



LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2022

MARKING GUIDELINES

MARKS: 150

This marking guidelines consist of 15 pages.

QUESTION 1

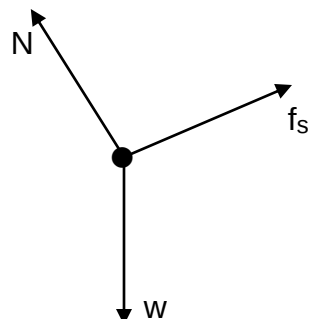
- 1.1 B ✓✓ (2)
- 1.2 A ✓✓ (2)
- 1.3 C ✓✓ (2)
- 1.4 A ✓✓ (2)
- 1.5 B ✓✓ (2)
- 1.6 D ✓✓ (2)
- 1.7 D ✓✓ (2)
- 1.8 A ✓✓ (2)
- 1.9 C ✓✓ (2)
- 1.10 A ✓✓ (2)

[20]

QUESTION 2

2.1.1 The force that opposes the tendency of motion of a stationary object relative to a surface. ✓✓ (2)

2.1.2



	Accept the following symbols:
N✓	F_N /Normal force/ $F_{\text{surface on crate}}$
f_s ✓	f / F_f /frictional force/static frictional force
w✓	F_g /mg/weight/gravitational force/ $F_{\text{Earth on crate}}$

Take uphill as POSITIVE

Notes:

- Mark is awarded for label and arrow.
- Do not penalize for length of arrows
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with dot/body: 2/3
- If arrows missing: 2/3

(3)

2.1.3

$$\begin{aligned}
 F_{\text{net}} &= ma \\
 \therefore f_s^{\text{max}} + (-mg \sin \theta) &= ma^{\text{max}} \quad \text{Any one } \checkmark \\
 \mu_s F_N - mg \sin \theta &= ma^{\text{max}} \\
 \mu_s mg \cos \theta - mg \sin \theta &= ma^{\text{max}} \\
 \therefore f_s^{\text{max}} - m(9,8)(\sin 10^\circ) &= ma^{\text{max}} \dots\dots \textcircled{1} \\
 \text{But } f_s^{\text{max}} &= \mu_s N \\
 \therefore f_s^{\text{max}} &= \mu_s (mg \cos \theta) \dots\dots \textcircled{2} \\
 \text{Subst. } \textcircled{2} \text{ into } \textcircled{1} : \\
 \therefore \mu_s (mg \cos \theta) - m(9,8)(\sin 10^\circ) &= m(a^{\text{max}}) \\
 \therefore (0,35) m(9,8)(\cos 10^\circ) \checkmark - m(9,8)(\sin 10^\circ) &= m(a^{\text{max}}) \\
 (\div m) : \therefore (0,35)(9,8)(\cos 10^\circ) \checkmark - (9,8)(\sin 10^\circ) \checkmark &= a^{\text{max}} \\
 \therefore \text{the maximum acceleration is } 1,676 \text{ m} \cdot \text{s}^{-2} \checkmark
 \end{aligned}$$

(5)

2.2.1

Marking criteria

-1 mark for each key word/phrase omitted in the correct context.

Each body in the universe attracts every other body with a (gravitational) force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. ✓✓

OR:

Every particle in the universe attracts every other particle with a (gravitational) force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. ✓✓

(2)

2.2.2

$$\begin{aligned}
 g_E &= \frac{GM_E}{R_E^2} = 9,8 \text{ m} \cdot \text{s}^{-2} \\
 g_M &= \frac{GM_M}{R_M^2} \quad \checkmark \\
 &= \frac{G \left(\frac{M_E}{153} \right)}{\left(\frac{R_E}{5} \right)^2} \quad \checkmark \\
 &= \frac{25}{153} \frac{GM_E}{R_E^2} \\
 &= \frac{25}{153} (9,8) \\
 &= 1,60 \text{ m} \cdot \text{s}^{-2} \quad \checkmark \\
 &\text{(downwards)}
 \end{aligned}$$

(3)

2.2.3 Equal to ✓

(1)

[16]

