basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2019

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. 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 D.

1.1 A car is moving at a **constant velocity**.

Which ONE of the following statements about the forces acting on the car is CORRECT?

A The net force acting on the car is zero.

B There are no forces acting on the car.

C The weight of the car is equal to the normal force acting on the car.

D There is a non-zero net force acting on the car. (2)

1.2 A ball is projected vertically upwards. Ignore air resistance.

Which ONE of the following statements about the acceleration of the ball at its maximum height is CORRECT?

The acceleration is equal to …

A zero.

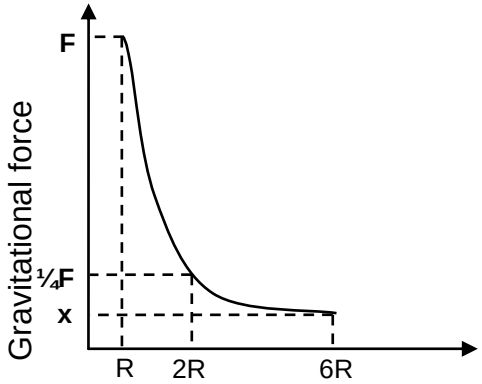
B *g* and is directed downwards.

C *g* and is directed upwards.

D *g* and is directed horizontally. (2)

1.3 The graph below, not drawn to scale, shows the relationship between the gravitational force on a given mass and its distance from the centre of Earth.

The magnitude of the force on the mass at a distance R from the centre of Earth is **F**.



Which ONE of the following is the CORRECT representation of the magnitude of force **x** shown on the graph?

A 6**F**

B 12**F**

C $\frac{1}{6}$**F**

D $\frac{1}{36}$**F** (2)

1.4 Ball M, moving at speed ***v*** to the right, collides with a stationary ball N on a smooth horizontal surface. Immediately after the collision, ball M comes to rest and ball N moves to the right with speed ***v***.

Which ONE of the following statements about the collision of the balls is CORRECT?

A Total momentum is conserved and the masses of the balls are unequal.

B Total kinetic energy is conserved and the masses of the balls are unequal

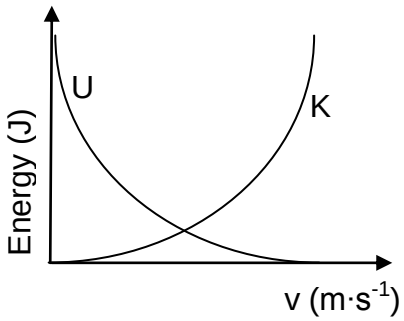
C Total momentum and total kinetic energy are conserved and the masses of the balls are equal.

D Total momentum is conserved but total kinetic energy is not conserved and the masses of the balls are equal. (2)

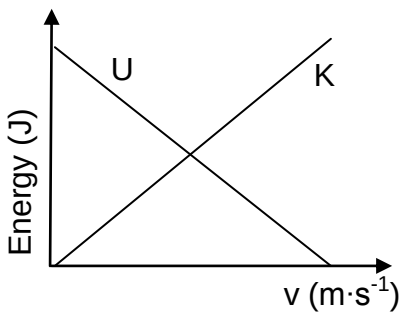
1.5 A small stone is dropped from rest and undergoes free fall.

Which ONE of the graphs below shows the CORRECT relationship between the gravitational potential energy (U) and speed *v* and the kinetic energy (K) and speed *v*, respectively, for the stone? The graphs are NOT drawn to scale.

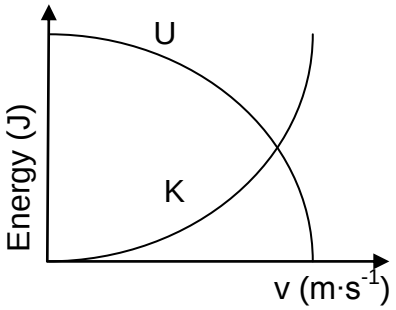
A



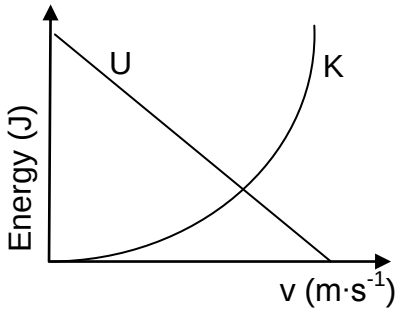
B



C



D



(2)

1.6 A stationary passenger at a railway station listens to a train approaching at constant speed.

Which ONE of the following is CORRECT for the sound of the approaching train heard by the stationary passenger?

A Lower pitch, lower frequency

B Higher pitch, lower frequency

C Higher pitch, higher frequency

D Lower pitch, higher frequency (2)

1.7 Particle P has charge Q and particle R has charge 2Q. They are separated by a small distance, *r*.

Which ONE of the statements below about the electrostatic forces, F_{PR}, which P exerts on R and F_{RP}, which R exert on P, is CORRECT?

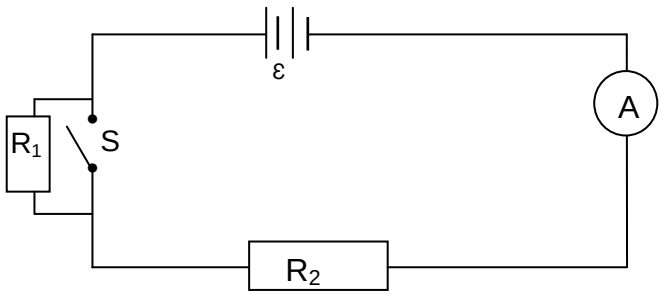
A $F_{PR} = ½F_{RP}$

B $F_{PR} = F_{RP}$

C $F_{PR} = 2F_{RP}$

D $F_{PR} = -F_{RP}$ (2)

1.8 A battery of emf ε and negligible internal resistance is connected in a circuit, as shown below. The resistances of R_1 and R_2 are high.



Which ONE of the following combinations about the ammeter readings will be CORRECT when switch S is open and when switch S is closed?

	SWITCH OPEN	**SWITCH CLOSED**
A	Ammeter reads only the current in R_1	Ammeter reads only the current in R_2
B	Ammeter reads only the current in R_2	Ammeter reads the current in both R_1 and R_2
C	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in both R_1 and R_2
D	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in R_2 only

(2)

1.9 The direction of the induced current in the coil of a generator depends on the …

A length of the coil.

B speed of rotation of the coil.

C direction of the magnetic field.

D strength of the magnetic field. (2)

1.10 The work function of zinc is greater than that of magnesium.

Which ONE of the following statements about the threshold frequencies of the metals is CORRECT?

A The threshold frequency of zinc is greater than that of magnesium.

B The threshold frequency of zinc is smaller than that of magnesium.

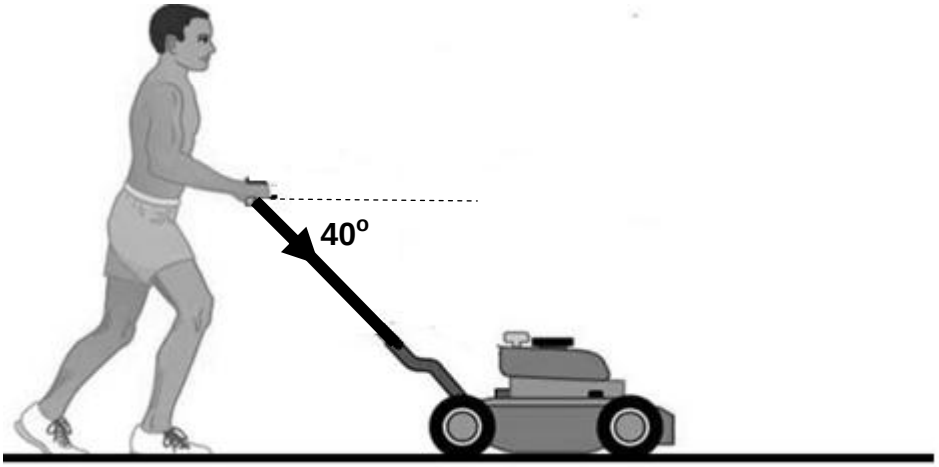
C Both zinc and magnesium have the same threshold frequency.

D The threshold frequencies of zinc and magnesium are independent of their work functions. (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 A person pushes a lawn mower of mass 15 kg at a **constant speed** in a straight line over a flat grass surface with a force of 90 N. The force is directed along the handle of the lawn mower. The handle has been set at an angle of 40° to the horizontal. Refer to the diagram below.



2.1.1 Draw a labelled free-body diagram for the lawn mower. (4)

2.1.2 Why is it CORRECT to say that the moving lawn mower is in equilibrium? (1)

2.1.3 Calculate the magnitude of the frictional force acting between the lawn mower and the grass (3)

The lawn mower is now brought to a stop.

