HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 1- Physics memo

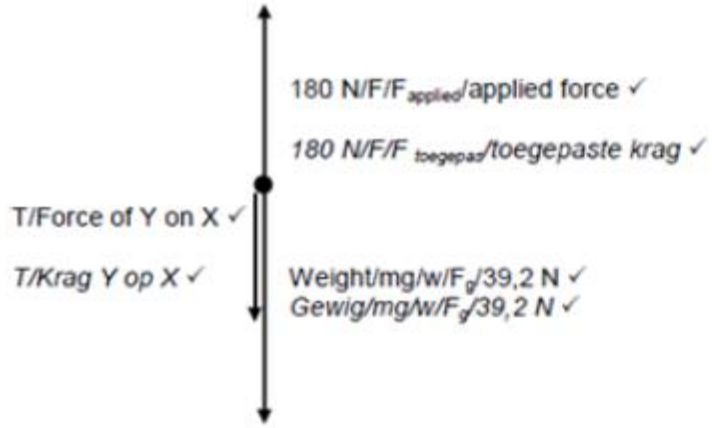
TRIALS 2022 **Total 150**

Question 1

1.1 D
1.2 C
1.3 C
1.4 C
1.5 A
1.6 B
1.7 C
1.8 A
1.9 C
1.10 B

Question 2

2.1



Notes/*Aantekeninge:*

- Correct arrow and label for each force for one mark. / *Korrekte pyle en benoeming vir elke krag vir een punt.*
- Comparative lengths of arrows are not required. / *Vergelykende lengte van pyle nie vereiste nie.*

2.2

For block **X** / *Vir blok* ***X***:
F_{net} = ma ✓
180 - w – T = ma
180 - (4)(9,8) – T = 4a ✓
140,8 – T = 4a .....(i)

For block **Y**/ *Vir blok* ***Y***:
F_{net} = ma
T - w = ma
T - (8)(9,8) = 8a ✓
-78,4 +T = 8a.....(ii)

281,6 – 2T = 8a
-78,4 + T = 8a ✓
360 – 3T = 0
T = 120 N
T = 120 N upwards / *opwaarts* ✓

Note/*Aantekeninge:*

- If the system approach is used to first calculate acceleration and then acceleration is substituted to obtain T:

Max. **3/5**

- *Indien die stelsel benader word om eerstens versnelling te bereken en dan die versnelling gebruik om T te bereken:*

Maks **3/5**

Option 2 for resolving two equations:
140,8 - T = 4a.....(i)
-78,4 + T = 8a .....(ii)
62,4 = 12 a
a = 5,1333 ms^{-2}
T = 8 a + 78,4
= 119,47 N

Question 3 – vertical projectile

3.1 A moving object upon which the only force acting is the force of gravity. ✓✓

'n Bewegende voorwerp waarop slegs gravitasiekrag inwerk. (2)

3.2.1 A ✓ (1)

3.2.2 The initial velocity is not zero. ✓

Die beginsnelheid (aanvanklike snelheid) is nie nul nie. (1)

3.3.1 **OPTION 1 / *OPSIE 1***

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

8 ✓ $= 0 + \frac{1}{2}(9,8)(\Delta t^2)$ ✓

$\Delta t = 1,28$ s ✓

Because the graph is given the learners should take down as positive only. The graph determines the direction of the ball and down is positive in the graph.

OPTION 2 / *OPSIE 2*

$v_f^2 = v_i^2 + 2a\Delta y$

$= 0 + 2(9,8)(8)$ ✓

$v_f = 12,52 \text{ m·s}^{-1}$

$v_f = v_i + a\Delta t$ ✓

$12,52 = 0 + 9,8\Delta t$ ✓

$t = 1,278$ s ✓

Omdat die grafiek gegee is behoort die leerders slegs afwaarts as positief te neem. Die grafiek bepaal die rigting van die bal en afwaarts is dan positief in die grafiek.

(4)

3.3.2 Positive marking from 3.3.1 / *Positiewe nasien vanaf 3.3.1:*

OPTION 1 / *OPSIE 1* (Downwards as positive) / *Afwaarts as positief*

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

8 ✓ $= v_i(1,28-0,6) + \frac{1}{2}(9,8)(1,28-0,6)^2$ ✓

$v_i = 8,43 \text{ m·s}^{-1}$ downwards / *afwaarts* ✓

3.3.2 removed – mistake in the question.

