale antwoord*



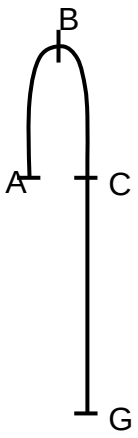
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
A-B: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ (s) ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ (s) ✓	**B-C:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-15 = 0 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ (s) ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $15 = 0 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ (s) ✓

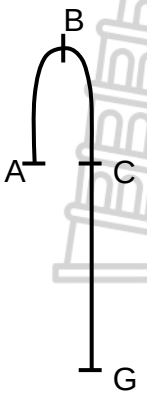
OPTION 3/*OPSIE 3* A-C:	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-15 = 15 + (-9,8)\Delta t$ ✓	$15 = -15 + (9,8)\Delta t$ ✓
$\Delta t = 3,06$	$\Delta t = 3,06$
$p = 3,06 \div 2$	$p = 3,06 \div 2$
$p = 1,53$ (s) ✓	$p = 1,53$ (s) ✓

(3)

3.3

POSITIVE MARKING FROM QUESTION 3.2/*POSITIEWE NASIEN VANAF VRAAG 3.2*	
Marking criteria/*Nasienkriteria* • Formula with v_f./*Formule met v_f.* ✓ • Correct substitution into formula./*Korrekte vervanging in formule.* ✓ • Correct final answer/*Korrekte finale antwoord*: 17,97 $m\cdot s^{-1}$ ✓ • **[RANGE: 17,93 – 18,33]**	
OPTION 1/*OPSIE 1* A-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$✓ $v_f^2 = (15)^2 + 2(-9,8)(-5)$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (-15)^2 + 2(9,8)(5)$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**OPTION 2/*OPSIE 2* A-G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:** $v_f = v_i + a\Delta t$ ✓ $= (15) + (-9,8)(3,36)$ ✓ $= -17,93$ $= 17,93$ $(m\cdot s^{-1})$ ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:** $v_f = v_i + a\Delta t$ ✓ $= (-15) + (9,8)(3,36)$ ✓ $= 17,93$ $(m\cdot s^{-1})$ ✓
OPTION 3/*OPSIE 3* C-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (-15)^2 + 2(-9,8)(-5)$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**C-G:** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (15)^2 + 2(9,8)(5)$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓
OPTION 4/*OPSIE 4* B-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (-15)^2 + 2(-9,8)\Delta y$ $\Delta y = -11,48$ m From B to C $= -11,48 + (-5)$ $= -16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + 2(-9,8)(-16,48)$ ✓ $v_f = -17,97$ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓	**B-G** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (15)^2 + 2(9,8)\Delta y$ $\Delta y = 11,48$ m From B to C $= 11,48 + 5$ $= 16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + 2(9,8)(16,48)$ ✓ $v_f = 17,97$ $(m\cdot s^{-1})$ ✓





OPTION 5/*OPSIE 5* C-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-5 = -15\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $\Delta t = 0,3$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-5 = \left(\frac{-15 + v_f}{2}\right)(0,3)$ ✓ $v_f = -18,33$ $v_f = 18,33$ (m·s^{-1}) ✓	**C-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $5 = 15\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $\Delta t = 0,3$ s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $5 = \left(\frac{15 + v_f}{2}\right)(0,3)$ ✓ $v_f = 18,33$ (m·s^{-1}) ✓
OPTION 6/*OPSIE 6* **UPWARDS AS POSITIVE** ***OPWAARTS AS POSITIEF:*** **A-G** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-5 = \left(\frac{15 + v_f}{2}\right)(3,36)$ ✓ $v_f = -17,98$ $v_f = 17,98$ (m·s^{-1}) ✓	**DOWNWARDS AS POSITIVE** ***AFWAARTS AS POSITIEF:*** **A-G** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $5 = \left(\frac{-15 + v_f}{2}\right)(3,36)$ ✓ $v_f = 17,98$ (m·s^{-1}) ✓
OR/*OF* **B-G** $v_f = v_i + a\Delta t$ ✓ $v_f = 0 + \underline{(-9,8)(3,36 - 1,53)}$ ✓ $v_f = -17,93$ $v_f = 17,93$ (m·s^{-1}) ✓	**OR/*OF*** **B-G** $v_f = v_i + a\Delta t$ ✓ $= 0 + \underline{(9,8)(3,36 - 1,53)}$ ✓ $v_f = 17,93$ (m·s^{-1}) ✓
OR/*OF* **C-G** $v_f = v_i + a\Delta t$ ✓ $v_f = \underline{-15 + (-9,8)(0,3)}$ ✓ $v_f = -17,94$ $v_f = 17,94$ (m·s^{-1}) ✓	**OR/*OF*** **C-G** $v_f = v_i + a\Delta t$ ✓ $v_f = \underline{15 + (9,8)(3,36 - 2(1,53))}$ ✓ $v_f = 17,94$ (m·s^{-1}) ✓

