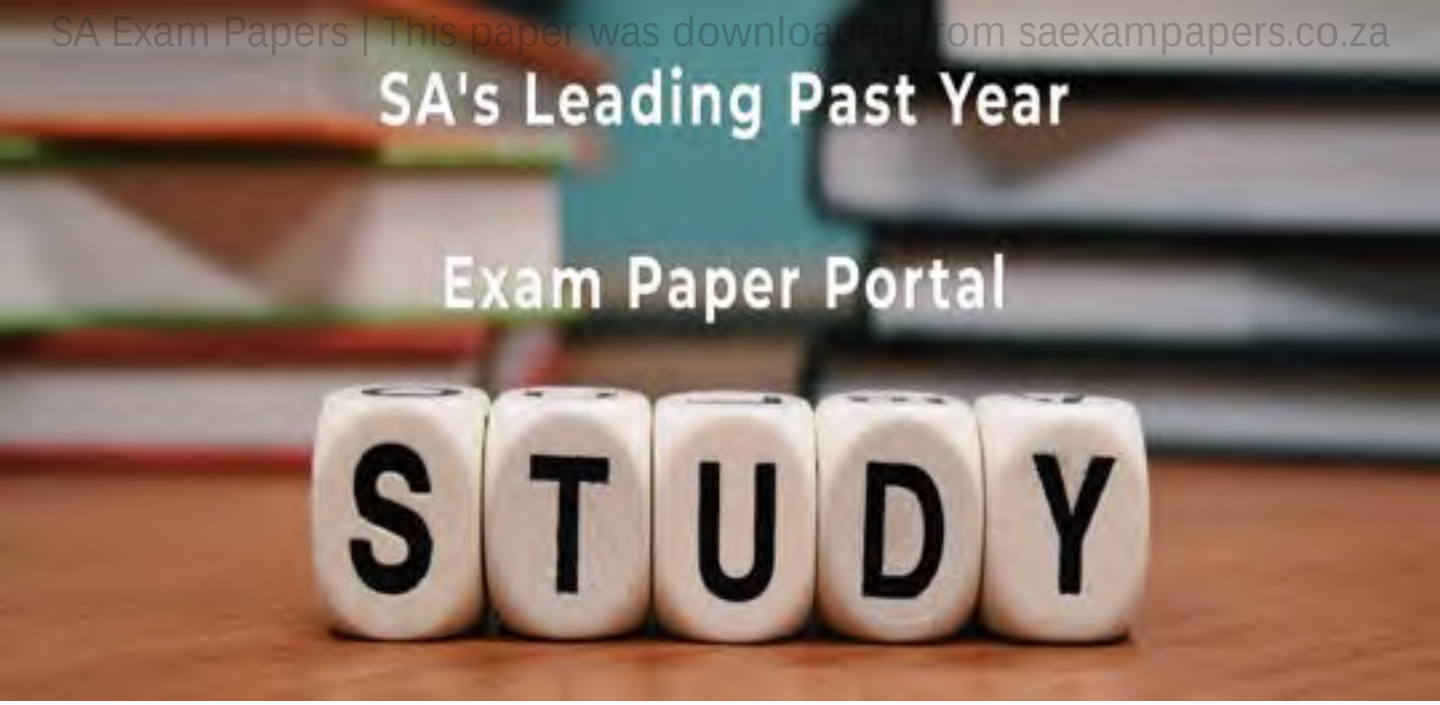


LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2023

MARKING GUIDLINES

MARKS: 150

These marking guidelines consist of 16 pages.

