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

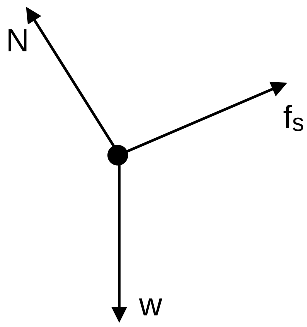
1.1	B ✓✓	(2)
1.2	A ✓✓	(2)
1.3	C ✓✓	(2)
1.4	A ✓✓	(2)
1.5	B ✓✓	(2)
1.6	D ✓✓	(2)
1.7	D ✓✓	(2)
1.8	A ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)

[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/$F_{surface\ on\ crate}$
f_s✓	f/F_f/frictional force/static frictional force
w✓	F_g/mg/weight/gravitational force/$F_{Earth\ on\ crate}$

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

$F_{net} = ma$
$\therefore f_s^{max} + (-mg\sin\theta) = ma^{max}$
$\mu_s F_N - mg\sin\theta = ma^{max}$
$\mu_s\ mg\cos\theta - mg\sin\theta = ma^{max}$
(Any one ✓)

$\therefore f_s^{max} - m(9,8)(\sin 10°) = ma^{max}$ …..①

But $f_s^{max} = \mu_s N$

$\therefore f_s^{max} = \mu_s(mg\cos\theta)$….②

Subst. ② into ① :

$\therefore \mu_s(mg\cos\theta) - m(9,8)(\sin 10°) = m(a^{max})$

$\therefore (0,35)\ m(9,8)(\cos 10°)$✓$- m(9,8)(\sin 10°) = m(a^{max})$

$(\div m)$: $\therefore (0,35)(9,8)(\cos 10°)$ ✓– $(9,8)(\sin 10°)$ ✓$= a^{max}$

$\therefore$the maximum acceleration is 1,676 $m \cdot s^{-2}$ ✓

(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

$g_E = \frac{GM_E}{R_E^2} = 9,8\ m\cdot s^{-2}$

$g_M = \frac{GM_M}{R_M^2}$ ✓

$= \frac{G\left(\frac{M_E}{153}\right)}{\left(\frac{R_E}{5}\right)^2}$ ✓

$= \frac{25}{153}\ \frac{GM_E}{R_E^2}$

$= \frac{25}{153}\ (9,8)$

$= 1,60\ m\cdot s^{-2}$ ✓
(downwards)

(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

<u>OPTION 1:</u>
<u>UPWARDS POSITIVE:</u>

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

(4)

<u>DOWNWARDS POSITIVE:</u>

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

<u>OPTION 2:</u> **<u>UPWARDS POSITIVE:</u>** **For stone X:** Consider upward motion: $v_f = v_i + a\Delta t$✓ <u>$0 = v_i + (-9,8)(5)$</u>✓ $v_i = 49$ m□s^{-1}	**For stone Y:** $v_{B_i} = \frac{49}{3}$ m□s^{-1} or 16.333 m□s^{-1} Consider upward motion: $v_f = v_i + a\Delta t$ <u>$0 = 16,333 + (9,8)\Delta t$</u>✓ Δt = 1,666(1,67 s) Δt(total) = 2 x 1,666 = 3,33 s

DOWNWARDS POSITIVE:

For stone X:	For stone Y:
Consider upward motion: $v_f = v_i + a\Delta t$ ✓ <u>$0 = v_i + (9,8)(5)$</u> ✓ $v_i = -49\ m\square s^{-1}$	$v_{B_i} = -\frac{49}{3}\ m\square s^{-1}$ or $-16.333\ m\square s^{-1}$ Consider upward motion: $v_f = v_i + a\Delta t$ <u>$0 = -16,333 + (9,8)\Delta t$</u> ✓ $\Delta t = 1,666 (1,67\ s)$ $\Delta t(total) = 2 \times 1,666 = 3,33\ s$

3.3 **POSITIVE MARKING FROM QUESTION 3.2:**

OPTION 1:
UPWARDS POSITIVE:

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

DOWNWARDS POSITIVE:

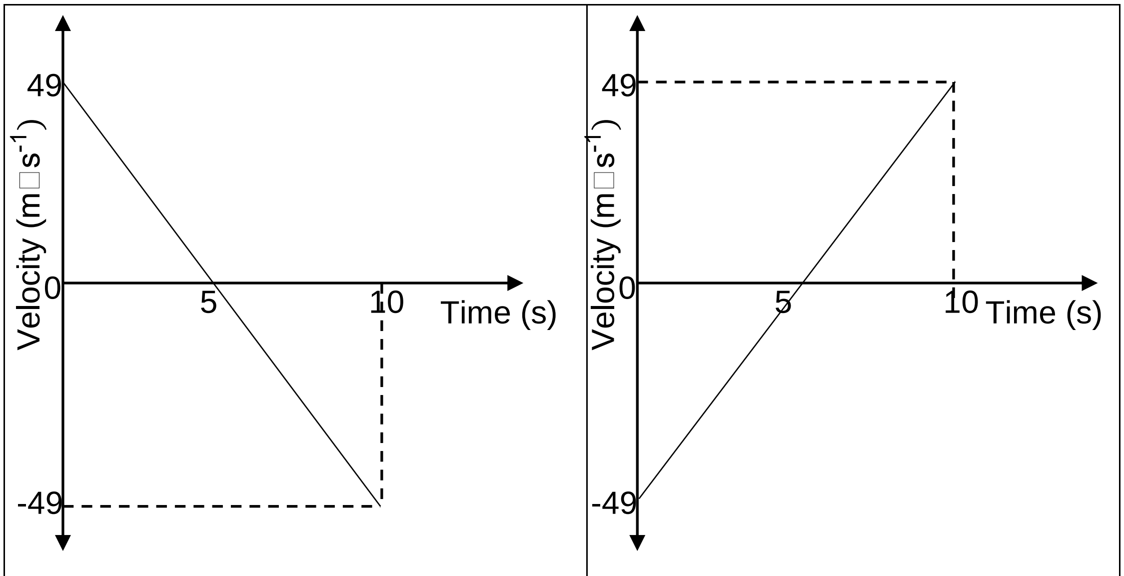
For stone Y	For stone X
$\Delta y = v_i\ \Delta t + \frac{1}{2}a(\Delta t)^2$ ✓ $H = \left(-\frac{49}{3}\right)\left(\frac{5}{3}\right) + \frac{1}{2}(9,8)\left(\frac{5}{3}\right)^2$ ✓ $H = \left(-\frac{245}{18}\right)m$	$\Delta y = v_i\ \Delta t + \frac{1}{2}a(\Delta t)^2$ $= \underline{(-49)(5)}$ ✓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

OPTION 2: **UPWARDS POSITIVE:**	**For stone X**
For stone Y $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (49)(5)$ ✓ $+ \frac{1}{2}(-9,8)(5)^2$ ✓ $= 122,5\ m$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= (16.333)(1,666) + \frac{1}{2}(9,8)(1,666)^2$ ✓ $= 13,61\ m = H$ $13,61 \times 9 = 122,49\ m = 9H (122,5\ m)$ ✓

DOWNWARDS POSITIVE:	**For stone X**
For stone Y $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (-49)(5)$ ✓ $+ \frac{1}{2}(9,8)(5)^2$ ✓ $= -122,5$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= (-16.333)(1,666) + \frac{1}{2}(9,8)(1,666)^2$ ✓ $= -13,61$ m = H -13,61 X 9 = -122,49 m = 9H(122,5 m) ✓

(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 <u>The total (linear) momentum of an isolated system remains constant</u> (is conserved). ✓✓ (2)