(3)

3.4 Inelastic. ✓
The height decreased/smaller. ✓
The **velocity** with which the ball strikes the ground is not the same as the velocity with which it left the ground. / **Kinetic energy** is converted to heat and sound energy / Kinetic energy is NOT conserved. / The kinetic energy is not the same before and after the ball strikes the ground ✓
ACCEPT: Kinetic energy is lost.
NOTE: DO NOT ACCEPT ANY CALCULATION AS AN EXPLANATION.

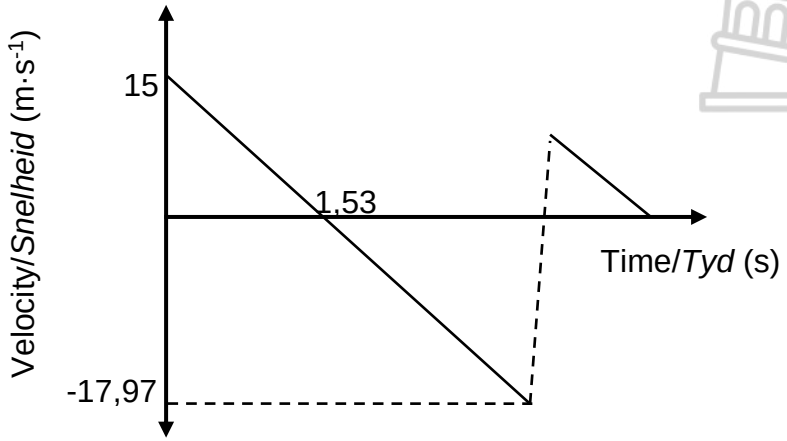
Onelasties.
Die hoogte neem af/kleiner.
*Die **snelheid** waarmee die bal die grond tref is nie dieselfde as die snelheid waarmee dit die grond verlaat nie. / **Kinetiese energie** is omgeskakel na hitte en klank / Kinetiese energie is nie behoue nie./ Die kinetiese energie is nie dieselfde voor en na die bal die grond tref nie.*
***AANVAAR**: Kinetiese energie is verloor*
LET WEL: GEEN BEREKENINGE WORD AANVAAR AS VERDUIDELIKING NIE. (3)