QUESTION 3

3.1 Motion during which the only force acting on an object is the gravitational force. ✓✓ (2)

3.2

OPTION 1:**UPWARDS POSITIVE:**

For stone X: $\Delta y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2 \checkmark$ $0 = (3v)(10) + \frac{1}{2}(-9,8)(10)^2 \checkmark$ $0 = 30v - 490$ $490 = 30v$ $v = \left(\frac{49}{3}\right) \text{ m s}^{-1}$	For stone Y: $\Delta y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$ $0 = \left(\frac{49}{3}\right) \Delta t + \frac{1}{2}(-9,8)(\Delta t)^2 \checkmark$ $0 = \Delta t \left(\frac{49}{3} - 4,9 \Delta t\right)$ $\Delta t = 0 \text{ s or } \Delta t = 3,333 \text{ s}$ $\Delta t = 3,33 \text{ s (3,333 s)} \checkmark$
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(4)

DOWNWARDS POSITIVE:

For stone X: $\Delta y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2 \checkmark$ $0 = (3v)(10) + \frac{1}{2}(9,8)(10)^2 \checkmark$ $0 = 30v + 490$ $-490 = 30v$ $v = \left(-\frac{49}{3}\right) \text{ m s}^{-1}$	For stone Y: $\Delta y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$ $0 = \left(-\frac{49}{3}\right) \Delta t + \frac{1}{2}(9,8)(\Delta t)^2 \checkmark$ $0 = \Delta t \left(-\frac{49}{3} + 4,9 \Delta t\right)$ $\Delta t = 0 \text{ s or } \Delta t = 3,333 \text{ s}$ $\Delta t = 3,33 \text{ s (3,333 s)} \checkmark$
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OPTION 2:**UPWARDS POSITIVE:**

For stone X: Consider upward motion: $v_f = v_i + a \Delta t \checkmark$ $0 = v_i + (-9,8)(5) \checkmark$ $v_i = 49 \text{ m s}^{-1}$	For stone Y: $v_{B_i} = \frac{49}{3} \text{ m s}^{-1} \text{ or } 16,333 \text{ m s}^{-1}$ Consider upward motion: $v_f = v_i + a \Delta t$ $0 = 16,333 + (9,8) \Delta t \checkmark$ $\Delta t = 1,666 (1,67 \text{ s})$ $\Delta t(\text{total}) = 2 \times 1,666 = 3,33 \text{ s}$
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DOWNWARDS POSITIVE:

For stone X: Consider upward motion: $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (9,8)(5)$ ✓ $v_i = -49 \text{ m s}^{-1}$	For stone Y: $v_{Bi} = -\frac{49}{3} \text{ m s}^{-1}$ or $-16,333 \text{ m s}^{-1}$ Consider upward motion: $v_f = v_i + a\Delta t$ $0 = -16,333 + (9,8)\Delta t$ ✓ $\Delta t = 1,666(1,67 \text{ s})$ $\Delta t(\text{total}) = 2 \times 1,666 = 3,33 \text{ s}$
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3.3 **POSITIVE MARKING FROM QUESTION 3.2:****OPTION 1:****UPWARDS POSITIVE:**

For stone Y $\Delta y = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$ ✓ $H = \left(\frac{49}{3}\right)\left(\frac{5}{3}\right) + \frac{1}{2}(-9,8)\left(\frac{5}{3}\right)^2$ ✓ $H = \left(\frac{245}{18}\right)\text{m}$	For stone X $\Delta y = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$ $= \underline{(49)(5)} + \frac{1}{2}(-9,8)(5)^2$ ✓ $= \frac{245}{2} = 9\left(\frac{245}{18}\right)$ ✓ = 9H
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DOWNWARDS POSITIVE:

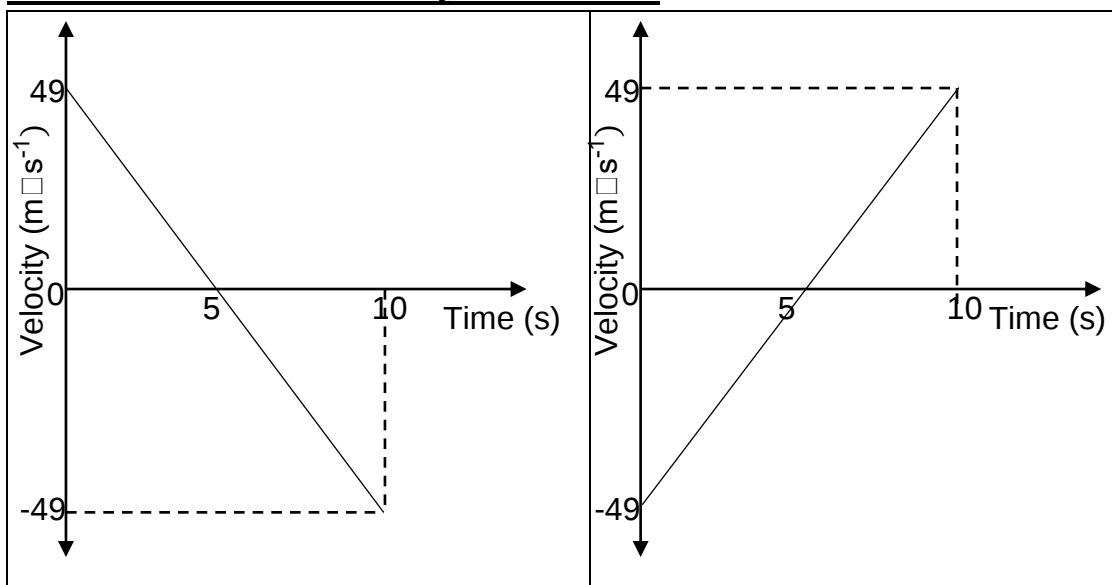
For stone Y $\Delta y = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$ ✓ $H = \left(-\frac{49}{3}\right)\left(\frac{5}{3}\right) + \frac{1}{2}(9,8)\left(\frac{5}{3}\right)^2$ ✓ $H = \left(-\frac{245}{18}\right)\text{m}$	For stone X $\Delta y = v_i \Delta t + \frac{1}{2}a(\Delta t)^2$ $= \underline{(-49)(5)} + \frac{1}{2}(9,8)(5)^2$ ✓ $= -\frac{245}{2} = 9\left(-\frac{245}{18}\right)$ ✓ = 9H
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OPTION 2:**UPWARDS POSITIVE:**

<u>For stone Y</u> $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (49)(5) + \frac{1}{2}(-9,8)(5)^2$ ✓ $= 122,5 \text{ m}$	<u>For stone X</u> $\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$ $= (16,333)(1,666) + \frac{1}{2}(9,8)(1,666)^2$ ✓ $= 13,61 \text{ m} = H$ $13,61 \times 9 = 122,49 \text{ m} = 9H(122,5 \text{ m})$ ✓
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<u>DOWNWARDS POSITIVE:</u> <u>For stone Y</u> $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $= (-49)(5) \checkmark + \frac{1}{2} (9,8)(5)^2 \checkmark$ $= -122,5 \text{ m}$	<u>For stone X</u> $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= (-16,333)(1,666) + \frac{1}{2} (9,8)(1,666)^2 \checkmark$ $= -13,61 \text{ m} = H$ $-13,61 \times 9 = -122,49 \text{ m} = 9H(122,5 \text{ m}) \checkmark$
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(5)

3.4 **POSITIVE MARKING FROM QUESTION 3.2:****Marking criteria:**

- Correct shape (Should intersect t-axis) ✓
- Final velocity and initial velocity shown ✓
- 5 s shown for maximum height ✓

(3)

[14]

QUESTION 4

4.1 The product of an object's mass and its velocity. ✓✓ **(2 or 0)** (2)

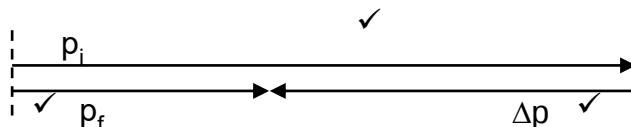
4.2 The total (linear) momentum of an isolated system remains constant (is conserved). ✓✓ (2)

4.3

<u>OPTION 1</u>	<u>OPTION 2</u>
$\Sigma p_i = \Sigma p_f$ $m_A v_{A_i} + m_B v_{B_i} = m_A v_{A_f} + m_B v_{B_f}$ $m_A(4) + m_B(-1) \checkmark = m_A(1) + m_B(3) \checkmark$ $4m_A - m_A = 3m_B + m_B$ $3m_A = 4m_B \checkmark$ $\frac{m_A}{m_B} = \frac{4}{3}$ $m_A : m_B = 4:3$	$\Delta p_A = -\Delta p_B$ $m_A(v_{A_f} - v_{A_i}) = m_B(v_{B_f} - v_{B_i})$ $m_A(1-4) \checkmark = -m_B(3-(-1)) \checkmark$ $m_A(-3) = -m_B(4)$ $m_A(-3) = m_B(4) \checkmark$ $\frac{m_A}{m_B} = \frac{-4}{-3} = \frac{4}{3}$ $m_A : m_B = 4:3$
<u>Marking criteria:</u> • Formula • Right hand substitution into formula • Left hand substitution into formula • This step: $m_A(-3) = m_B(4)$	