OPTION 2 / *OPSIE 2* (Downwards as positive) / *Afwaarts as positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (0)^2 + 2(9,8)(8)$ ✓

$v_f = 12,52 \text{ m·s}^{-1}$

$v_f = v_i + a\Delta t$ ✓

$12,52 = v_i + (9,8)(1,28 - 0,6)$ ✓

$v_i = 8,34 \text{ m·s}^{-1}$ downwards / *afwaarts* ✓ (4)

3.4 Same as ✓. They fall from the same height / change in position is the same for A and B. ✓

Dieselfde as. ✓ *Beide balle val van dieselfde hoogte / verandering in posisie is dieselfde vir beide A en B.* ✓

OR / *OF* (2)

Area under the graph indicates the total displacement. It was the same height for both the objects.

Die oppervlakte onder die grafiek dui die totale verplasing aan. Dit was dieselfde hoogte vir beide die voorwerpe.

3.5 $9{,}8\ m{\cdot}s^{-2}$ ✓ downwards / *afwaarts* ✓ (2)

[16]

Question 4 – momentum

4.1

NOTE: -1 Mark for each key word /phrase omitted in the correct context.
LET WEL: - 1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.

(2)

The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant.✓✓
Die totale meganiese energie (som van gravitasie- potensiële energie en kinetiese energie) in 'n geslote sisteem bly konstant.

4.2 **OPTION 1/*OPSIE 1***

$\Delta E_M = 0$
$E_{Mf} - E_{Mi} = 0$
$E_{Mi} = E_{Mf}$
$E_{Ki} + E_{Pi} = E_{Kf} + E_{Pf}$
$\frac{1}{2}(m_P+m_Q)v_i^2+(m_P+m_Q)gh_i=\frac{1}{2}(m_P+m_Q)v_f^2+(m_P+m_Q)gh_f$

✓Any One/Enige een

$\left[\frac{1}{2}(4+6)(4{,}5)^2+(4+6)(9{,}8)(6)\right]$ ✓ $=\left[\frac{1}{2}(4+6)v_f^2+(4+6)(9{,}8)(0)\right]$ ✓

OR/*OF*

$\left[\frac{1}{2}(10)(4{,}5)^2+(10)(9{,}8)(6)\right]$ ✓ $=\left[\frac{1}{2}(10)v_f^2+(10)(9{,}8)(0)\right]$ ✓

$v = 11{,}74\ m{\cdot}s^{-1}$ ✓

4.3 **OPTION 1/*OPSIE 1*** (1)

$\sum \vec{p}_{after/na} - \sum \vec{p}_{(before/voor)} = 0$

$\sum \vec{p}_{(before/voor)} = \sum \vec{p}_{(after/na)}$

$m_P\vec{v}_{P(bef/voor)} + m_Q\vec{v}_{Q(bef/voor)} = (m_P)\vec{v}_{P(after/na)} + m_Q\vec{v}_{Q(aft/na)}$

✓Any one / *Enige een*

positive to the right/*na regs is positief*:

$(4)(+11,74)+(6)(+11,74)$ ✓ $= (4)\vec{v}_{P(after/na)}+(6)(+12,914)$ ✓

$\vec{v}_{P(after/na)} = +9,979\ m\cdot s^{-1}$ ✓ **OR/*OF*** $\vec{v}_{P(after/na)} = +9,98\ m\cdot s^{-1}$

OR/*OF*

$\vec{v}_{P(after/na)} = 9,98\ m\cdot s^{-1}$ to the right/*na regs* ✓

NOTE/*LET WEL:*

11,74 - 100%

X - 10 %

$X = \frac{11,74 \times 10}{100} = 1,174$

$v_Q = 11,74 + 1,174$

$v_Q = 12,914\ m\cdot s^{-1}$

OPTION 2/*OPSIE 2*

$\sum \vec{p}_{after/na} - \sum \vec{p}_{(before/voor)} = 0$

$\sum \vec{p}_{(before/voor)} = \sum \vec{p}_{(after/na)}$

$m_P\vec{v}_{P(bef/voor)} + m_Q\vec{v}_{Q(bef/voor)} = (m_P)\vec{v}_{P(after/na)} + m_Q\vec{v}_{Q(aft/na)}$

✓Any one / *Enige een*

positive to the left/*na links is positief*:

$(4)(-11,74)+(6)(-11,74)$ ✓ $= (4)\vec{v}_{P(after/na)}+(6)(-12,914)$ ✓

$\vec{v}_{P(after/na)} = -9,979\ m\cdot s^{-1}$ ✓ **OR/*OF*** $\vec{v}_{P(after/na)} = -9,98\ m\cdot s^{-1}$