3.5 **POSITIVE MARKING FROM QUESTION 3.2 AND 3.3**
POSITIEWE NASIEN VANAF VRAAG 3.2 EN 3.3

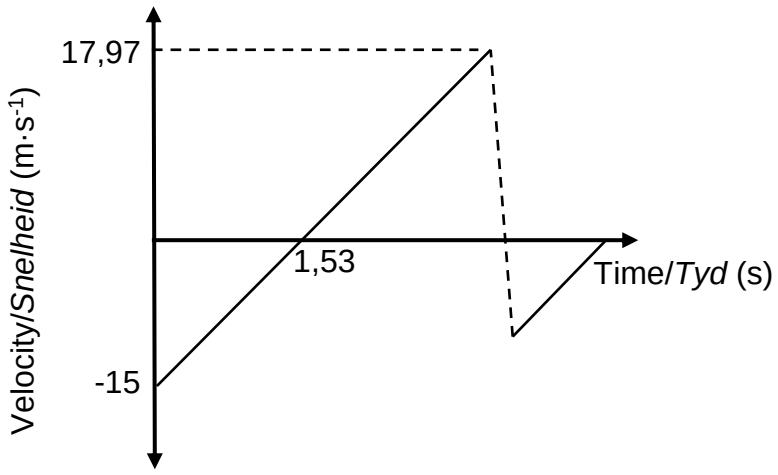
Criteria for graph/*Kriteria vir grafiek*	
• Straight line starting at v = 15 m·s^{-1} with negative final velocity or straight line starting at v = –15 m·s^{-1} with positive final velocity. *Reguitlyn wat begin by v = 15 m·s^{-1}met negatiewe finale snelheid of reguitlyn wat begin v = –15 m·s^{-1}* met positiewe finale snelheid.	✓
• Straight line cuts time axis at time calculated in Question 3.2/ *Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.*	✓
• Correct velocity as calculated in Q 3.3 and the ball is on the ground/ *Korrekte snelheid bereken in Vr 3.3 en die bal is op die grond*	✓
• Velocity of the second line is less than calculated in question Q 3.3, lines are drawn parallel and ends at v = 0 / *Snelheid van tweede lyn is minder as die waarde bereken in Vr 3.3, lyne is parallel geteken en eindig by v = 0*	✓
NOTE: Accept if no contact time is shown on the graph. ***NOTA**: Aanvaar indien geen kontaktyd op die grafiek getoon word*	

(4)

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



[15]

QUESTION 4/*VRAAG 4*

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

The product of the resultant/net force acting on an object and the time the (net) force acts on the object.✓✓
Die produk van die resulterende/netto krag wat op 'n voorwerp inwerk en die tyd wat die (netto) krag op die voorwerp inwerk.

OR/*OF*

The product of the resultant/net force and the contact time.
Die produk van die resulterende/netto krag en die kontak tyd (2)

4.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
Gradient/F_{net} $= \frac{\Delta p_f}{\Delta(\Delta t)}$ $= \frac{4,5-0}{0,03-0,01}$ ✓✓ $= 225$ N F_{net} = 225 N to the right / opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*	$F_{net}\Delta t = \Delta p$ $F_{net}(0,01) = 0 - p_i$ ✓ ..... eq (1) $F_{net}(0,03) = 4,5 - p_i$ ✓ ..... eq (2) $4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$ F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*

OPTION 3/*OPSIE 3*

$F_{net}\Delta t = \Delta p$

$F_{net}(0,01) = 0 - 0,15v_i$ ✓ ..... eq (1)

$F_{net}(0,03) = 4,5 - 0,15v_i$ ✓ ..... eq (2)

$4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$

F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓

Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal (3)

4.2.2

POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF VRAAG 4.2.1

OPTION 1/*OPSIE 1*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = p_f - p_i$
$F_{net}\Delta t = mv_f - mv_i$
✓ Any one / *enige een*

$(225)(0,03)$ ✓ $= 4,5 - (0,15)v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = p_f - p_i$
$F_{net}\Delta t = mv_f - mv_i$
✓ Any one / *enige een*

$(225)(0,01)$ ✓ $= 0 - (0,15)v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 3/*OPSIE 3*

$p_f = F_{net}\Delta t + p_i$

$4,5 = 225(0,03) + p_i$ ✓

$p_i = -2,25$

$p_i = mv_i$ ✓

$-2,25 = 0,15v_i$ ✓

$v_i = -15\ m\cdot s^{-1}$

$v_i = 15\ m\cdot s^{-1}$ ✓

OPTION 4/*OPSIE 4*

$F_{net} = ma$

$225 = 0,15a$ ✓

$a = 1500\ m\cdot s^{-2}$

$p_f = mv_f$

$4,5 = 0,15v_f$

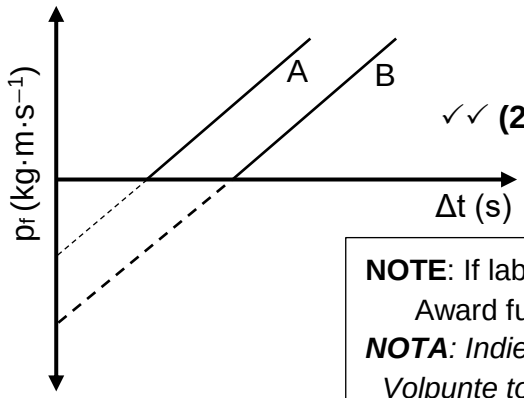
$v_f = 30\ m\cdot s^{-1}$

$a = \frac{\Delta v}{\Delta t}$ ✓

$1500 = \frac{30 - v_i}{0,03 - 0}$ ✓

$v_i = 15\ m\cdot s^{-1}$ ✓ (4)