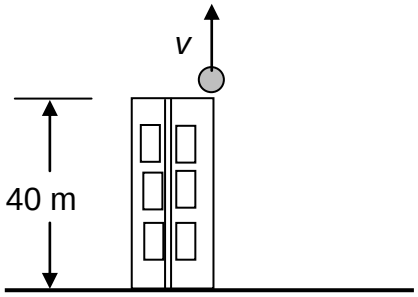
2.1.4 Calculate the magnitude of the constant force that must be applied through the handle in order to accelerate the lawn mower *from rest* to 2 $m \cdot s^{-1}$ in a time of 3 s. Assume that the frictional force between the lawn mower and grass remains the same as in QUESTION 2.1.3. (6)

2.2 Planet **Y** has a radius of 6×10^5 m. A 10 kg mass weighs 20 N on the surface of planet **Y**.

Calculate the mass of planet **Y**. (4)
[18]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards, with velocity *v*, from the edge of a roof of a 40 m tall building. The ball takes 1,53 s to reach its maximum height. Ignore air resistance.



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

3.2 Calculate the:

3.2.1 Magnitude of the initial velocity *v* of the ball (3)

3.2.2 Maximum height reached by the ball above the edge of the roof (3)

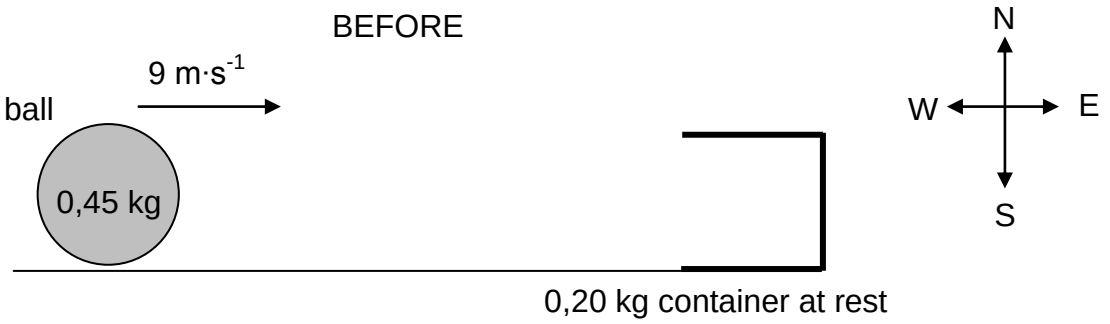
3.3 Take the edge of the roof as reference point. Determine the position of the ball relative to the edge of the roof after 4 s. (3)

3.4 Will any of the answers to QUESTIONS 3.2 and 3.3 change if the height of the building is 30 m? Choose from YES or NO.

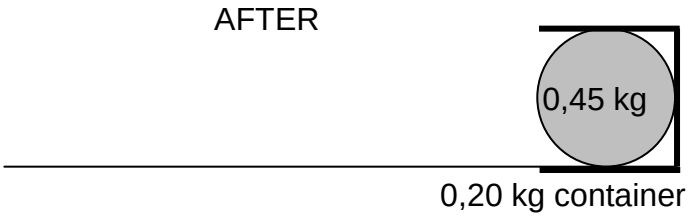
Give a reason for the answer. (3)
[14]

QUESTION 4 (Start on a new page.)

A soccer player kicks a ball of mass 0,45 kg to the east. The ball travels horizontally at a velocity of 9 $m \cdot s^{-1}$ along a straight line, without touching the ground, and enters a container lying at rest on its side, as shown in the diagram below. The mass of the container is 0,20 kg.



The ball is stuck in the container after the collision. The ball and container now move together along a straight line towards the east. Ignore friction and rotational effects.



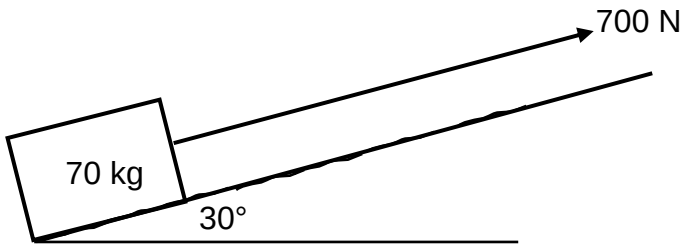
4.1 State the principle of conservation of linear momentum in words. (2)

4.2 Calculate the magnitude of the velocity of the ball-container system immediately after the collision. (4)

4.3 Determine, by means of a suitable calculation, whether the collision between the ball and container is elastic or inelastic. (5)
[11]

QUESTION 5 (Start on a new page.)

A 70 kg box is initially at rest at the bottom of a ROUGH plane inclined at an angle of 30° to the horizontal. The box is pulled up the plane by means of a light inextensible rope, held parallel to the plane, as shown in the diagram below. The force applied to the rope is 700 N.



5.1 What is the name given to the force in the rope? (1)

5.2 Give a reason why the mechanical energy of the system will NOT be conserved as the box is pulled up the plane. (1)

The box is pulled up over a distance of 4 m along the plane. The kinetic frictional force between the box and the plane is 178,22 N.

5.3 Draw a labelled free-body diagram for the box as it moves up the plane. (4)

5.4 Calculate the work done on the box by the frictional force over the 4 m. (3)

5.5 Use energy principles to calculate the speed of the box after it has moved 4 m. (5)

5.6 When the box is 4 m up the incline, the rope accidentally breaks, causing the box to slide back down to the bottom of the inclined plane.

What will be the total work done by friction when the box moves up and then down to the bottom of the inclined plane? (1)

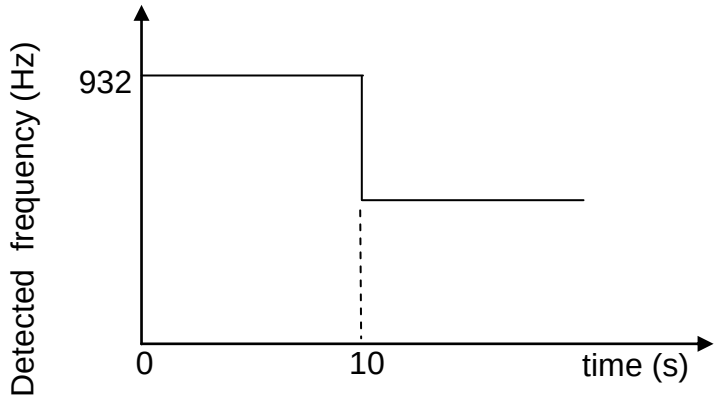
[15]

QUESTION 6 (Start on a new page.)

6.1 A patrol car is moving at a constant speed towards a stationary observer. The driver switches on the siren of the car when it is 300 m away from the observer.

The observer records the detected frequency of the sound waves of the siren as the patrol car *approaches*, *passes* and *moves away* from him.

The information obtained is shown in the graph below.



6.1.1 Calculate the speed of the patrol car. (2)

6.1.2 State the Doppler effect. (2)

6.1.3 The detected frequency suddenly changes at t = 10 s. Give a reason for this change. (2)

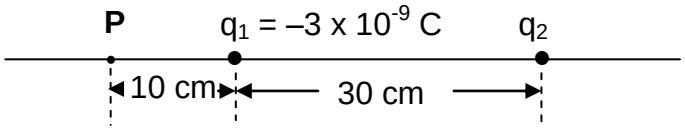
Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.4 Calculate the frequency of the sound emitted by the siren. (4)

6.2 State TWO applications of the Doppler effect. (2)
[12]

QUESTION 7 (Start on a new page.)

Two point charges, q_1 and q_2, are placed 30 cm apart along a straight line. Charge $q_1 = -3 \times 10^{-9}$ C. Point **P** is 10 cm to the left of q_1, as shown in the diagram below. The **net** electrostatic field at point **P** is **zero.**



7.1 Define the term *electric field at a point*. (2)

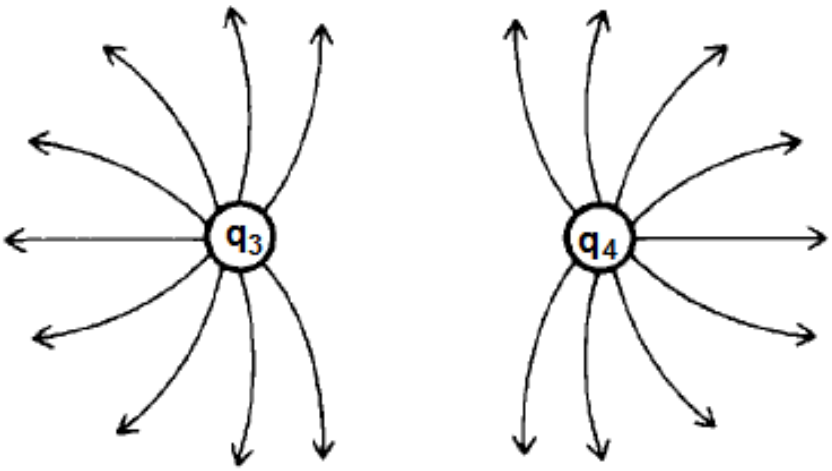
7.2 State, giving reasons, whether point charge q_2 is positive or negative. (3)

7.3 Calculate the magnitude of charge q_2. (4)

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

7.5 Calculate the magnitude of the electrostatic force exerted by charge q_1 on charge q_2. (3)

7.6 The two charges are now brought into contact with each other and are then separated. A learner draws the electric field pattern for the new charges q_3 and q_4 **after** contact, as shown below.