4.3

<table>
<tr>
<td><u>OPTION 1</u>

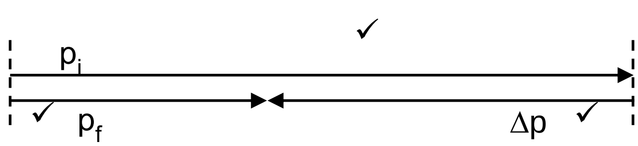
$\sum p_i = \sum p_f$ } Any one✓
$m_A v_{A_i} + m_B v_{B_i} = m_A v_{A_f} + m_B v_{B_f}$
$\underline{m_A(4) + m_B(-1)}$ ✓ = $\underline{m_A(1) + m_B(3)}$ ✓
$4m_A - m_A = 3m_B + m_B$
$\underline{3m_A = 4m_B}$ ✓
$\frac{m_A}{m_B} = \frac{4}{3}$
$m_A : m_B = 4:3$</td>
<td><u>OPTION 2</u>

$\Delta p_A = -\Delta p_B$ } Any one✓
$m_A(v_{A_f} - v_{A_i}) = m_B(v_{B_f} - v_{B_i})$
$\underline{m_A(1-4)}$ ✓ = $\underline{-m_A(3-(-1))}$ ✓
$m_A(-3) = -m_B(4)$
$\underline{m_A(-3) = m_B(4)}$ ✓
$\frac{m_A}{m_B} = \frac{-4}{-3} = \frac{4}{3}$
$m_A : m_B = 4:3$</td>
</tr>
<tr>
<td colspan="2"><u>Marking criteria:</u>

• Formula
• Right hand substitution into formula
• Left hand substitution into formula
• This step: $m_A(-3) = m_B(4)$</td>
</tr>
</table>

(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)

<u>**OPTION 1:**</u>

5.2

$W_{net} = \Delta E_K$ OR $W_f + W_w + W_N = \Delta E_K$
$f\Delta x\square\cos\theta + mg\Delta x(\cos\theta) + 0 = \frac{1}{2}m(v_f^2 - v_i^2)$ } Any one✓

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

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

$\Delta x = 3,86$ m

x = 3,86 m✓ (4)

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

$W_w = mg\sin\theta\Delta x\cos\square$
$= (10)(9,8)(\sin 35°)x\cos 180°$
$= (-56,2105x)$J

OR: $W_w = -\Delta E_p$
$= mg(h_i - h_f)$
$= (10)(9,8)(0 - x\sin 35°)$
$= (-56,2105x)$J

<u>**OPTION 2**</u>:

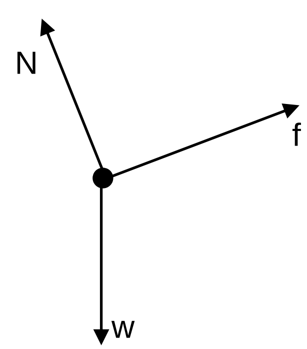
$W_{nc} = \Delta E_p + \Delta E_k$
$= mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$W_f = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$f\underline{\Delta x}\cos\theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } Any one✓

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

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

x = 3,86 m✓

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:	**OPTION 2:**
$f_s = w_{\|\|} = mg\sin\theta$ ✓ $=(10)(9,8)(\sin 35°)$ ✓ $f_s = 56,21$ N ✓	$\mu_s = \tan\theta = \tan 35° = 0,7002$ $f_s = \mu_s N = \mu_s mg\cos\theta$ (ANY ONE) ✓ $=(0,7002)(10)(9.8)(\cos 35°)$ ✓ $=56,21$ N ✓

(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. ✓✓ (2)

6.2

$v = f_s\lambda$ ✓ $340 = (300)\lambda$ ✓ $\lambda = 1,13$ m ✓

(3)

6.3 **ANY ONE:**
- To monitor the heartbeat of a foetus (unborn baby). ✓
- To measure the rate of blood flow. ✓

(1)

6.4.1

OPTION 1:	**OPTION 2:**
$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$ ✓ $= \left(\frac{340}{340-30}\right)(300)$ ✓ $= 329,032$ Hz $v = f_L\lambda$ $340 = (329,032)\lambda$ ✓ $\lambda = 1,033$ m ✓	$\lambda_B = \frac{v - v_S}{f_s}$ ✓ $= \frac{340-30\ ✓}{300\ ✓}$ $= 1,03$ m ✓