OR/*OF*

$\vec{v}_{P(after/na)} = 9,98\ m\cdot s^{-1}$ to the right/*na regs* ✓

Note/*Aantekening*: Do not penalise if vector notation is not used./*Moenie penaliseer indien vektornotasie nie gebruik is nie.*

4.4 **OPTION 1/*OPSIE 1***

$\vec{F}\Delta t = \Delta\vec{p}$ ***OR/OF*** $F\Delta t = \Delta p$

$\vec{J} = \Delta\vec{p}$ ***OR/OF*** $\vec{I} = \Delta\vec{p}$ ***OR/OF*** Impulse/Impuls$= \Delta p$

$\vec{J} = \vec{p}_f - \vec{p}_i$

✓Any one/Enige een

$\vec{J} = m(\vec{v}_f - \vec{v}_{fi})$ ***OR/OF*** $\vec{J} = m\vec{v}_f - m\vec{v}_{fi}$

positive to the right/*na regs is positief*:

$\vec{J} = 4[(+9,98-(+11,74)]$ ✓ ***OR/OF*** $\vec{J} = [(4)(+9,98)]-[(4)(+11,74)]$

$\vec{J} = -7,00\ N\cdot s$

$J = 7,00\ N\cdot s$ ✓ Accept/*Aanvaar* J/I/Impulse/Impuls$= 7\ N\cdot s$

OPTION 2/*OPSIE 2*

$\vec{F}\Delta t = \Delta\vec{p}$ ***OR/OF*** $F\Delta t = \Delta p$

$\vec{J} = \Delta\vec{p}$ ***OR/OF*** $\vec{I} = \Delta\vec{p}$ ***OR/OF*** Impulse/Impuls$= \Delta p$

$\vec{J} = \vec{p}_f - \vec{p}_i$

✓Any one/Enige een

$\vec{J} = m(\vec{v}_f - \vec{v}_{fi})$ ***OR/OF*** $\vec{J} = m\vec{v}_f - m\vec{v}_{fi}$

positive to the left/*na links is positief*:

$\vec{J} = 4[(-9,98-(-11,74)]$ ✓ ***OR/OF*** $\vec{J} = [(4)(-9,98)]-[(4)(-11,74)]$

$\vec{J} = +7,00\ N\cdot s$

$J = 7,00\ N\cdot s$ ✓ Accept/*Aanvaar* J/I/Impulse/Impuls$= 7\ N\cdot s$

Note/*Aantekening*: Do not penalise if vector notation is not used./*Moenie penaliseer indien vektornotasie nie gebruik is nie.*

(4)

[13]

Question 5 – work, power and energy

$\theta = \sin^{-1}\frac{1,2}{6}$ ✓ $= 11,537^0$

Option 1 / *Opsie 1*

$W_{nett} = \Delta E_k$ ✓

$W_A + W_f + W_N + W_\perp + W_{//} = 0$ ✓

$W_A + F_f\Delta \times Cos180 + 0 + 0 + 100 \times 9,8Sin\ 11,537$✓$\times 6Cos0$ ✓$= 0$

$W_A + 60 \times 6Cos180$✓ $+ 100 \times 9,8Sin\ 11,537 \times 6Cos0 = 0$

$W_A = -\ 816,3058\ J$

$W_A = F\Delta \times \cos\theta$ ✓ $= -\ 816,3058\ J$

$= F \times 6\ \cos\ 180$✓ $= -\ 816,3058\ J$

$F_A = 136,05\ N$ ✓

Question 6 – doppler

6.1 The (apparent) change in frequency (or pitch) of the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓

OR:

An (apparent) change is observed/detected frequency (pitch) as a result of the relative motion between a source and a n observer (a listener) ✓✓

(2)

6.2.1 $v = f_s\lambda$

$340 = f_s(0{,}25)$ ✓

$\therefore f_s = 1\,360$ Hz

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

$$1\,480 \checkmark = \left(\frac{340 + 0}{340 - v_S}\right) \checkmark (1\,360) \checkmark$$

$$\frac{37}{34} = \frac{340}{340 - v_S}$$

$\therefore 12\,580 - 37 \cdot v_S = 11\,560$

$\therefore v_S = 27,568\ m \cdot s^{-1}$ ✓

(6)

6.2.2 $$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s \checkmark$$

$$= \left(\frac{340 - 0}{340 + 27{,}568}\right) \checkmark (1\,360) \checkmark$$

$= 1\,257,999$ Hz ✓

(4)

6.3 The spectral lines (light) from the star are shifted towards the lower frequency✓✓
Die spektrale lyne (lig) van die ster word na die laer frekwensie verskuif