Is the diagram CORRECT? Give a reason for the answer. (2)
[16]

QUESTION 8 (Start on a new page.)

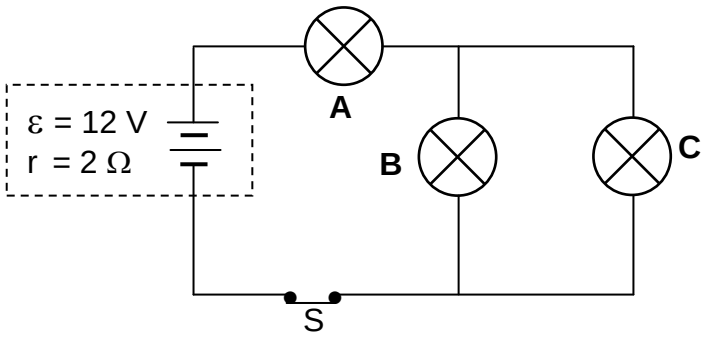
8.1 Three identical light bulbs, **A**, **B** and **C**, are each rated at 6 W, 12 V.

8.1.1 Define the term *power*. (2)

8.1.2 Calculate the resistance of EACH bulb when used as rated. (3)

The light bulbs are connected in a circuit with a battery having an emf (ε) of 12 V and internal resistance (*r*) of 2 Ω. Refer to the diagram below.

Assume that the resistance of each light bulb is the same as that calculated in QUESTION 8.1.2. Switch S is closed.

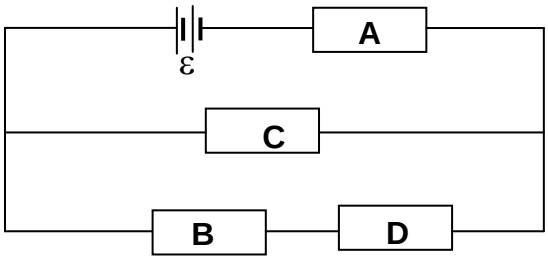


8.1.3 Calculate the total current in the circuit. (5)

8.1.4 Calculate the potential difference across light bulb **C**. (3)

8.1.5 Explain why light bulb **C** in the circuit will NOT burn at its maximum brightness. (3)

8.2 Resistors **A**, **B**, **C** and **D** are connected to a battery having emf (ε) and negligible internal resistance, as shown in the diagram below.



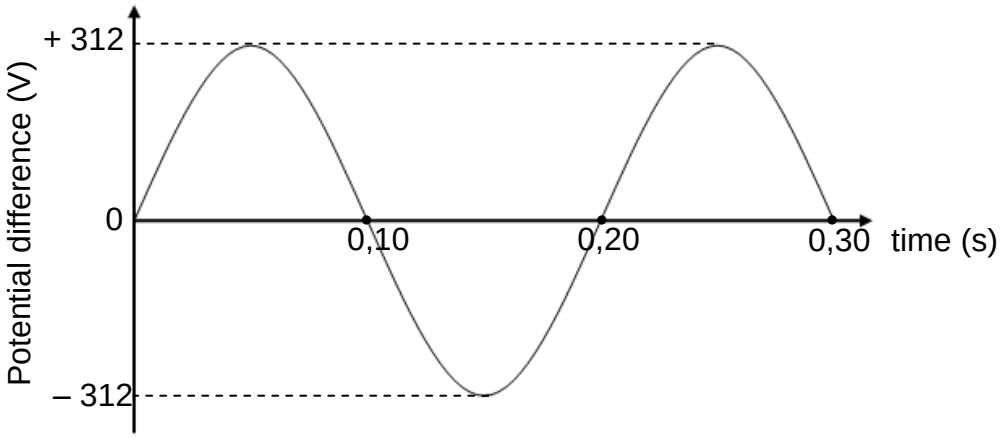
8.2.1 Give a reason why the current in resistor **A** is greater than that in resistor **C**. (2)

8.2.2 Resistor **C** is removed. How will the current in resistor **B** compare to the current in **A**? Give a reason for the answer. (2)

[20]

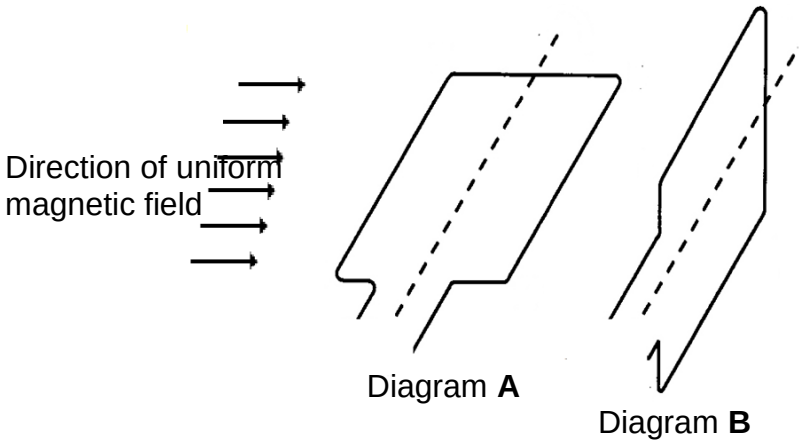
QUESTION 9 (Start on a new page.)

The diagram below shows the voltage output of a generator.



9.1 Does this generator have split rings or slip rings? (1)

9.2 Which ONE of the diagrams below, **A** or **B**, shows the position of the generator's coil at time = 0,10 s?



(1)

9.3 Calculate the root mean square (rms) voltage for this generator. (3)

9.4 A device with a resistance of 40 Ω is connected to this generator.

Calculate the:

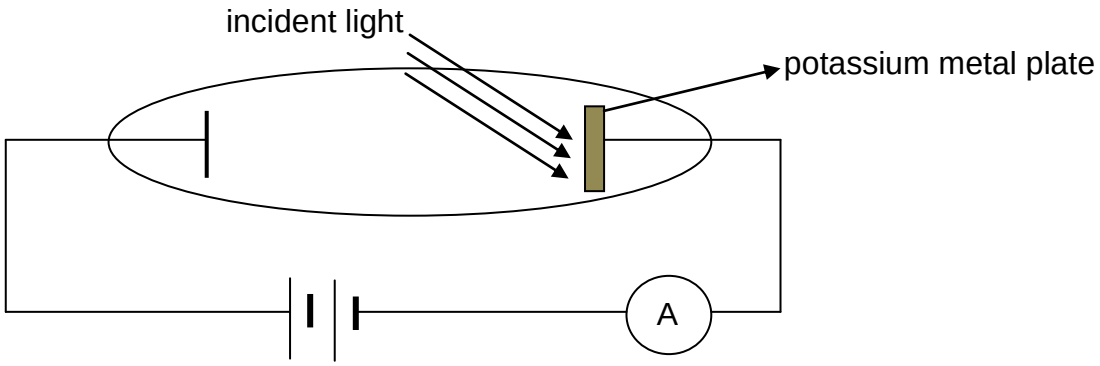
9.4.1 Average power delivered by the generator to the device (3)

9.4.2 Maximum current delivered by the generator to the device (4)

[12]

QUESTION 10 (Start on a new page.)

A potassium metal plate is irradiated with light of wavelength 5 x 10^{-7} m in an arrangement, as shown below. The threshold frequency of potassium is 5,55 x 10^{14} Hz.



10.1 Define the term *threshold frequency*. (2)

10.2 Calculate the energy of a photon incident on the metal plate. (3)

10.3 Using a suitable calculation, prove that the ammeter will show a reading. (4)

10.4 The intensity of the light is now increased. Explain why this change causes an increase in the ammeter reading. (3)
[12]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

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

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

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

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

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

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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

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

2019

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 28 pages./
Hierdie nasienriglyne bestaan uit 28 bladsye.

QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 C ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C✓✓ (2)

1.7 D✓✓ (2)

1.8 D ✓✓ (2)

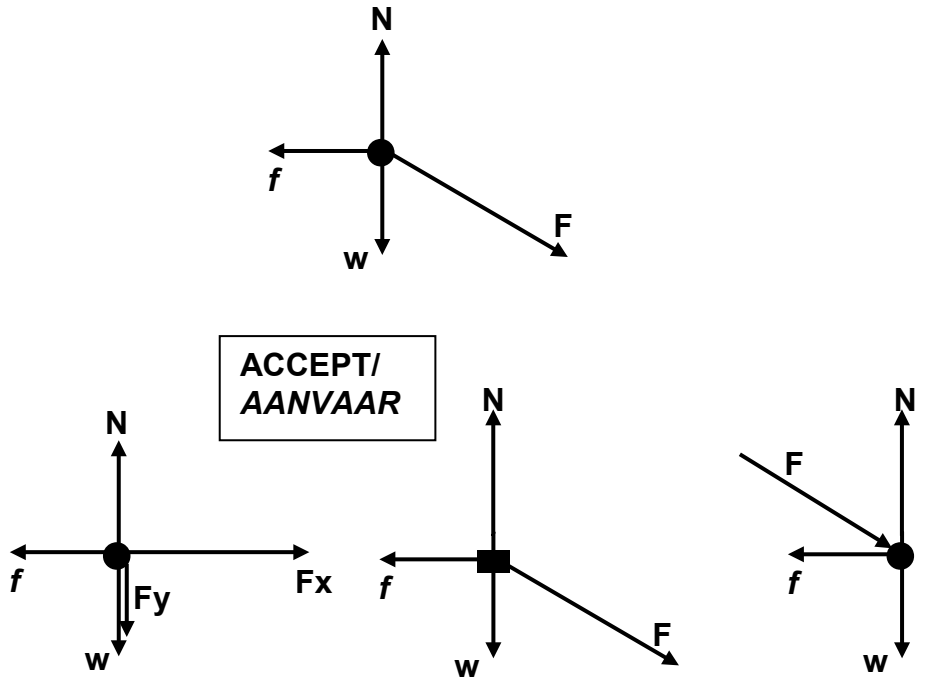
1.9 C ✓✓ (2)

1.10 A ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

2.1.1



Accepted labels/*Aanvaarde benoemings*	
F	F_A/90 N/F_{90}
w	F_g / $F_{w/}$weight / mg / gravitational force *F_g / $F_{w/}$ gewig / mg / gravitasiekrag*
f	(Kinetic) Friction / F_f / / f_k / *wrywing* / F_w
N	F_{Normal} / Normal/Normaal / F_N

Notes/*Aantekeninge*

- Mark awarded for label and arrow / *Punt toegeken vir benoeming en pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te) Max/Maks* $^3/_4$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $^3/_4$
- Deduct 1 mark for an arrow/arrows omitted / *trek 1 punt af indien pyl/pyle weggelaat* (4)

2.1.2 It is moving at constant speed in a straight line/, the acceleration is zero/ the net force (resultant) acting on it is zero/it is moving at constant velocity ✓
Dit beweeg teen konstante spoed in 'n reguit lyn / versnelling is nul / netto krag (resultant) wat daarop inwerk is nul/ dit beweeg teen konstante snelheid (1)

2.1.3

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\cos 40^o - f = 0$

✓ any one
enige een

$\underline{90 \cos 40^o - f = 0}$ ✓
$f = 68{,}94$ N ✓

OR/OF

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\cos 320^o - f = 0$

✓ any one
enige een

$\underline{90 \cos 320^o - f = 0}$ ✓
$f = 68{,}94$ N ✓

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\sin 50^o - f = 0$

✓ any one
enige een

$\underline{90 \sin 50^o - f = 0}$ ✓
$f = 68{,}94$ N ✓

(3)

NOTE:
1 mark for formula/equation, 1 mark substitution with zero, 1 mark answer.
LW:1 punt vir formule/vergelyking, 1 punt substitusie, 1 punt antwoord.

2.1.4

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 1/*OPSIE 1*

$v_f = v_i + a\Delta t$
$\underline{2 = 0}$ ✓ + $\underline{a(3)}$ ✓
$a = 0{,}67$ m·s^{-2}

$F_{net} = ma$ ✓
$F\cos 40^o$ ✓ $- 68{,}94$ ✓ $= 15(0{,}67)$

$F = 103{,}11$N ✓ (103,05 N – 103,11N)

$F_{net} = ma$ ✓
$F\cos 320^o - f = 15(0{,}67)$
$F\cos 320^o$ ✓ $- 68{,}94$ ✓ $= 15(0{,}67)$
$F = 103{,}11$N ✓

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 2/*OPSIE 2*

$F_{net}.\Delta t = \Delta p$ ✓

$F\cos 40^o$ ✓ $- (68{,}94)$ ✓ (3) ✓ $= 15(2 - 0)$ ✓

$F = 103{,}11$ N ✓

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 3/*OPSIE 3*

$F_{net} = ma$
$F_x - f_k = ma$

✓ any one
enige een

$F_x - 68{,}94\checkmark = 15\ \frac{(2-0)}{3}\checkmark$

$F_x = 78{,}94$ N

$\tan\theta = \frac{F_y}{F_x}$

$\tan 40^\circ = \frac{F_y}{78{,}94}$

$F_y = 66{,}24$ N

$F^2 = F_x^2 + F_y^2$

$F^2 = \underline{(78{,}94)^2} + \underline{(66{,}24)^2}\checkmark$

$F = 103{,}05$ N✓

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 4/*OPSIE 4*

$\Delta x = \frac{v_i + v_f}{2}\ \Delta t$

$= \frac{(2+0)}{2}\checkmark\ (3)\checkmark$

$\Delta x = 3$ m

$W_{net} = \Delta K$

$W_F + W_f = \Delta K$ ✓

$F\Delta x\cos\theta + f\Delta x\cos\theta = \Delta K$

$\underline{F(3)\cos 40^\circ}\checkmark + \underline{68{,}94(3)\cos 180^\circ}\checkmark = ½\,(15)(2^2) - ½\,(15)(0)^2$

$F = 103.06$ N✓

(6)

2.2

OPTION 1/*OPSIE 1*

$F = G\frac{m_1 m_2}{r^2}$ ✓

$20 = (6{,}67 \times 10^{-11})\frac{m_{planet}(10)}{(6 \times 10^5)^2}$ ✓✓

m_{planet} = 1,08 x 10^{22} kg✓

OPTION 2/*OPSIE 2*

$w = mg$

$20 = (10)(g)$ ✓

$g = 2\ m \cdot s^{-2}$

$g = \frac{GM}{R^2}$

$2 = \frac{(6{,}67 \times 10^{-11})M}{(6 \times 10^5)^2}$ ✓

$M = 1{,}08 \times 10^{22}$ kg✓

✓ Any one
Enige een

(4)
[18]

QUESTION 3/*VRAAG 3*

3.1 Motion of an object under the influence of gravity/gravitational force (weight) only✓✓.
Beweging van 'n voorwerp slegs onder die invloed van gravitasie/gravitasie krag (gewig).

OR/*OF*
Motion in which the only force acting on the object is gravity/weight. ✓✓
Beweging waar die enigste krag wat op die voorwerp inwerk, gravitasie/gewig is.

ACCEPT/*AANVAAR*
Vertical motion in which friction/air resistance is absent. ✓✓
Vertikale beweging waar wrywing/lugweerstand afwesig is.