4.3



✓✓ **(2 or 0)**

NOTE: If labels A and B not indicated ($^0/_2$)
Award full marks for solid lines with labels.
***NOTA**: Indien lyne nie benoem A en B ($^0/_2$)*
Volpunte toegeken vir soliede benoemde lyne

(2)
[11]

QUESTION 5/*VRAAG 5*

5.1

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

The net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓
Die netto/totale arbeid wat (op 'n voorwerp) verrig is, is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/*OF*
The work done (on an object) by a resultant/net force is equal to the change in the object's kinetic energy.
Die arbeid verrig (op 'n voorwerp) deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

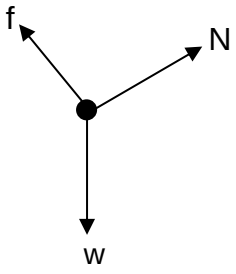
5.2

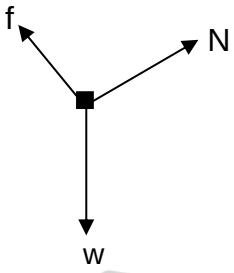
$W_{net} = \Delta E_k$
$W_{FA} = \Delta E_k$
$F_A \Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } ✓ Any one / *Enige een*
$W_{nc} = \Delta E_p + \Delta E_k$

$(12)(7)\cos 0° = E_{kf} - 0$ ✓
$E_{kf} = 84$ J ✓ (3)

5.3

ACCEPT/*AANVAAR*:





Accepted labels/*Aanvaarde benoemings*	
w	F_w / F_g / mg /gravitational force / 29,4 N/ *gravitasiekrag* / weight / *gewig*
f	F_f / f_k / (kinetic) Friction / 21 N *(kinetiese) wrywing* / F_w
N	F_N / Normal (force) / *Normaal (krag)*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks* $^2/_3$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $^2/_3$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^2/_3$ (3)

5.4

POSITIVE MARKING FROM 5.2/*POSITIEWE NASIEN VANAF VRAAG 5.2*

MARKING CRITERIA/NASIENKRITERIA:

- Correct substitution to calculate W_{Fg}/*Korrekte vervanging om W_{Fg} te bereken* ✓
- Correct substitution to calculate W_f/*Korrekte vervanging om W_f te bereken* ✓
- Correct substitution to calculate ΔE_k/*Korrekte vervanging om ΔE_k te bereken* ✓
- Correct final answer/*Korrekte finale antwoord* ✓
- Conclusion/*Gevolgtrekking* ✓

NOTE: ACCEPT for all options: cos70° of sin20°
NOTA: *AANVAAR vir alle opsies*: cos70° of sin20°

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = E_{kf} - E_{ki}$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = E_{kf} - E_{ki}$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$\underline{(3)(9,8)\sin 20°\Delta x\cos 0°}$ ✓ $\underline{+ 21\Delta x\cos 180°}$ ✓ $= 0 \underline{- 84}$ ✓
$\Delta x = 7,68$ m ✓

7,68 m > 6,8 m
The crate will pass point C. ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = \Delta E_k$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = \Delta E_k$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$\underline{(3)(9,8)\sin 20°(6,8)\cos 0°}$ ✓ $\underline{+ (21)(6,8)\cos 180°}$ ✓ $= \underline{E_{kf} - 84}$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52\ m\cdot s^{-1}$

9,58 J > 0 J **OR** $2,52\ m\cdot s^{-1} > 0\ m\cdot s^{-1}$
The crate will pass point C. ✓

OPTION 3/*OPSIE 3*

$\sin 20° = \frac{h}{6,8}$
$h = 2,326$ m

$W_{nc} = \Delta E_k + \Delta E_p$
$f_k\,\Delta x\cos\theta = +\Delta E_k + \Delta E_p$
$\underline{(21)(6,8)\cos 180°}$ ✓ $= \underline{(E_{kf} - 84)}$ ✓ $\underline{- (3)(9,8)(2,326)}$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52\ m\cdot s^{-1}$