QUESTION 1

1.1 A ✓✓ (2)

1.2 C ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 B ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

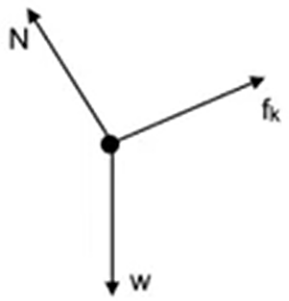
1.9 C ✓✓ (2)

1.10 D ✓✓ (2)
[20]

QUESTION 2

2.1.1 The force that opposes the motion of a moving object relative to a surface.✓✓ (2 or 0)

2.1.2



Accept the following symbols:	
N✓	F_N/Normal force
f_k✓	f/F_f/ (kinetic) friction/frictional force
w✓	F_g/mg/weight/gravitational force

Notes:
- Mark is awarded for label and arrow, but penalize only once if arrows are omitted.
- Do not penalize for length of arrows, drawing is not to scale.
- Any other additional force(s) deduct 1 mark.
- If force(s) do not make contact with the dot, deduct 1 mark
- If arrows missing: 2/3

(3)

2.1.3 **DOWNHILL AS POSITIVE:**

$F_{net} = ma$
$w_{//} + (-f_k) = ma$
$mg\sin\theta - \mu_k N = ma$
$mg\sin\theta - \mu_k mg\cos\theta = ma$ } Any one✓

$(2)(9,8)(\sin 30°)$✓ $- (0,20)(2)(9,8)(\cos 30°)$ ✓$= (2)a$
$(2)(4,9) - (2)(1,69741) = (2)\,a$
$\therefore a = 3,20259\ m\,s^{-2}$ ✓downhill✓

UPHILL AS POSITIVE:

$F_{net} = ma$
$f_k + (-w_{//}) = ma$
$\mu_k N - mg\sin\theta = ma$
$\mu_k\, mg\cos\theta - mg\sin\theta = ma$ } Any one✓

$(0,20)(2)(9,8)(\cos 30°)$✓ $- (2)(9,8)(\sin 30°)$ ✓$= 2a$
$(2)(1,69741) - (2)(4,9) = 2a$
$\therefore a = -3,20259\ m\,s^{-2}$
$\therefore a = 3,20259\ m\,s^{-2}$ ✓$(3,20\ m\,s^{-2})$downhill✓

(5)

2.2

$F = \frac{Gm_1m_2}{r^2}$ or $F = \frac{Gm_1m_2}{d^2}$ ✓

$F_{(inner\ walls)} = \frac{Gm_1m_2}{(r)^2}$ ✓

$F_{(outer\ walls)} = \frac{Gm_1m_2}{(35)^2}$ ✓

$\therefore \frac{F_{(inner\ walls)}}{F_{(outer\ walls)}} = \frac{Gm_1m_2}{49} \div \frac{Gm_1m_2}{1225}$ ✓

$= \frac{1225}{49}$

$= 25$

$\therefore F_{(inner\ walls)} = 25 \times F_{(outer\ walls)}$

(4)

[14]

QUESTION 3

3.1 An object which has been given an initial velocity and then it moves under the influence of the gravitational force only.✓✓ (2)

3.2.1

OPTION 1:

UPWARDS AS POSITIVE	DOWNWARDS AS POSITIVE
$v_f^2 = v_i^2 + 2a\Delta y$ $= (-2)^2 + 2(-9,8)(-50)$✓ $\therefore v_f = -31,36877\ m\cdot s^{-1}$ $v_f = v_i + a\Delta t$✓ $-31,36877 = -2 + (9,8)\Delta t$✓ $\therefore \Delta t = 2,997\ s$✓(3,00 s)	$v_f^2 = v_i^2 + 2a\Delta y$ $= (2)^2 + 2(9,8)(50)$✓ $\therefore v_f = 31,36877\ m\cdot s^{-1}$ $v_f = v_i + a\Delta t$✓ $31,36877 = 2 + (9,8)\Delta t$✓ $\therefore \Delta t = 2,997\ s$✓(3,00 s)

OPTION 2:

UPWARDS AS POSITIVE	DOWNWARDS AS POSITIVE
$v_f^2 = v_i^2 + 2a\Delta y$ $= (-2)^2 + 2(-9,8)(-50)$✓ $\therefore v_f = -31,36877\ m\cdot s^{-1}$ $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$✓ $-50 = \left(\frac{-31,36877 + (-2)}{2}\right)\Delta t$✓ $\therefore \Delta t = 2,997\ s$✓(3,00 s)	$v_f^2 = v_i^2 + 2a\Delta y$ $= (2)^2 + 2(9,8)(50)$✓ $\therefore v_f = 31,36877\ m\cdot s^{-1}$ $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$✓ $(50) = \left(\frac{31,36877 + (-2)}{2}\right)\Delta t$✓ $\therefore \Delta t = 2,997\ s$✓(3,00 s)

OPTION 3:

UPWARDS AS POSITIVE	DOWNWARDS AS POSITIVE
$\Delta y = v_i\,\Delta t + \frac{1}{2}a(\Delta t)^2$✓ $-50,0 = (-2)t + \frac{1}{2}(9,8)t^2$✓ $0 = (4,9)t^2 + (2)t - 50$✓ $t = \frac{(-2) \pm \sqrt{(2)^2 - 4(4,9)(-50)}}{2(4,9)}$ $\therefore t = 2,997\ s$✓(3,00 s)	$\Delta y = v_i\,\Delta t + \frac{1}{2}a(\Delta t)^2$ ✓ $50 = (2)t + \frac{1}{2}(9,8)t^2$✓ $0 = (4,9)t^2 + (2)t - 50$✓ $t = \frac{(-2) \pm \sqrt{(2)^2 - 4(4,9)(-50)}}{2(4,9)}$ $\therefore t = 2,997\ s$✓(3,00 s)

(4)

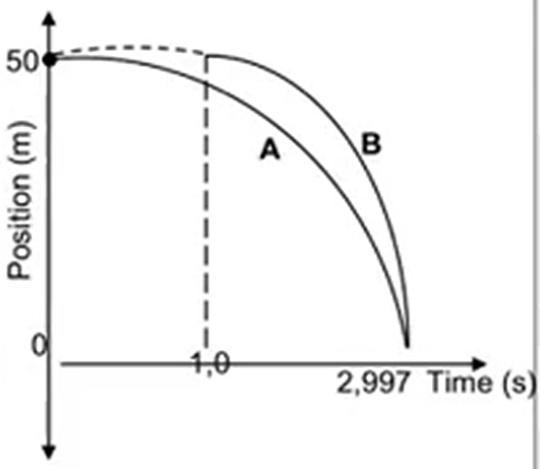
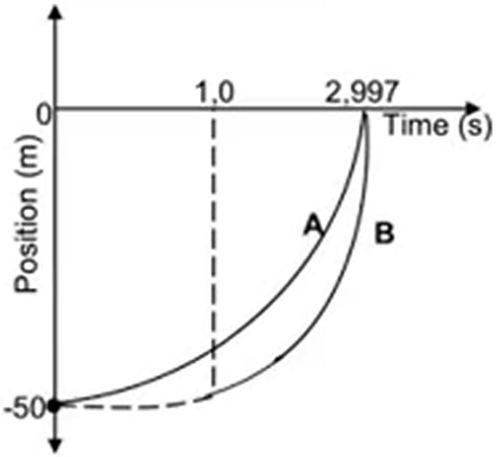
3.2.2 $t_2 = 2,997 - 1,997s$
$= 1,997\ s\checkmark(2,00\ s)$ (1)

3.2.3

UPWARDS AS POSITIVE	DOWNWARDS AS POSITIVE
$\Delta y = v_i\Delta t + \frac{1}{2}a\,(\Delta t)^2\checkmark$	$\Delta y = v_i\Delta t + \frac{1}{2}a\,(\Delta t)^2\checkmark$
$-50,0 = v_i(1,997) + \frac{1}{2}(-9,8)(1,997)^2\checkmark$	$50,0 = v_i(1,997) + \frac{1}{2}(9,8)(1,997)^2\checkmark$
$\therefore v_i = -15,2523\ m\,s^{-1}$	$\therefore v_i = 15,2523\ m\,s^{-1}\checkmark(15,25\ m\,s^{-1})$
$\therefore v_i = 15,2523\ m\,s^{-1}\checkmark(15,25\ m\,s^{-1})$	