Motion in air with an acceleration of 9,8 $m \cdot s^{-2}$. ✓✓
Beweging in lug met 'n versnelling van 9,8 $m \cdot s^{-2}$. (2)
NOTE: 2 OR ZERO/ *2 of nul*

3.2.1

OPTION 1/*OPSIE 1*
Upwards positive/*Opwaarts positief*:
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(1,53)$ ✓
$\therefore v_i = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓
Downwards positive/*Afwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(1,53)$ ✓
$\therefore v_i = -14,99\ m \cdot s^{-1}$
$v_i = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓

OPTION 2/*OPSIE 2*
$F_{net} = ma$
$= 9,8\ (m)$
$F_{net}\ \Delta t = m\Delta v$✓
$(9,8)(m)(1,53) = (m)(v_f - 0)$ ✓
$v_f = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓

OPTION 3/*OPSIE 3*
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = v_i(3,06) + \frac{1}{2}(-9,8)(3,06)^2$✓
$v_i = 14,99\ m \cdot s^{-1}$✓$(15\ m \cdot s^{-1})$

Downwards positive/*Afwaarts positief*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = v_i(3,06) + \frac{1}{2}(9,8)(3,06)^2$✓
$v_i = 14,99\ m \cdot s^{-1}$✓ $(15\ m \cdot s^{-1})$

NOTE: initial and final velocities can be swopped if starting from top, as long as sign of g is changed accordingly.
LW: v_f en v_i kan omgeruil word indien van bopunt begin, solank teken van g dienooreenkomstig verander word. (3)

3.2.2

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{14,99\ (1,53) + \frac{1}{2}\ (-\ 9,8)(1,53)^2}$ ✓
$= 11,47$ m✓(11,46-11,48)
Maximum height is/*Maksimum hoogte is* 11,47 m

Downwards positive/*Afwaarts positief*
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= -\underline{14,99\ (1,53) + \frac{1}{2}\ (9,8)(1,53)^2}$ ✓
$= -11,47$ m (11,46-11,48)
Maximum height is /*Maksimum hoogte is* 11,47 m✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:
$v_f^2 = v_i^2 + 2a\Delta y$✓
$\underline{0 = (14,99)^2 + 2(-9,8)(\Delta y)}$✓
$\Delta y = 11,47$ m·✓(11,46-11,48)
Maximum height reached is/*Maksimum hoogte bereik is* 11,47 m

Downwards positive/*Afwaarts positief:*
$v_f^2 = v_i^2 + 2a\Delta y$✓
$\underline{0 = (-14,99)^2 + 2(9,8)(\Delta y)}$✓
$\Delta y = -11,47$ m·(11,46-11,48)
Maximum height reached is/*Maksimum hoogte bereik is* 11,47 m✓

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(14,99 + 0)}{2}\right)(1,53)\ ✓$$
$\Delta y = 11,47$ m✓
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m

Downwards positive/*Afwaarts positief:*
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(-14,99 + 0)}{2}\right)(1,53)\ ✓$$
$\Delta y = -11,47$ m (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m✓

OPTION 4/*OPSIE 4*
POSITIVE MARKING FROM 3.2.1

$\Delta E = \Delta K + \Delta U$
$\frac{1}{2} mv_i^2 + mgh_i = \frac{1}{2} mv_f^2 + mgh_f$ } 1 mark for any✓ / *1 punt vir enige*

$\frac{1}{2} (14,994)^2 + (9,8)(0) = 0 + 9,8\ h_f$ ✓
$h_f = 11,47$ m✓ (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m

OR/*OF*
$\Delta K = - \Delta U$✓
$\frac{1}{2} m(v_f^2 - v_i^2) = - mg(h_f - h_i)$
$\frac{1}{2} (0 - 14,99^2) = - 9,8(h_f - 0)$ ✓
$h_f = 11,47$ m (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m✓ (3)

3.3 **OPTION 1/*OPSIE 1***
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= (14,99)\ (4) + \frac{1}{2}\ (- 9,8)(4)^2$✓
$= -18,4$ m
Position is 18,4 m downwards (below the edge of the roof) ✓ / *Posisie is 18,4 m afwaarts (onder die kant van die dak).*

Downwards positive/*Afwaarts positief*
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= (-14,99)\ (4) + \frac{1}{2}\ (9,8)(4)^2$✓
$= 18,4$ m
Position is 18,4 m downwards (below the edge of the roof) ✓/ *Posisie is 18,4 m afwaarts (onder die kant van die dak)*

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:

$v_f = v_i + a\Delta t$
$= (14,99) + (-9,8)\ (4)$
$= -\ 24,2\ m\cdot s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta y$✓
$(-24,2)^2 = (14,99)^2 + 2(-9,8)(\Delta y)$✓
$\Delta y = -\ 18,4\ m$·
Ball is 18,4 m downwards (below the edge of the roof) / *Bal is 18,4 m afwaarts (onder die kant van die dak)*✓

Downwards positive/*Afwaarts positief:*

$v_f = v_i + a\Delta t$
$= (-14,99) + (9,8)\ (4)$
$= 24,2\ m\cdot s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta y$✓
$(24,2)^2 = (-14,99)^2 + 2(9,8)(\Delta y)$✓
$\Delta y = 18,4\ m$·
Ball is 18,4 m downwards (below the edge of the roof)✓/ *Bal is 18,4 m afwaarts (onder die kant van die dak)*

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(14,99 - 24,2)}{2}\right)(4) \quad ✓$$

$v_f = v_i + a\Delta t$
$= (14,99) + (-9,8)\ (4)$
$= -\ 24,2\ m\cdot s^{-1}$

$\Delta y = -\ 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) ✓ / *Bal is 18,4 m afwaarts (onder die kant van die dak).*

Downwards positive/*Afwaarts positief:*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(-14,99 + 24,2)}{2}\right)(4) \quad ✓$$

$v_f = v_i + a\Delta t$
$= (-14,99) + (9,8)\ (4)$
$= 24,2\ m\cdot s^{-1}$

$\Delta y = 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) ✓ / *Bal is 18,4 m afwaarts (onder die kant van die dak.)*

OPTION 4/*OPSIE 4*
Total time to return to starting point/*totale tyd terug na beginpunt*
= 2(1,53) = 3,06 s
∴ time from reference point to ground/ *tyd vanaf verwysingspunt tot by grond*
= (4 – 3,06) = 0,94 s
$\Delta y = v_i\Delta t + ½ (g)\Delta t^2$ ✓
$= (14,99)(0,94) + ½(9,8)(0,94)^2$ ✓
= 18,43 m ✓downwards (below the edge of the roof) /*afwaarts (onder die kant van die dak.* (3)

3.4 No/*Nee*✓
The motion of the ball is only dependent on its initial velocity✓✓/the initial velocity depends on the time taken to reach maximum height.
Die beweging van die bal is slegs afhanklik van sy beginsnelheid./die aanvanklike snelheid hang af van die tyd wat dit neem om maksimum hoogte te bereik.

ACCEPT for 1 mark/ *AANVAAR vir 1 punt:*

The ball will still be in the air.✓
Die bal sal nog steeds in die lug wees.

OR/*OF*
The ball is still falling.✓
Die bal is steeds besig om te val.

OR/*OF*
The ball would not have reached the ground.✓
Die bal sal nog nie die grond bereik het nie.

OR/OF
The motion of the ball is independent of the height of the building. ✓
Die beweging van die bal is onafhanklik van die hoogte van die gebou.

NOTE: If learners gave separate answers for 3.2 and 3.3, mark them together. Thus, if one answer is correct and the other incorrect 0/3 (3)
LW: Indien leerders twee afsonderlike antwoorde gee vir 3.2 en 3.3, sien as geheel na. Dus, indien een verkeerd is, 0/3 **[14]**

QUESTION 4/*VRAAG 4*

4.1 The total (linear) momentum in a isolated/closed system remains constant./ is conserved ✓✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant/behoue.

OR/*OF*
In an isolated/closed system the total momentum before a collision is equal to the total momentum after the collision. ✓✓
In 'n geslote/geïsoleerde sisteem is die totale momentum voor die botsing gelyk aan die totale momentum na die botsing.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat.
Take the whole statement in context /*Vat die hele stelling in konteks*. (2)

4.2

OPTION 1/*OPSIE 1*

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

1 mark for any
1 punt vir enige

$\{0,45(9) + 0,20(0)\}$✓ $= (0,45 + 0,20)v$✓
$v = 6,23\ m\cdot s^{-1}$✓

OR
$\Delta p_{ball/bal} = -\Delta p_{cont/houer}$✓
$0,45(v - 9)$ ✓ $= -0,2(v - 0)$ ✓
$v = 6,23\ m\cdot s^{-1}$✓

If – sign omitted from formula 0/4
Indien – teken weggelaat uit formula 0/4

OPTION 2/*OPSIE 2*

$\sum p_i = \sum p_f$
$p_{f\ Total} = p_{i\ Total}$

1 mark for any✓
1 punt vir enige

(Thus change in total momentum = 0 /*Dus verandering in momentum is=0*))
0 ✓$= \underline{(0,65v_f) - (9)(0,45)}$✓
$v_f = 6,23\ m\cdot s^{-1}$✓ (4)

4.3

POSITIVE MARKING FROM 4.2/*POSITIEWE NASIEN VANAF 4.2* $K = ½ mv^2$✓ (or $E_K = ½ mv^2$) Total kinetic energy before collision:/*Totale kinetiese energie voor botsing:* $\underline{½ (0,45)(9)^2}$ $\underline{+ 0}$✓= 18,225J Total kinetic energy after collision:/ *Totale kinetiese energie na botsing:* $\underline{½ (0,45 + 0,20)(6,23)^2}$✓ = 12,614J $\sum K_{before/voor} \neq \sum K_{after/na}$ Collision is inelastic. /*Botsing is onelasties*✓✓
If start with/ *indien begin met* $\sum E_{Ki} = \sum E_{Kf}$ 4/5 max/*maks* No calculation/ *geen berekening*: 0 Do not accept a conclusion of inelastic collision based on any other calculation (such as that of momentum or mechanical energy)*./ Moet geen afleiding van ' n onelastiese botsing aanvaar wat op enige ander berekening gebaseer is nie (soos byvoorbeeld momentum of meganiese energie).*