(4)

4.4



(3)

Criteria	mark
• Large initial momentum in the same direction as final momentum	✓
• Small final momentum in the same direction as initial momentum	✓
• Change in momentum in the opposite direction	✓

[11]

QUESTION 5

- 5.1 The net work done on an object is equal to the change in the object's kinetic energy. ✓✓

OR:

The work done on an object by the net force is equal to the change in the object's kinetic energy. ✓✓

(2)

OPTION 1:

5.2

$$W_{\text{net}} = \Delta E_K \text{ OR } W_f + W_w + W_N = \Delta E_K$$

$$f\Delta x \cos \theta + mg\Delta x (\cos \theta) + 0 = \frac{1}{2}m(v_f^2 - v_i^2) \quad \left. \begin{array}{l} \text{Any one} \checkmark \end{array} \right\}$$

$$(45)(\Delta x)(\cos 180^\circ) + (10)(9,8)(\Delta x)(\cos 125^\circ) \checkmark + 0 = \frac{1}{2}(10)(0^2 - 8,84^2) \checkmark$$

$$-45\Delta x - 56,2105\Delta x = -390,728$$

$$\Delta x = 3,86 \text{ m}$$

$$x = 3,86 \text{ m} \checkmark$$

(4)

NB: The work done by the gravitational force W_w can also be calculated as follows:

$$W_w = mg \sin \theta \Delta x \cos \theta$$

$$= (10)(9,8)(\sin 35^\circ)x \cos 180^\circ$$

$$= (-56,2105x) \text{ J}$$

$$\text{OR: } W_w = -\Delta E_p$$

$$= mg(h_i - h_f)$$

$$= (10)(9,8)(0 - x \sin 35^\circ)$$

$$= (-56,2105x) \text{ J}$$

OPTION 2:

$$W_{\text{nc}} = \Delta E_p + \Delta E_k$$

$$= mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$$

$$W_f = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2) \quad \left. \begin{array}{l} \text{Any one} \checkmark \end{array} \right\}$$

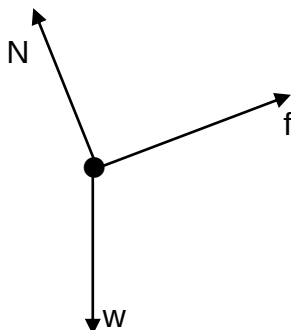
$$f\Delta x \cos \theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$$

$$(45)x \cos 180^\circ = (10)(9,8)(x \sin 35^\circ - 0) \checkmark + \frac{1}{2}(10)(0^2 - 8,84^2) \checkmark$$

$$-45x = 56,2105x - 390,728$$

$$x = 3,86 \text{ m} \checkmark$$

5.3

**Accepted labels**

N✓	F_N / Normal force/ F_{normal}
f✓	f/F_f / frictional force/ f_s
w✓	F_g/mg /weight/gravitational force

Notes:

- Mark is awarded for label and arrow.
- Do not penalize for length of arrows
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with dot/body: 2/3
- If arrows missing: 2/3

(3)

5.4

OPTION 1:

$$f_s = w_{||} = mg \sin \theta \checkmark$$

$$= (10)(9,8)(\sin 35^\circ) \checkmark$$

$$f_s = 56,21 \text{ N} \checkmark$$

OPTION 2:

$$\mu_s = \tan \theta = \tan 35^\circ = 0,7002$$

$$f_s = \mu_s N = \mu_s mg \cos \theta \text{ (ANY ONE)} \checkmark$$

$$= (0,7002)(10)(9,8)(\cos 35^\circ) \checkmark$$

$$= 56,21 \text{ N} \checkmark$$

(3)

[12]**QUESTION 6**

- 6.1 The apparent 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. $\checkmark \checkmark$

(2)

6.2

$$v = f_s \lambda \checkmark$$

$$340 = (300) \lambda \checkmark$$

$$\lambda = 1,13 \text{ m} \checkmark$$

(3)