9,58 J > 0 J **OR** $2,52\ m\cdot s^{-1} > 0\ m\cdot s^{-1}$
The crate will pass point C. ✓

OPTION 4/*OPSIE 4*

Relative to C:
E_p at B = mgh = (3)(9,8)(6,8)sin 20°
= 68,38 J

$W_{nc} = \Delta E_k + \Delta E_p$
$\underline{(21)(6,8)\cos 180°}$ ✓ $= \underline{(E_{kf} - 84)}$ ✓ + $(0 \underline{- 68,38})$ ✓
$E_{kf} = 9,58$ J ✓

The crate will pass point C. ✓

OPTION 5/*OPSIE 5*
$W_{net} = \Delta E_k$ $F_{net}\Delta x\cos\theta = E_{kf} - E_{ki}$ $[(3)(9,8)\sin 20° - 21]\checkmark\Delta x\cos 0°\checkmark = 0 - 84\checkmark$ $\Delta x = 7,68$ m ✓ 7,68 m > 6,8 m The crate will pass point C. ✓ **OR/*OF*** $[3(9,8)\sin 20° - 21]\checkmark(6,8)\cos 0°\checkmark = E_{kf} - 84$ ✓ $E_{kf} = 9,58$ J ✓ The crate will pass point C. ✓ (5)

[13]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte 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** Is an (apparent) change in (observed/detected) frequency (pitch) as a result of the relative motion between a sound source and an observer. *Die (skynbare) verandering in (waargenome) frekwensie (toonhoogte) as gevolg van relatiewe beweging tussen die klankbron en 'n luisteraar* (2)

6.2.1 Velocity/speed/v_s of the ambulance/source ✓
Snelheid van die ambulans/klankbron (1)

6.2.2 **Frequency**/wavelength of the sound produced by the **ambulance siren** / f_s / **speed of sound**/ **density/temperature** of air/**detector/listener** is stationary ✓
***Frekwensie**/golflengte van die klank voortgebring deur die **sirene van die ambulans** / f_s / **spoed van klank** / **digtheid/temperatuur** van lug / **detektor/luisteraar** staan stil* (1)

6.3 As the velocity of the ambulance increases, the detected frequency decreases. ✓✓
Soos die snelheid van die ambulans toeneem, sal die waargenome frekwensie afneem.
NOTE: If inversely proportional indicated ***NOTA**: Indien omgekeerd eweredig* ($^0/_2$) (2)

6.4

Ambulance approaching/*Ambulans beweeg nader*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V - V_S} f_S$ ✓

$1298 = \frac{v}{v - 25} f_S$ ✓

$v f_S = 1298(v - 25)$ ..... eq. (1)

✓ Either/ *Enige*

Ambulance moving away/*Ambulans beweeg weg*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V + V_S} f_S$ ✓ Either/ *Enige*

$1115 = \frac{v}{v + 25} f_S$ ✓

$v f_S = 1115(v + 25)$ ..... eq. (2)

(1) = (2) **OR/*OF*** (1) ÷ (2)

$\underline{1298(v - 25) = 1115(v + 25)}$ ✓ **OR/*OF*** $1{,}164(v - 25) = v + 25$

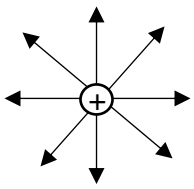
$v = 329{,}64 \text{ m·s}^{-1}$ ✓

(6)
[12]

QUESTION 7/*VRAAG 7*

7.1 A region of space in which an electric charge experiences a force. ✓✓
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind **(2 or 0)** (2)

7.2



Marking criteria/*Nasienkriteria*:	
Direction / *Rigting*	✓
Field lines radially outward/*Veldlyne radiaal uitwaarts*	✓
Two or more field lines inside sphere / not touching sphere / cross each other: deduct 1 mark *Twee of meer veldlyne binne sfeer / raak nie aan sfeer / kruis: trek 1 punt af* If more than one charge drawn/*Indien meer as een lading geteken*: $^0/_2$	