(5)
[11]

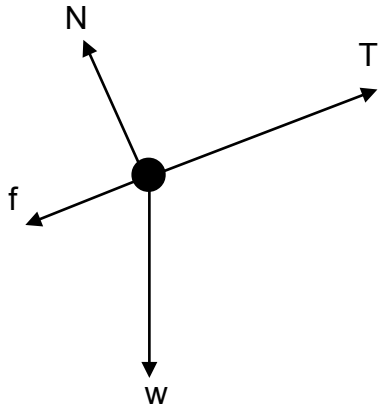
QUESTION 5/*VRAAG 5*

5.1 Tension/*Spanning*✓ (1)

5.2 There is friction/ tension in the system ✓
Daar is wrywing/spanning in die sisteem
OR/*OF*
Friction/tension is a non-conservative force ✓
Wrywing/spanning 'n 'n nie-konserwatiewekrag
OR/*OF*
The system is not isolated because there is friction/tension ✓
Die sisteem in nie geïsoleerd nie omdat daar wrywing/spanning is

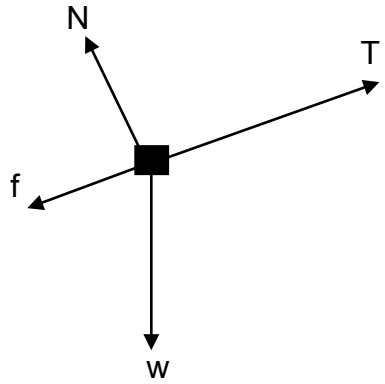
OR/*OF*
The internal energy increases because of friction ✓
Die interne energie neem toe as gevolg van wrywing.
OR
The applied force is non-conservative✓
Die toegepaste krag is nie-konservatief
OR
It is not an isolated system✓ (1)

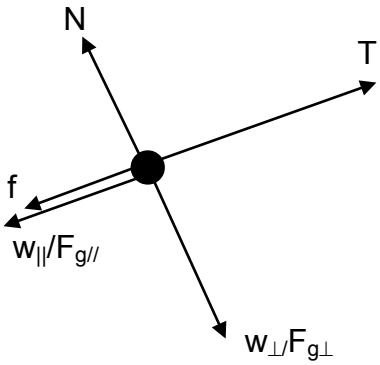
5.3



NOTE: maximum ¾ if friction and tension are not on a straight line
LW: maksimum ¾ indien wrywing en spanning nie in 'n reguitlyn nie.

ACCEPT/*AANVAAR*





NOTE: maximum ¾ if N and $w_{\perp}$ are not on a straight line
LW: maksimum ¾ indien N en $w_{\perp}$ nie in 'n reguitlyn nie.

Accepted labels/*Aanvaarde benoemings*		
w	F_g/F_w/weight/mg/gravitational force *F_g/F_w/gewig/mg/gravitasiekrag*	✓
f	Friction/F_f/f_k/178,22 N/*wrywing*/*F_w*	✓
N	Normal (force)/$F_{normalL}/F_N/F_{normaal}/F_{reaction/reaksie}$	✓
T	$F_T/F_A/F_{applied/toegepas}$/700 N/Tension	✓

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* $^3/_4$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $^3/_4$

Deduct 1 mark for an arrow/arrows omitted / *trek 1 punt af indien pyl/pyle weggelaat* (4)

5.4

$W = F\Delta x\cos\theta$✓
$W_f = [178,22(4)\cos 180^o]$ ✓
$= -712,88$ J✓ (3)

5.5

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM QUESTIONS 5.4 *POSITIEWE NASIEN VANAF VRAE 5.4*

$W_{net} = \Delta E_K$
$W_f + W_g + W_T = \Delta K$
$W_f + mg\sin\theta\Delta x\cos\theta + W_T = \Delta K$

1 mark for any one✓/
1 punt vir enige een

$-712,88 + \underline{(70)(9,8)(\sin 30^o)(4)\cos 180^o}$ ✓$+ \underline{(700 \times 4 \times \cos 0^o)}$✓ $= \underline{½\ 70(v_f^2 - 0)}$✓
$v_f = 4,52\ m\cdot s^{-1}$✓

NOTE: W_g can be obtained using any of the following formulae:
LW: w_g kan verkry word deur enige een van die volgende formules:

$W_{gravity/gravitasie} = mg\Delta x\cos\theta$
$= (70)(9,8)(4).(\cos 120^o)$

$\therefore$ $-712,88 + \underline{(70)(9,8)(4)\cos 120^o)}$ ✓$+ \underline{(700 \times 4 \times \cos 0^o)}$✓ $= \underline{½\ 70(v_f^2 - 0)}$✓
$v_f = 4,52\ m\cdot s^{-1}$✓

$W_{gravity/gravitasie} = -\Delta mgh = -mg(h_f - h_{0)}$
$= mg\Delta y\cos\theta$
$= ((70)(9,8)\ 4(\sin 30^o).\cos 180^o$
$W_{gravity/gravitasie} = mg\sin\theta\Delta x\cos\theta$
$= (70)(9,8)\ (\sin 30^o)(4).\cos 180^o$

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 5.4 / *POSITIEWE NASIEN VANAF 5.4*
$W_{nc} = \Delta E_K + \Delta E_p$ ✓
$W_T + W_f = \Delta E_K + \Delta E_p$
$(700)(4)\cos 0^o$✓ + (-712,88) = [(70)(9,8) 4(sin 30°). - 0]✓+ $\frac{1}{2}\,70(v_f^2 - 0)$✓
$v_f = 4{,}52\ m{\cdot}s^{-1}$✓

OPTION 3
$F_{net} = F_T - [mg\sin\theta + f_k]$
$= 700 - [(70 \times 9{,}8 \sin 30^o) + 178{,}22]$ ✓
$= 178{,}78$ N
$W_{net} = \Delta E_K$✓
$F_{net} . \Delta x\cos\theta = \Delta E_K$
$(178{,}78)(4)\cos 0^o$ ✓=.$\frac{1}{2}\,70(v_f^2 - 0)$✓
$v_f = 4{,}52\ m{\cdot}s^{-1}$✓ (5)

5.5

WHERE EQUATIONS OF MOTION ARE USED:/ *WAAR BEWEGINGSvERGELYKING GEBRUIK:* MAX/*MAKS* $\frac{1}{5}$

$F_{net} = ma$
$F_T - [mg\sin\theta + f_k] = ma$
$700 - [(70 \times 9{,}8 \sin 30^o) + 178{,}22]$ ✓$= 70a$
$a = 2{,}554\ ms^{-2}$
$v_f^2 = v_i^2 + 2a\Delta x$
$= 0 + 2(2{,}554)(4)$
$v_f = 4{,}52\ m{\cdot}s^{-1}$

5.6

POSITIVE MARKING FROM 5.4/*POSITIEWE NASIEN VANAF 5.4*

2(-712,88) = -1425,76 J✓

OR/OF
Double the answer (in question 5.4). ✓
Dubbel die antwoord (in vraag 5.4) (1)

[15]

QUESTION 6/*VRAAG 6*

6.1.1

$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$
$300 = v_i (10)$ ✓
$v_i = 30\ m\cdot s^{-1}$✓

$v = \frac{d}{t} = \frac{300}{10}$✓$=30 m\cdot s^{-1}$✓

NOTE/*LET WEL*:
Accept/*Aanvaar* $\Delta x = v_i\Delta t$ (2)

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

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

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat (2)

6.1.3 Car/source (just) passes observer ✓✓
Motor beweeg net verby die waarnemer
Accept:
Car moves away from observer ✓✓
No relative motion between car and observer ✓✓
Car and observer at the same place/position✓✓

***Aanvaar**:*
Motor beweeg verby waarnemer
Geen relatiewe beweging tussen motor en waarnemer
Motor en waarnemer by dieselfde plek/posisie. (2)

6.1.4

POSITIVE MARKING FROM 6.1.1/*POSITIEWE NAISEN VANF 6.1.1*

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

✓ $932 = \frac{340}{340 - 30} f_s$ ✓

$f_s = 849{,}76$ Hz ✓ (4)

Notes/*Aantekeninge*:

- Any other Doppler formula, e.g. /*Enige ander Doppler formula b.v.*

  $f_L = \frac{v - v_L}{v - v_s} f_s$ - Max/*Maks.* $\frac{3}{4}$

Marking rule 1.5: No penalisation if zero substitutions are omitted.
Nasienreël 1.5. Geen penalisering indein nul vervangings uitgelaat word

6.2 Doppler / Blood flow meter
Dopplervloeimeter/ bloedvloeimeter
Measuring the heartbeat of a foetus
Meting van hartklop van 'n fetus
Radar
Sonar
Used to determine whether stars are receding or approaching earth/
Gebruik om te bepaal of sterre na of weg van die aarde beweeg

Any 2 ✓✓
Enige 2

(2)
[12]

QUESTION 7/*VRAAG 7*

7.1 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die elektrostatiese krag *wat per eenheid positiewe lading wat by daardie punt geplaas word, ervaar word.* ✓✓

NOTE/*LET WEL*:
-1 for each key word/phrase omitted. If definition of electric field: 0/2
-1 vir elke sleutel woorde/frase weggelaat. Indien definisie van elektriese veld 0/2 (2)

7.2 q_2 is positive ✓

The electric field due to q_1 points to the right because q_1 is negative. ✓ Since the net field is zero, field due to q_2 must point to the left away from q_2, ✓ hence q_2 is positive.

q_2 is positief

Die elektriese veld as gevolg van q_1 is na regs gerig omdat $q_1$negaitief is. Aangesien die net veld nul is, moet die veld as gevolg van q_2 na links weg van q_2 wees.