6.3

ANY ONE:

- To monitor the heartbeat of a foetus (unborn baby). $\checkmark$
- To measure the rate of blood flow. $\checkmark$

(1)

6.4.1

OPTION 1:

$$f_L = \left(\frac{v \pm v_L}{v \pm v_S} \right) f_s \checkmark$$

$$= \left(\frac{340}{340-30} \right) (300) \checkmark$$

$$= 329,032 \text{ Hz}$$

$$v = f_L \lambda$$

$$340 = (329,032) \lambda \checkmark$$

$$\lambda = 1,033 \text{ m} \checkmark$$

OPTION 2:

$$\lambda_B = \frac{v - v_S}{f_s} \checkmark$$

$$= \frac{340-30}{300} \checkmark$$

$$= 1,03 \text{ m} \checkmark$$

(4)

6.4.2

OPTION 1:	OPTION 2:
$f_L = \left(\frac{v \pm v_L}{v \pm v_S} \right) f_s$ $= \left(\frac{340}{340+30} \right) (300) \checkmark$ $= 275,676 \text{ Hz}$ $v = f \lambda$ $(340) = (275,676) \lambda$ $\lambda = \frac{340}{275,676}$ $= 1,23 \text{ m} \checkmark$	$\lambda_A = \left(\frac{V - V_S}{f_s} \right) \checkmark$ $= \left(\frac{340+30}{300} \right) \checkmark$ $= 1,23 \text{ m} \checkmark$

(3)

6.5 Less than ✓

(1)

[14]**QUESTION 7**

7.1.1 Distance (between the point charges)/medium/air ✓

(1)

7.1.2 The electrostatic force is directly proportional to the product of charges. ✓

(1)

7.1.3

$\text{gradient} = \frac{\Delta F}{\Delta Q^2}$ $= \frac{(4-3) \times 10^{12}}{\Delta Q^2} \checkmark$ $= \frac{1 \times 10^{12}}{1} \checkmark$ $= 1 \times 10^{12} \text{ N} \cdot \text{C}^{-2} \checkmark$	NOTE: accept any value from the graph
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(3)

7.1.4

$F = \frac{kQ_1Q_2}{r^2} \checkmark$ $\frac{F}{Q^2} = \frac{k}{r^2}$ $1 \times 10^{12} \checkmark = \frac{9 \times 10^9}{r^2} \checkmark$ $r^2 = 9 \times 10^{-3}$ $r = 0,09487 \text{ m} (0,095 \text{ m}) \checkmark$ $\text{NOTE: If } F = \frac{kQ^2}{r^2} \text{ is used, then maximum: } \frac{3}{4}$

(4)

7.2.1 A region of space in which an electric charge experiences a force. ✓✓ (2)

7.2.2

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_{\text{net,p}} = 0$$

$$\frac{kQ_1}{r^2} \checkmark = \frac{kQ_2}{r^2}$$

$$\frac{(9 \times 10^9)(8 \times 10^{-6})}{(0,4-d)^2} = \frac{(9 \times 10^9)(2 \times 10^{-6})}{d^2} \checkmark$$

ACCEPT: If 10^{-6} is omitted since it appears on both sides.

$$\frac{d^2}{(0,4-d)^2} = \frac{(2 \times 10^{-6})}{(8 \times 10^{-6})}$$

$$= 0,25$$

$$\frac{d}{0,4-d} = 0,5$$

$$d = 0,1333 \text{ m}$$

∴ The distance is 0,1333 m ✓

(4)

7.2.3

OPTION 1:	OPTION 2:
$Q_{\text{new}} = \frac{Q_1 + Q_2}{2}$ $= \frac{8 \times 10^{-6} + 2 \times 10^{-6}}{2} \checkmark$ $= 5 \times 10^{-6} \text{ C}$ $n = \frac{Q}{e} \checkmark$ $n = \frac{5 \times 10^{-6} - 8 \times 10^{-6}}{-1,6 \times 10^{-19}} \checkmark$ $n = 1,875 \times 10^{13} \text{ electrons } \checkmark$	$Q_{\text{new}} = \frac{Q_1 + Q_2}{2}$ $= \frac{8 \times 10^{-6} + 2 \times 10^{-6}}{2} \checkmark$ $= 5 \times 10^{-6} \text{ C}$ $n = \frac{Q}{e} \checkmark$ $n = \frac{5 \times 10^{-6} - 2 \times 10^{-6}}{-1,6 \times 10^{-19}} \checkmark$ $n = 1,875 \times 10^{13} \text{ electrons } \checkmark$