(2)

7.3

$E = \frac{kQ}{r^2}$ ✓

$1{,}08 \times 10^6$ ✓ $= \frac{(9 \times 10^9)(3 \times 10^{-7})}{r^2}$ ✓

$r = 0{,}05$ m

(3)

7.4

NOTE: Ignore if negative charges are substituted.
***NOTA**: Ignoreer indien negatiewe ladings invervang is*

OPTION 1/*OPSIE 1*

$F_{XY} = \frac{kQ_XQ_Y}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓

$= 0,54$ N

$F_{XZ} = \frac{kQ_XQ_Z}{r^2}$

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,68$ N

$F_{net}(E) = F_{XZ} + F_{XY}$
$= \underline{0,68 - 0,54}$ ✓
$= 0,14$ N

No/*Nee* ✓
$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 2/*OPSIE 2*

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

$= \frac{(9 \times 10^9)(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(4 \times 10^{-7})}{(0,04)^2}$ ✓

$E_{net} = 450\ 000$ N·C^{-1}

$F_{net} = qE$ ✓
$F_{net} = \underline{(3 \times 10^{-7})(450\ 000)}$ ✓
$F_{net} = 0,14$ N

No/*Nee* ✓
$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 3/*OPSIE 3*

$F_{net}(E) = \frac{kQ_XQ_Y}{r^2} - \frac{kQ_XQ_Z}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,14$ N

$0,0427 = 0,14 - f$ ✓
$f = 0,0923$ N ✓

No/*Nee* ✓

(6)

7.5 Decrease/*Neem af* ✓✓ (2)

[15]

QUESTION 8/*VRAAG 8*

8.1 Maximum/ Total energy provided / work done by a battery/ cell per unit/ coulomb of charge passing through it. ✓✓
Die maksimum/ totale energie gelewer/ arbeid verrig deur battery per eenheids/ coulomb-lading wat daardeur vloei. **(2 or 0)** (2)

8.2
$$R = \frac{V}{I}\checkmark$$
$$0{,}1 = \frac{V}{120}\checkmark$$
$$V = 12\ V\ \checkmark$$
(3)

8.3.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P = I^2R$ ✓ $15 = I^2(12)$ ✓ $I = 1{,}12\ A$ ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13{,}42\ V$ $P = VI$ ✓ $15 = (13{,}42)I$ ✓ $I = 1{,}12\ A$ ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13{,}42\ V$ $V = IR$ ✓ $13{,}42 = I(12)$ ✓ $I = 1{,}12\ A$ ✓

(3)

8.3.2

POSITIVE MARKING FROM QUESTION 8.3.1 ***POSITIEWE NASIEN VANAF VRAAG 8.3.1***
$A_1 = (1{,}12)(2)$ $= 2{,}24\ A$ ✓

(1)

8.4

POSITIVE MARKING FROM QUESTION 8.2 and 8.3.2
POSITIEWE NASIEN VANAF VRAAG 8.2 en 8.3.2

[RANGE: 13,42 V – 13,47 V]

OPTION 1/*OPSIE 1*

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

$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{12}$ ✓

$R_p = 6\ \Omega$

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

$R_p = \frac{(12)(12)}{12 + 12}$ ✓

$R_p = 6\ \Omega$

When S_1 closed and S_2 open/*Wanneer S_1 gesluit en S_2 oop is*:

$\varepsilon_1 = I(R + r)$ ✓

$= 2{,}24(6 + r)$ ✓

When S_1 open and S_2 closed/*Wanneer S_1 oop en S_2 gesluit is*:

$\varepsilon_2 = I(R + r)$

$= 120(0{,}1 + r)$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)