OR/OF

q_2 is positive ✓

Since E_{net} is zero, E_1 and E_2 are in opposite directions ✓ therefore q_1 and q_2 are oppositely charged. ✓

q_2 is positief ✓
Omdat E_{net} nul is, is E_1 en E_2 in teenoorgestelde rigtings ✓*daarom is q_1 en q_2 teenoorgesteld gelaai.* ✓ (3)

7.3

$E = k\frac{Q}{r^2}$ ✓

$E_{net} = 0$

$\therefore k\frac{q_1}{r_1^2} = k\frac{q_2}{r_2^2}$ OR

$\frac{q_1}{r_1^2} = \frac{q_2}{r_2^2}$

$\frac{(9\times10^9)(3\times10^{-9})}{(0,1)^2}$ ✓ $= \frac{(9\times10^9)q_2}{(0,4)^2}$ ✓

$q_2 = + 4,8 \times 10^{-8}$ C✓

1 mark for formula
1 mark for equating the two fields
1 mark for both substitutions
1 mark for answer
1 punt vir vergelyking
1 punt vir twee velde gelyk gestel
1 punt vir altwee substitusies
1 punt vir antwoord

(4)

7.4 The electrostatic force (of attraction/repulsion) between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. ✓✓
Die elektrostatiese krag(aantekking/afstotend) tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.If masses used instead of charges 0
-1 vir elke sleutel woorde/frase weggelaat Indien massas gebruik 0

7.5

POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(3\times10^{-9})(4,8\times10^{-8})}{(0,3)^2}$ ✓

$= 1,44 \times 10^{-5}$ N✓

(3)

7.6 **POSITIVE MARKING FROM 7.2 AND 7.3/*POSITIEWE NASIEN van 7.2 en 7.3***
YES/*JA*✓
Both charges are equal and positive ✓
Beide ladings is gelyk en positief

Accept calculation which shows charges the same and positive/ *Aanvaar berekening wat toon dat ladings dieselfde en positief is.*

If the answer is YES, mark according to the memo, if NO check 7.2 first for sign of charge. If stated NEGATIVE at 7.2, then answer is:
No✓, the direction is incorrect. ✓
Positiewe nasien vanaf 7.2: Indien antwoord vir 7.2 NEGATIEF, dan is hierdie antwoord: Nee ✓, die rigting is verkeerd. ✓

(2)
[16]

QUESTION 8/*VRAAG 8*

8.1.1 The rate at which (electrical) energy is converted (to other forms) (in a circuit)
The rate at which energy is used/Energy used per second
The rate at which work is done ✓✓
(2 or zero)
Die tempo waarteen elektriese energie omgesit word (in ander vorms) in 'n stroombaan.
Die tempo waarteen energie verbruik word.
Die tempo waarteen arbeid verrig word.
(2 of nul) (2)

8.1.2

$P = \frac{V^2}{R}$ ✓ $6 = \frac{(12)^2}{R}$ ✓ $R = 24\ \Omega$✓	$W = \frac{V^2\Delta t}{R}$ ✓ $6 = \frac{(12)^2(1)}{R}$ ✓ $R = 24\ \Omega$✓	$P = VI$ $6 = (12)(I)$ $\therefore I = 0,5$ A $P = I^2R$✓ $6 = (0,5)^2 R$✓ $R = 24\ \Omega$✓	$P = VI$✓ $6 = (12)(I)$ $\therefore I = 0,5$ A $V = IR$ $12 = (0,5)R$✓ $R = 24\ \Omega$✓

(3)

8.1.3 **POSITIVE MARKING FROM 8.1.2/*POSITIEWE NASIEN VANAF 8.1.2***
OPTION 1/*OPSIE 1*

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$
$= \frac{1}{24} + \frac{1}{24}$ ✓
$R_{//} = 12\ \Omega$

$R_{ext} = (R_s + R_{//})$
$R_{ext} = (24 + 12)$ ✓
$= 36\ \Omega$
$V = IR$
OR
$\varepsilon = I(R + r)$
$12 = I(36 + 2)$ ✓
$I = 0,32$ A✓(0,316 A)

✓ any one
Enige 1

$R_{tot} = (R_s + \frac{R_1R_2}{R_1 + R_2})$
$R_{tot} = \{24 + \frac{(24)(24)}{48}$ ✓$\}$ ✓
$= 36\ \Omega$

POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2
OPTION 2/OPSIE 2

Rext = (Rs + R//)

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{24} + \frac{1}{24}$ ✓

R// = 12 Ω

Rext = (24 + 12)✓

= 36 Ω

$R_{ext} = R_s + \frac{R_1R_2}{R_1 + R_2}$

$R_{ext} = \left\{24 + \frac{(24)(24)}{48}\checkmark\right\}\checkmark$

= 36Ω

$P = I^2R = \frac{V^2}{R}$ ✓

$I^2(36 + 2) = \frac{(12)^2}{38}$ ✓

I = 0,32 A✓(0,316) ✓

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

$I^2R^2 = V^2$

V = IR

12 = I(38) ✓

I = 0,316 A✓

(5)

8.1.4

POSITIVE MARKING FROM 8.1.3
POSITIEWE NASIEN VANAF 8.1.3
OPTION 1/*OPSIE 1*
V = IR
V = I(R_A+r)
= 0,316(26) ✓
= 8,216 V (8,32 V)
 	
$V_{//}$ = (12 – 8,216) ✓
= 3,784 V(3,68 V)
∴V_C = 3,78 V (3,68 V) ✓
	POSITIVE MARKING FROM 8.1.3
	POSITIEWE NASIEN VANAF 8.1.3
	OPTION 2/*OPSIE 2*
	V = IR
	For the parallel portion (or from 8.1.3):
	Vir die parallel gedeelte (of vanaf 8..1.3)
	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ OR $R = \frac{R_1R_2}{(R_1 + R_2)}$
	$R = \frac{(24)(24)}{48}$
	= 12 Ω
	$V_{//} = V_C$ ✓
	V = $IR_{//}$
	= (0,316)(12) ✓
	= 3.79 V (3,84 V)✓
		(3)

POSITIVE MARKING FROM 8.1.3 ***POSITIEWE NASIEN VANAF 8.1.3*** **OPTION 3/*OPSIE 3*** $I_A = I_B + I_C$ = 2 I_B 0,316 = 2I_B✓ I_B = 0,158 A V = 0,158 (24) ✓ = 3,79 V✓		(3)

8.1.5 **OPTION 1/*OPSIE 1***

The power rating (output voltage) of the bulb is 6 W, 12 V. /*Die gloeilamp is gemerk 6W ; 12 V*

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

[For a given resistance, power is directly proportional to V^2] ✓
[of *Vir 'n gegewe resistor is drywing direk eweredig aan* V^2]
Since the potential difference across light bulb C is less than the operating voltage,✓ the output/power will be less, ✓/ Omdat d*ie potensiaalverskil oor gloeilamp C minder is as die benodigde spanning sal die uitset/drywing minder wees*.

OPTION 2/*OPSIE 2*

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

The potential difference across light bulb C is less than the operating voltage. ✓ Thus for the same resistance, ✓ brightness decreases.
Die potensiaalverskil oor gloeilamp C is minder as die benodigde potensiaalverskil. Dus vir dieselfde weerstand, sal die helderheid afneem.