(3)

3.3

UPWARDS AS POSITIVE	DOWNWARDS AS POSITIVE
	

Marking Criteria	Marks
Correct shape for stone **A** and stone **B** ending on time-axis and at the same time.	✓
Gradient for stone **B** higher than that of stone **A**	✓
Graph for stone **B** starting at t = 1,0 s	✓
Maximum height correctly indicated (50 or -50)	✓

(4)
[14]

QUESTION 4

4.1 External force✓ (1)

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

4.3.1

TO THE RIGHT AS POSITIVE: (ALSO CONSIDER TO THE LEFT AS POSITIVE)	
Option 1:	**Option 2:**
$F_{net} = ma$ $-f_k = ma$ $-\mu_K N = ma$ Any one✓ $-(0,20)$ ✓$(0,005 + 3)(9,8) = (0,005+3)a$✓ $\therefore a = -1,96\ m\,s^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$✓ $(0)^2 = v_i^2 + 2(-1,96)(0,25)$ ✓ $V_i = 0,98995\ m\,s^{-1}$✓$(0,99\ m\,s^{-1})$	$F_{net} = ma$ $f_k = ma$ $\mu KN = ma$ Any one✓ $(0,20)$ ✓$(0,005 + 3)(9,8) = (0,005 +3)a$✓ $\therefore a = -1,96\ m\,s^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$✓ $(0)^2 = v_i^2 + 2(-1,96)(0,25)$ ✓ $v_i = 0,98995\ m\,s^{-1}$✓$(0,99\ m\,s^{-1})$

(6)

4.3.2

Option 1:	**Option 2:**
$\sum p_i = \sum p_f$ $m_b v_{b_i} + m_B v_{B_i} = (v_b - v_B)v_f$ Any one✓ $(0,005)v+(3)(0)=(0,005+3)(0,98995)$✓ $(0,005)v = 2,97479975$ $v = 594,95995\ m\,s^{-1}$✓$(594,96\ m\,s^{-1})$ due East. ✓	$\Delta p_b = -\Delta p_B$ $m_b(v_{b_f} - v_{b_i}) = -m_B(v_{B_f} - v_{B_i})$ Any one✓ $(0,005)(0,98995-v)=-(3)(0,98995-0)$✓ $0,98995 - v = -593,97$ $v = 594,95995\ m\,s^{-1}$✓$(594,96\ m\,s^{-1})$ due East. ✓

(4)
[13]

QUESTION 5

5.1 The rate at which work is done✓✓

OR: The rate at which energy is expended. ✓✓ (2)

5.2

OPTION 1:	**OPTION 2:**
$W = F\Delta y\cos\theta$ / $Ww = mg\Delta y\cos\theta$ Any one✓ $Ww = (125)(9,8)(6,8)(\cos180°)$✓ $= -8330$ J✓	$Ww = -\Delta E_P$ / $Ww = -mg(h_f - h_i)$ Any one✓ $Ww = -(125)(9,8)(6,8 - 0)$ ✓ $= -8330$ J✓

(3)

5.3

$W = F\Delta y\cos\theta$
$W_{mp} = mg\Delta y\cos\theta$
$W_{mp} = (100)(9,8)(6,8)(\cos0°)$✓
$= 6664$ J

$W_{net} = \Delta E_k$
$W_{motor} + W_{mp} + Ww = \Delta E_k$
$W_{motor} + 6664$✓ $+ (-8330)$ ✓ $= 0$✓
$W_{motor} = 1666$ J
$P = \frac{W}{\Delta t}$✓
$P = \frac{1,666}{0,01}$✓
$= 166,6$ W✓

(7)

[12]

QUESTION 6

6.1.1 **Marking criteria:**
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark.