(4)

6.4.2

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

(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

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

(3)

7.1.4

$F = \frac{KQ_1Q_2}{r^2}$ ✓ $\frac{F}{Q^2} = \frac{k}{r^2}$ 1×10^{12} ✓ $= \frac{9 \times 10^9}{r^2}$ ✓ $r^2 = 9 \times 10^{-3}$ $r = 0{,}09487$ m (0,095 m)✓ NOTE: If $F = \frac{KQ^2}{r^2}$ 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

$E = \frac{kQ}{r^2}$ ✓

$E_{net,p} = 0$

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

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

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

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

$= 0,25$

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

$d = 0,1333$ m

∴The distance is 0,1333 m ✓ (4)

7.2.3

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

(4)

[19]

QUESTION 8

8.1 Emf✓ (1)

8.2.1

$V_{lost} = Ir$
$24 - 21,6$✓ $= I(2)$
$I = 1,2$ A

$I_{total} = 1,2$ A
$V_{12\,\Omega} = IR = (1,2)(12)$✓ $= 14,4$ V
$V_{10\,\Omega} = 21,6 - 14,4 = 7,2$ V
$I_{10\,\Omega} = \frac{V}{R}$ ✓$= \frac{7,2}{10}$ ✓$= 0,72$ A✓
$I_A = 0,72$ A

(5)

8.2.2

$I_X = 1,2$✓ $- 0,72$
$= 0,48$ A
$R_X = \frac{V}{I}$ ✓$= \frac{7,2}{0,48}$ ✓
$= 1,50\ \Omega$✓

(4)

8.3

POSITIVE MARKING FROM QUESTION 8.2.1

$P = I^2R$✓
$= (1,2)^2$✓ (12)✓
$= 17,28$ W✓

(4)

8.4 Decreases ✓

- Total resistance in the circuit increases. ✓
- Current in the circuit decreases $\left(I \propto \frac{I}{R}\right)$. ✓
- $P = I^2R$; 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 $V_{rms} = \frac{V_{rms}}{\sqrt{2}}$✓
$200 = \frac{V_{rms}}{\sqrt{2}}$✓
$V_{rms} = (200)(\sqrt{2})$
$V_{rms} = 282,8427$ V✓ (3)

[12]

QUESTION 10

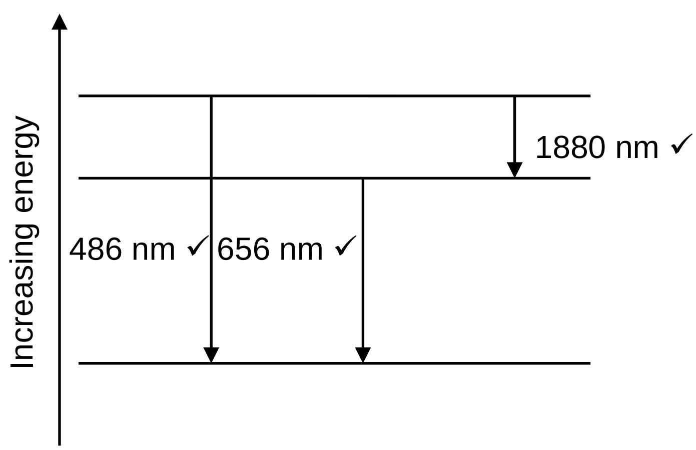
10.1.1 The process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface. ✓✓ (2)

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
$E = hf$
$E = \frac{hc}{\lambda}$ ✓
$\therefore E = \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{(450 \times 10^{-9})}$ ✓ ✓
$E = 4,42 \times 10^{-19}$ J ✓
Since photon energy is less than the work function of the metal, so, no emission occurs. ✓ (5)

10.2.



[14]
TOTAL: 150