OPTION 3/*OPSIE 3*

$P = I^2 R$
For a given resistance✓, power is directly proportional to I^2 Since current decreases✓, brightness decreases.]
[*vir 'n gegewe resistor is drywing direk eweredig aan* I^2 *Omdat stroom afneem sal die helderheid afneem]*

OPTION 4/*OPSIE 4*

$P = I^2 R$
In the circuit, the total current in light bulb C is less than the optimum current required (0,5 A). ✓ Thus for the same resistance, ✓ the power will be less✓ hence brightness will decrease.
In die stroombaan is die totale stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Dus vir dieselfde weerstand, is die drywing minder en die helderheid sal afneem.

OPTION 5/*OPSIE 5*

P = IV✓ [Power is directly proportional/equal to product of V and I. ✓
Since current decreases✓, brightnes decreases/
drywing is direk eweredig/gelyk aan produk van V en I. Omdat stroom afneem sal die helderheid afneem]]
OR/OF
The voltage across light bulb C, as well as the current in the bulb are all less✓ than the optimum values✓ hence power is less✓ and brightness is less.
Die potensiaalverskil oor gloeilamp C sowel as die stroom in die gloeilamp is almal minder as die optimum waardes, dus is die drywing minder en die helderheid minder. (3)
NOTE: No mark if only equation is given.

8.2.1 The total current passes through resistor A. ✓ For the parallel portion, the current branches, therefore only a portion of the total current passes through resistor C. ✓
Die totale stroom vloei deur resistor A. Vir die parallelle gedeelte verdeel die stroom, dus vloei slegs 'n gedeelte van die stroom deur resistor C. (2)
ACCEPT for 1 mark: Resistor C is connected parallel to resistors B and D together. Current is dividing ✓at the junction.
AANVAAR vir 1 punt: Resistor C is in parallel geskakel met B en D saam. Die stroom breek op ✓ by die koppeling.

8.2.2 The current in B is equal✓ to the current in A. The circuit becomes a series circuit. ✓
Die stroom in B is gelyk aan die stroom in A. Die stroombaan word 'n serie stroombaan. (2)
[21]

QUESTION 9/*VRAAG 9*

9.1 Slip rings/*Sleep ringe* ✓ (1)

9.2 B ✓ (1)

9.3

$$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}} \checkmark$$
$$= \frac{312}{\sqrt{2}} \checkmark$$
$$= 220{,}62 \text{ V} \checkmark$$

(3)

9.4.1

POSITIVE MARKING FROM 9.3/*POSITIEWE NASIEN VANAF 9.3*
OPTION 1/*OPSIE 1*

$$P_{aver / gemid} = \frac{V^2_{rms / wgk}}{R} \checkmark$$
$$= \frac{(220{,}62)^2}{40} \checkmark$$
$$= 1216{,}83 \text{ W} \checkmark$$

POSITIVE MARKING FROM 9.3/*POSITIEWE NASIEN VANAF 9.3*
OPTION 2/*OPSIE 2*

$$I_{rms} = \frac{V_{rms / wgk}}{R}$$
$$= \frac{(220{,}62)}{40}$$
$$= 5{,}515$$
$$P_{ave} = I^2_{rms}R$$
$$= (5{,}515)^2(40) \checkmark$$
$$= 1216{,}61 \text{ W} \checkmark$$

OR

$$P_{ave} = V_{rms}I_{rms}$$
$$= (220{,}62)(5{,}515) \checkmark$$
$$= 1216{,}72 \text{ W} \checkmark$$

✓ for any/ *vir enige*

OPTION 3/*OPSIE 3*

$I_{max} = \frac{V_{max}}{R}$

$= \frac{312}{40}$

$= 7,80$ A

$P_{ave} = \frac{I_{max} V_{max}}{2}$

$= \frac{(7,8)(312)}{2}$ ✓

$= 1216,80$ W ✓

✓ for any/ *vir enige*

(3)

9.4.2

OPTION 1/*OPSIE 1*

$I_{max/maks} = \frac{V_{max/maks}}{R}$ ✓

$= \frac{312}{40}$ ✓ ✓

$= 7,8$ A✓

Accept/ *Aanvaar*: $I = \frac{V}{R}$

POSITIVE MARKING FROM 9.3 AND 9.4.1/*POSITIEWE NASIEN VANAF 9.3 EN 9.4.1*

OPTION 2/*OPSIE 2*

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$

$1\,216,83 = 220,62\ I_{rms/wgk}$ ✓

$I_{rms/wgk} = 5,515$ A

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5,515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7,8$ A✓

✓ for any/ *vir enige*

OPTION 3/*OPSIE 3*

$P_{ave/gemid} = I^2_{rms/wgk} R$

$1\,216,83 = I^2_{rms/wgk}(40)$✓

$I_{rms/wgk} = 5,515$ A

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5,515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7,8$ A ✓

✓ for any/ *vir enige*

(4)

[12]

QUESTION 10/*VRAAG 10*

10.1 The minimum frequency of light needed to eject electrons from a metal (surface)✓✓.
Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal (oppervlak) vry te stel.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat. (2)

10.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$E = h\frac{c}{\lambda}$ ✓ $= \frac{(6{,}63\times10^{-34})(3\times10^{8})}{5\times10^{-7}}$ ✓ $= 3{,}98 \times 10^{-19}$ J✓	$c = f\lambda$ $3 \times 10^{8} = f(5 \times 10^{-7})$ $f = 6 \times 10^{14}$ Hz $E = hf$ $= (6{,}63 \times 10^{-34})(6 \times 10^{14})$ ✓ $= 3{,}98 \times 10^{-19}$ J✓

✓Both equations
Beide vergelykings

(3)

NOTE: do not penalise if *v* is used in place of *c.*

10.3

OPTION 1/*OPSIE 2*
POSITIVE MARKING FROM QUESTION 10.2/*POSITIEWE NASIEN VANAF VRAAG 10.2*

$E = W_0 + E_{kmax}$

$hf = W_0 + \frac{1}{2}mv^2_{max}$ ✓

$h\frac{c}{\lambda} = W_0 + E_{K(max/maks)}$

$h\frac{c}{\lambda} = hf_0 + E_{K(max/maks)}$

1 mark any one/*1 punt vir enige*

$3{,}98 \times 10^{-19} = (6{,}63 \times 10^{-34})(5{,}55 \times 10^{14}) + E_{K(max/maks)}$ ✓
$E_{K(max/maks)} = 3{,}0 \times 10^{-20}$ J✓

$E_{K(max/maks} > 0$ ✓

(The electrons emitted from the metal plate have kinetic energy to move between the plates, hence the ammeter registers a reading.
Die elektrone vrygestel vanaf die metaalplaat het kinetiese energie om tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing)

OPTION 2/OPSIE 2
POSITIVE MARKING FROM QUESTION 10.2/*POSITIEWE NASIEN VANAF VRAAG 10.2*

$W_o = hf_o$ ✓
$= \underline{(6,63 \times 10^{-34})(5,55 \times 10^{14})}$ ✓
$= 3,68 \times 10^{-19}$ J

$E_{photon} > W_o$ ✓

(The energy of the incident photon is greater than the work function of potassium. From the equation $hf = W_0 + E_{Kmax}$, the ejected photoelectrons will move between the plates, ✓ hence the ammeter registers a reading.
Die energie van die invallende foton is hoër as die arbeidsfunksie van kalium. Vanaf die vergelyking $hf = hf_0 + E_{K(maks)}$, *sal die vrygestelde foto-elektrone tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing.*)

OPTION 3/*OPSIE 3*

$c = f\lambda$ ✓
$3 \times 10^8 = f(5 \times 10^{-7})$ ✓
$f = 6 \times 10^{14}$ Hz

$f > f_0$ ✓

The frequency of the incident photon is higher than the threshold frequency. From the equation $hf = hf_0 + E_{K(max)}$, the ejected photoelectrons will be able to move between the plates ✓ (for the given frequency), hence the ammeter registers a reading.
Die frekwensie van die invallende foton is hoër as die drumpelfrekwensie. Vanaf die vergelyking $hf = hf_0 + E_{K(maks)}$, *sal die vrygestelde foto-elektrone tussen die plate kan beweeg en gevolglik registreer die ammeter 'n lesing.)* (4)

10.4 The increase in intensity increases the *number* of photons per second.✓
Soos die intensiteit toeneem, neem die aantal fotone per sekonde toe.

Since each photon releases one electron✓ the number of ejected electrons per second increases.✓
Aangesien elke foton een elektron vrystel, neem die aantal vrygesteld e elektrone per sekonde toe.
ACCEPT: Flow of electrons per unit time increases ✓ (1 mark)
AANVAAR: vloei van elektrone per eenheidstyd neem toe (1 punt)

This causes the current /ammeter reading to increase.
Dit veroorsaak dat die stroom/ammeterlesing toeneem. (3)

[12]

TOTAL/*TOTAAL*: 150