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. ✓✓

OR: An apparent change in observed/detected frequency/pitch/wavelength, as a result of the relative motion between a source and an observer (listener). ✓✓ (2)

6.1.2 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$15,0 = (0)t + \frac{1}{2}(9,8)t^2$✓

$15,0 = (4,9)t^2$

$t = 1,749635531$ s

$v_f = v_i + a\,\Delta t$

$V_s = 0 + (9,8)(1,749635531)$✓

$= 17,15$ m□s^{-1}

∴speed = 17,15 m□s^{-1}

$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right)f_s$✓

$= \left(\frac{343 - 0}{343 + 17,15}\right)$✓(600)✓

= 571,4286 Hz✓(571,43 Hz) (6)

6.1.3 The clock radio undergoes a constant gravitational acceleration and, as a result, its speed (v_s) increases✓ as it falls.

From $f_L = \left(\frac{v}{v + v_s}\right)$, for a constant speed of sound (v), ✓ the denominator (v + vs) increases. So, $f_L < 600$ Hz✓ (3)

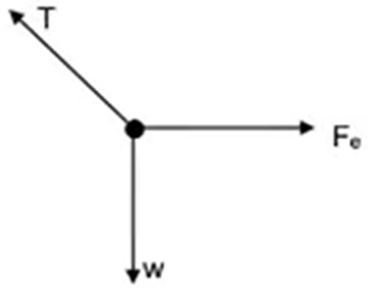
6.2.1 Y✓ (1)

6.2.2 Towards the earth✓ (1)
[13]

QUESTION 7

7.1.1 The magnitude of the electrostatic force exerted by point charge (at rest) on another (stationary) point charge is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓ (2)

7.1.2



Accepted labels	
T✓	Tension/F_T/$F_{wire\ on\ insulator}$
F_e✓	Electrostatic force / coulomb's force
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)

7.1.3

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(6 \times 10^9)(6 \times 10^{-7})(9 \times 10^{-7})}{(0,15)^2}$ ✓

=0,216 N✓(0,22 N)

(3)

7.1.4

POSITIVE MARKING FROM QUESTION 7.1.3

Marking criteria.

- T_x = 0,216 N or 0,216 – T_x = 0✓
- Substitution in w = mg✓
- Substitution in $\frac{T_x}{T_Y}$ ✓
- Final answer✓

OPTION 1:	OPTION 2:
0,216 – Tsinθ = 0 Tsinθ = 0,216 …①✓ $F_{net, y}$ = 0 Tcosθ + (-w) = 0 Tcosθ – mg = 0 Tcosθ – (8 x 10^{-2})(9,8) ✓ = 0 Tcosθ – 0,784 = 0 Tcosθ = 0,784 …② ① ÷ ② : $\frac{T\sin\theta}{T\cos\theta} = \frac{0,216}{0,784}$ ✓ tanθ = 0,27551 θ=15,40°✓	T_x = Fe = 0,216 N✓ w = mg = (8 x 10-2)(9,8) ✓ = 0,784 N T_y = w = 0,784 N tanθ = $\frac{T_x}{T_Y}$ = $\frac{0,216}{0,784}$ ✓ θ=15,40°✓

(4)

7.1.5

POSITIVE MARKING FROM QUESTION 7.1.3

OPTION 1:	OPTION 2:	OPTION 3:
$T = \sqrt{T_X^2 + T_Y^2}$ = $\sqrt{(0,216)^2 + (0,784)^2}$ ✓ = 0,813 N✓(0,81 N)	From ① in 7.1.3 Tsin(15,40°) = 0,216✓ T = 0,813 N✓(0,81 N)	From ② in 7.1.3 Tcos(15,40°) = 0,784✓ T = 0,813 N✓(0,81 N)