$2{,}24(6 + r) = 120(0{,}1 + r)$ ✓

$r = 0{,}012\ \Omega$

$\varepsilon = I(R + r)$
$= 2{,}24(6 + 0{,}012)$
$= 13{,}46$ V ✓

OR/*OF*

$\varepsilon = IR + Ir$
$= 120(0{,}1 + 0{,}012)$
$= 13{,}47$ V ✓

OPTION 2/*OPSIE 2*

$\varepsilon_1 = IR + Ir$ ✓

$= 12 + 120r$ ✓

$P = \frac{V^2}{R}$

$15 = \frac{V^2}{12}$ ✓

$V = 13{,}42$ V

OR/*OF*

$V_p = IR$
$= 2{,}24(6)$ ✓
$= 13{,}44$ V

OR/*OF*

$V_P = IR$
$= 1{,}12(12)$ ✓
$= 13{,}44$ V

$\varepsilon_2 = V_{ext} + Ir$

$= 13{,}42 + 2{,}24r$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)

$12 + 120r = 13{,}42 + 2{,}24r$ ✓

$r = 0{,}012\ \Omega$

$\varepsilon_1 = IR + Ir$
$= 12 + (120)(0{,}012)$
$= 13{,}47$ V ✓

$\varepsilon_2 = IR + Ir$
$= 13{,}42 + (2{,}24)(0{,}012)$
$= 13{,}45$ V ✓

(6)

8.5

Decrease✓
- Total/External resistance decreases ✓
- Total current increases. ✓
- $V_{internal}$ increases✓
- Voltage across the light bulbs decreases / $V_{external}$ decreases. ✓

NOTE: Calculation given as explanation $^{1}/_{5}$

Neem af
- *Totale/Eksterne weerstand neem af*
- *Totale stroom neem toe*
- *V_{intern} neem toe*
- *Potensiaalverskil oor die gloeilamp neem af / $V_{ekstern}$ neem af*

NOTA: Berekening gegee as verduideliking $^{1}/_{5}$

ACCEPT/*AANVAAR:*
NOTE/*NOTA*: max: $^{3}/_{5}$
Mark for INCREASES will ONLY be awarded if explanation is correct
Punt vir TOENEEM sal SLEGS toegeken word indien verduideliking korrek is

Refer to the explanation first to check if the candidate is referring to Q8.2
Verwys na verduideliking eerste om te bepaal of die kandidaat verwys Vr8.2

Increases ✓
- Initial reading of A_1 = 0 A when switch S_1 is open ✓
- Now both switch closed the current is flowing through the circuit. ✓

Toeneem
- *Aanvanklike lesing op A_1 = 0 A wanneer skakelaar S_1 oop is*
- *Nou is beide skakelaars gesluit en stroom vloei deur die stroombaan*

(5)
[20]

QUESTION 9/*VRAAG 9*

9.1 **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 AC potential difference /voltage that produces/dissipates the same amount of energy as an equivalent DC potential difference/voltage. ✓✓
Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente GS-potensiaalverskil.

NOTE: If DC written first/ energy or heating effect is omitted/ alternating current is defined: $^{0}/_{2}$
***LET WEL:** Indien GS eerste geskryf/ energie of verhittingseffek uitgelaat is/ wisselstroom gedefinieer : $^{0}/_{2}$*

(2)

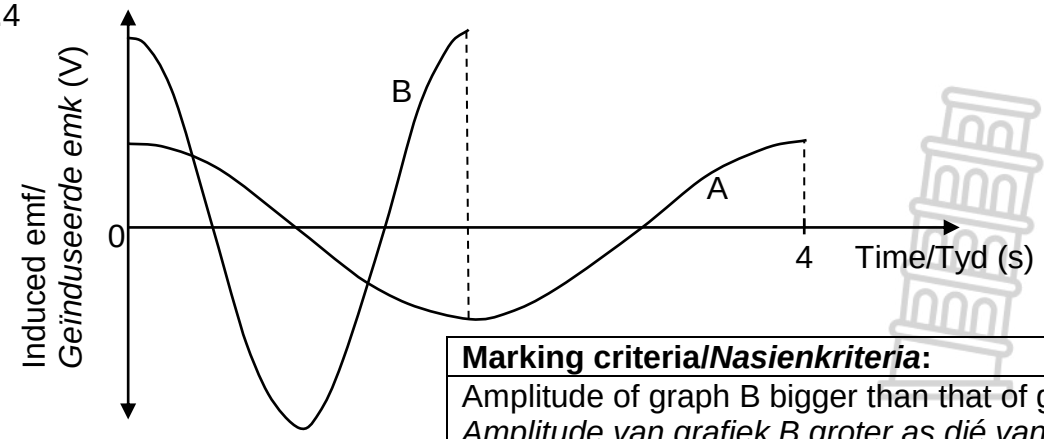
9.2 N/North/*Noord* ✓✓ (2)