(4)

[19]

QUESTION 8

8.1 Emf✓ (1)

8.2.1

$$V_{\text{lost}} = Ir$$

$$24 - 21,6\checkmark = I(2)$$

$$I = 1,2 \text{ A}$$

$$I_{\text{total}} = 1,2 \text{ A}$$

$$V_{12 \Omega} = IR = (1,2)(12)\checkmark = 14,4 \text{ V}$$

$$V_{10 \Omega} = 21,6 - 14,4 = 7,2 \text{ V}$$

$$I_{10 \Omega} = \frac{V}{R} \checkmark = \frac{7,2}{10} \checkmark = 0,72 \text{ A}\checkmark$$

$$I_A = 0,72 \text{ A}$$

(5)

8.2.2

$$I_X = 1,2\checkmark - 0,72$$

$$= 0,48 \text{ A}$$

$$R_X = \frac{V}{I} \checkmark = \frac{7,2}{0,48} \checkmark$$

$$= 1,50 \Omega\checkmark$$

(4)

8.3

POSITIVE MARKING FROM QUESTION 8.2.1

$$P = I^2 R\checkmark$$

$$= (1,2)^2\checkmark (12)\checkmark$$

$$= 17,28 \text{ W}\checkmark$$

(4)

8.4 Decreases ✓

- Total resistance in the circuit increases. ✓
- Current in the circuit decreases $(I \propto \frac{1}{R})$. ✓
- $P = I^2 R$; when R is constant, P decreases ✓

(4)

[18]

QUESTION 9

9.1.1 From electrical energy to mechanical energy. ✓ (1)

9.1.2 Clockwise. ✓ (2)

9.1.3 (carbon) brush ✓✓ (1)

9.1.4 It reverses the direction of the current in the coil after each half-cycle. ✓ (1)

9.1.5 Increases. ✓
The current increases ✓ (2)

9.2.1 The rms potential difference is the AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference ✓✓

ACCEPT:

The rms voltage is the DC potential difference which dissipates/produces the same amount of energy as the equivalent AC potential difference ✓✓ (2)

9.2.2 $V_{\text{rms}} = \frac{V_{\text{rms}}}{\sqrt{2}}$ ✓
 $200 = \frac{V_{\text{rms}}}{\sqrt{2}}$ ✓
 $V_{\text{rms}} = (200)(\sqrt{2})$
 $V_{\text{rms}} = 282,8427 \text{ V}$ ✓ (3)

[12]

QUESTION 10

10.1.1 The process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface. ✓✓ (2)

10.1.2 The minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓✓ (2)

10.1.3 (a) Frequency (of the incident light). ✓ (1)

(b) Frequency (of the incident light). ✓ (1)

10.1.4

$$E = hf$$

$$E = \frac{hc}{\lambda} \checkmark$$

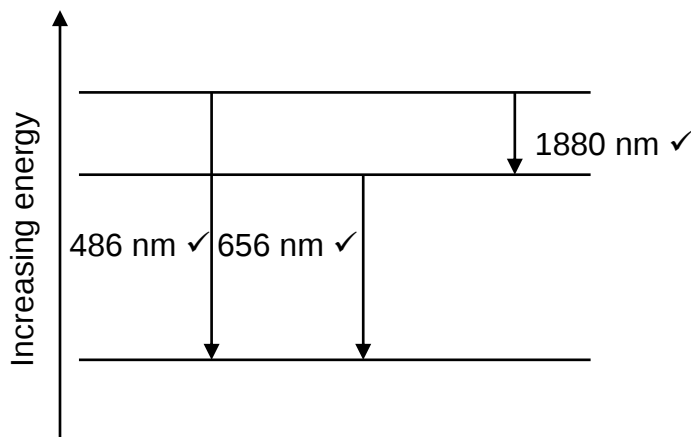
$$\therefore E = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{(450 \times 10^{-9})} \checkmark$$

$$E = 4,42 \times 10^{-19} \text{ J } \checkmark$$

Since photon energy is less than the work function of the metal, so, no emission occurs. ✓

(5)

10.2.



[14]
TOTAL: 150