(2)

7.2

$E = \frac{KQ}{r^2}$ ✓
✓
E_{Q_1} at p = E_{Q_1} at p
$\frac{(9 \times 10^9)(16 \times 10^{-6})}{(3,0 + x)^2}$ ✓ = $\frac{(9 \times 10^9)(16 \times 10^{-6})}{x^2}$ ✓
$\frac{x^2}{(3,0 + x)^2} = \frac{1}{4}$
$\frac{x}{3,0 + x} = \frac{1}{2}$
x = 3,0 m✓

(5)
[19]

QUESTION 8

8.1 The maximum energy provided by a battery per unit charge passing through it.✓✓

OR: The total electrical energy supplied per unit charge by the battery. ✓✓ (2)

8.2 To control the current in the circuit by changing the resistance. ✓✓ (2)

8.3.1

Marking criteria.
- Formula ε = I(R + r) for switch open or closed.✓
- Substitution for switch open.✓
- Substitution for switch closed.✓
- Equating ① and ②✓
- Final answer. ✓

SWITCH OPEN:	**SWITCH CLOSED:**
ε = I(R + r) ✓ = 4(8,4 + r)✓ = 33,6 + 4r …①	ε = I(R + r) = 6(4,4 + r) ✓ = 26,4 + 6r …②
EQUATE ① and ②:	
33,6 + 4r = 26,4 + 6r ✓ 7,2 = 2r r = 3,60 Ω✓	

(5)

8.3.2 From ① : ε = 33,6 + 4(3,60) ✓
= 48 V✓

OR: From ② : ε = 26,4 + 6(3,60) ✓
= 48 V✓ (2)

8.4.1

OPTION 1:	OPTION 2:	OPTION 3:
$P = I^2R$ $= (6)^2(3,6)$ ✓ $= 129,60$ W✓	$V_{internal} = IR$ $= (6)(3,6)$ $= 21,6$ V $P = VI$ $= (21,6)(6)$✓ $= 129,60$ W✓	$V_{internal} = IR$ $= (6)(3,6)$ $= 21,6$ V $P = \frac{V^2}{R}$ $= \frac{(21,6)^2}{(3,6)}$✓ $= 129,60$ W✓

(2)

8.4.2

OPTION 1:	OPTION 2:	OPTION 3:
$W = I^2R\Delta t$✓ $= (4)^2(0,4)(360)$ ✓ $= 2\,304$ J✓	$V_{bulb} = IR$ $= (4)(0,4)$ $= 1,6$ V $W = V\,I\Delta t$✓ $= (1,6)(4)(360)$ ✓ $= 2\,304$ J✓	$V_{bulb} = IR$ $= (4)(0,4)$ $= 1,6$ V $W = \frac{V^2\,\Delta t}{R}$✓ $= \frac{(1,6)^2\,(160)}{(0,4)}$✓ $= 2\,304$ J✓

(3)

8.5 Dimmer. ✓

- Total resistance in the circuit increases✓
- Current in the circuit decreases $\left(I \propto \frac{1}{R}\right)$. ✓
- Power dissipated by the bulb decreases $(P \propto I^2)$.

(3)
[19]