9.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW cost = PΔt × tariff $= \underline{0,80659(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW E = PΔt $= \underline{0,80659(1,5)}$ = 1,21 kWh ✓ for both/*beide* cost = E × tariff $= \underline{1,21(3,33)}$ = R4,03 ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$P_{ave} = V_{rms}I_{rms}$ ✓ $= \left(\frac{311,11}{\sqrt{2}}\right)$ ✓ $\left(\frac{220}{60}\right)$ ✓ $= 806,67$ W $= 0,8067$ kW cost = PΔt × tariff $= \underline{0,8067(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $W = \frac{V^2}{R}\Delta t$ ✓ $= \frac{(219,99)^2}{60}(1,5)(10^{-3})$ ✓ = 1,21 kWh Cost = E x tariff $= \underline{(1,21)(3,33)}$ ✓ = R4,03 ✓

(5)

9.4



Marking criteria/*Nasienkriteria*:	
Amplitude of graph B bigger than that of graph A *Amplitude van grafiek B groter as dié van A*	✓
Period of B is half of A/*Periode van B helfte van A*	✓
Correct shape and one cycle(Cosine graph)/ *Vorm en een siklus(cos-grafiek)*	✓

(3)

9.5 By replacing slip rings with split ring commutator / split ring / commutator.✓
Vervang sleepringe met splitring kommutator / splitring / kommutator (1)

[13]

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.*
Minimum energy needed for the electrons to be emitted from the metal surface ✓✓
Die minimum energie benodig om 'n elektron uit die oppervlak van 'n metaal vry te stel.

NOTE: If threshold frequency defined
***NOTA**: Indien drumpelfrekwensie gedefinieer:* $^{0}/_{2}$ (2)

10.1.2 $1{,}045 \times 10^{15}$ Hz ✓ (1)

10.1.3 Greater than ✓
- The maximum kinetic energy of electrons from sodium is smaller. ✓
- E is constant / same frequency used / same light used ($E_{K(max)}$ is smaller; W_0 is larger).✓

Groter as
- *Die maksimum kinetiese energie van die elektrone van natrium sal kleiner wees.*
- *E is konstant/ dieselfde frekwensie gebruik/dieselfde lig gebruik is (sal $E_{k(maks)}$ kleiner wees; W_0 groter)* (3)

10.1.4 No ✓
- The intensity of light does not have any effect on the ejection of electrons for metal M ✓ **OR**
- The frequency of light has not changed / Energy of a photon has not changed.

Nee
- *Die intensiteit van die lig het geen invloed op die vrystelling van elektrone vir metaal M nie **OF***
- *Die frekwensie van lig het nie verander nie/ Energie van fotone het nie verander* (2)

10.2.1

OPTION 1/*OPSIE 1*

$E = hf$ ✓

$5{,}7 \times 10^{-19} - 1{,}3 \times 10^{-19}$ ✓ $= (6{,}63 \times 10^{-34})\,f$ ✓

$f = 6{,}64 \times 10^{14}$ Hz ✓

Accept $E_3 - E_1$ **OR** $E_1 - E_3$ in all options
Aanvaar: $E_3 - E_1$ **OF** $E_1 - E_3$ in alle opsies

OPTION 2/*OPSIE 2*

$\Delta E = E_1 - E_3$

$= 1{,}3 \times 10^{-19} - 5{,}7 \times 10^{-19}$ ✓

$= -4{,}4 \times 10^{-19}$

$E = hf$ ✓

$4{,}4 \times 10^{-19} = (6{,}63 \times 10^{-34})f$ ✓

$f = 6{,}64 \times 10^{14}$ Hz ✓

f must be positive/ *f moet positief wees*

(4)

10.2.2 No ✓ The energy does not correspond to any transition in this atom ✓
Nee Die energie stem nie ooreen met enige oorgang in hierdie atoom nie (2)

[14]

TOTAL/*TOTAAL*: 150