QUESTION 9

9.1 From mechanical (kinetic) energy to electrical energy. ✓ (1)

9.2.1 Direct current (DC) generator✓ (1)

9.2.2 Alternating current (AC) generator✓ (1)

9.3 DC generator - has a split ring commutator. ✓
AC generator – has slip rings✓ (2)

9.4.1 The AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference. ✓✓ (2)

9.4.2

$$V_{rms} = \frac{V_{max}}{\sqrt{2}} \checkmark$$

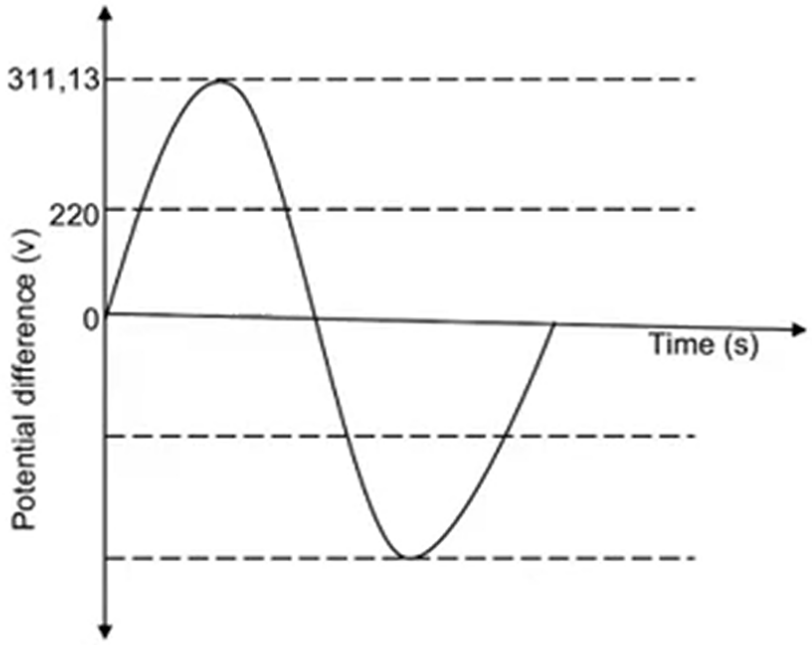
$$220 = \frac{V_{max}}{\sqrt{2}} \checkmark$$

$$V_{max} = (220)(\sqrt{2})$$

$$= 311{,}13\ V \checkmark$$

(3)

9.4.3



Marking criteria:	
• Both peak and rms values shown	✓
• Correcto shape	✓
• Only one cycle drawn	✓

(3)

[13]

QUESTION 10

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

10.2

Marking criteria.
- Formula✓
- Substitution in the formula h ana c✓
- Substitution in the formula for $E_{k(max)} = 4,48 \times 10^{-19}$✓
- Substitution for 1,5λ✓
- Substitution for $E_{k(max)} = 1,76 \times 10^{-19}$✓
- $1,5W_o + 2,64 \times 10^{-19}$

$E = W_o + E_{k(max)}$
$hf = W_o + E_{k(max)}$ Any one✓
$\frac{hc}{\lambda} = W_o + E_{k(max)}$

$\frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{\lambda}$✓ $= W_o + 4,48 \times 10^{-19}$✓

$\frac{1,989 \times 10^{-25}}{\lambda} = W_o + 4,48 \times 10^{-19}$ …①

$\frac{1,989 \times 10^{-25}}{1,5\,\lambda}$✓ $= W_o + 1,76 \times 10^{-19}$✓

$\frac{1,989 \times 10^{-25}}{\lambda} = (1,5)W_o + 2,64 \times 10^{-19}$ …②

Equate ② and ① :

$(1,5)W_o + 2,64 \times 10^{-19}$✓ $= W_o + 4,48 \times 10^{-19}$

$(0,5)\ W_o = 4,48 \times 10^{-19}$

$W_o = 3,68 \times 10^{-19}$ J (6)

10.3 From ① : $\frac{1,989 \times 10^{-25}}{\lambda} = 3,68 \times 10^{-19}$✓ $+ 4,48 \times 10^{-19}$

$\frac{1,989 \times 10^{-25}}{\lambda} = 8,16 \times 10^{-19}$

$\lambda = \frac{1,989 \times 10^{-25}}{8,16 \times 10^{-19}}$

$= 0,00000024375$ m✓

$= 2,4375 \times 10^{-7}$ m $\therefore = 244$ nm (2)

10.4.1 Increases✓ (1)

10.4.2 Decreases✓ (1)

10.4.3 Remains the same✓ (1)

[13]

TOTAL: [150]