(2)
[14]

Question 7 – electrostatics

7.1 Positive/Positief.✓ (1)

7.2 $Q = ne$ ✓ **OR/*OF*** $n = \frac{q}{e}$

$Q = 938(1{,}6 \times 10^{-19}\ C)$✓ **OR/*OF*** $Q = 938(1{,}6 \times 10^{-19})$

$Q = 1{,}50 \times 10^{-16} C$ ✓ (3)

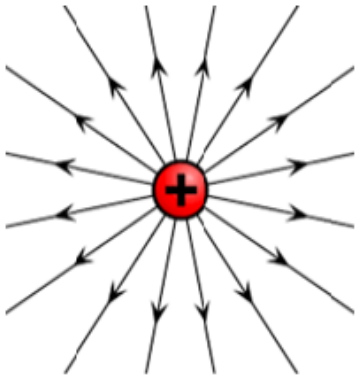
7.3

NOTE: -1 Mark for each key word /phrase omitted in the correct context. *LET WEL: - 1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

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 eenheidspositiewe-lading wat by daardie punt geplaas is, ondervind word. (2)

7.4



Marking criteria/ *Nasienkriteria*	
Shape (radial)/*Vorm (radiaal)*	✓
Correct direction/*Korrekte rigting*	✓

(3)

7.5 At **A**.✓

The distance from A to the charged sphere **X** is smaller than the distance from B to the charged sphere X ✓and the electric field at a point due to a point charge is inversely proportional to the square distance between the point and the charge $(E \propto \frac{1}{d^2})$ ✓

*By **A***

*Die afstand vanaf A na die gelaaide sfeer **X** is kleiner as die afstand van B na die gelaaide sfeer X en die elektriese veld op 'n punt as gevolg van 'n puntlading omgekeerd eweredig is aan die vierkante afstand tussen die punt en die lading* $(E \propto \frac{1}{d^2})$. (3)

7.6.1 The magnitude of the electrostatic force exerted by one point charge on another 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.✓

Die grootte van die elektrostatiese krag wat een puntlading op 'n ander puntlading uitoefen, is direk eweredig aan die produk van die groottes van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.6.2 **OPTION 1/*OPSIE 1***

$F=\frac{KQ_1Q_2}{r^2}$ ✓ **OR/*OF*** $F=\frac{KQ_XQ_Y}{r^2}$

$F_{YonX}=\frac{9\times10^{9}\times(1,5\times10^{-16}\times(2,8\times10^{-16})}{(0,03)^2}$ ✓

$F_{YonX}=4,2\times10^{-19}$N .to the right/*na regs*

$F=\frac{KQ_XQ_Z}{r^2}$

$F_{ZonX}=\frac{9\times10^{9}\times(1,5\times10^{-16}\times(3,2\times10^{-16})}{(0,01)^2}$ ✓

$F_{ZonX}=43,2\times10^{-19}$N . to the right/*na regs*

Positive to the right/*Positief na regs*

$\vec{F}_{net}=\vec{F}_{YonX}+\vec{F}_{ZonX}$ **OR/*OF*** $F_{net}=F_{YonX}+F_{ZonX}$

$\vec{F}_{net}=4,2\times10^{-19}+43,2\times10^{-19}$ ✓

$\vec{F}_{net}=47,4\times10^{-19}$N.to the right/*na regs* ✓

OR/*OF*

$F_{net}=4,74\times10^{-18}$N to the right/*na regs* ✓

OPTION 3/*OPSIE 3*

Positive to the right/ *Positief na regs*

$E=K\frac{Q}{r^2}$

$E_x=9\times10^{9}\times\frac{(3,2\times10^{-16})}{(0,01)^2}$ ✓

$E_A=28,8\times10^{-3}\,N\cdot C^{-1}$ to the right/*na regs*

$E_Y=9\times10^{9}\times\frac{(2,8\times10^{-16})}{(0,03)^2}$ ✓

$\vec{E}_B=2,8\times10^{-3}\,N\cdot C^{-1}$ to the right/*na regs*

$\vec{E}_{net}=\vec{E}_X+\vec{E}_Y$

$E_{net}=E_X+E_B$

$E_{net}=28,8\times10^{-3}+2,8\times10^{-3}$

$E_{net}=31,6\times10^{-3}N\cdot C^{-1}$

$\vec{E}_{net}=31,60\times10^{-3}\,N\cdot C^{-1}$*to the right/na regs*

$F=qE$ ✓

$F=1,5\times10^{-16}\times31,60\times10^{-3}$ ✓

$F=47,4\times10^{-19}N$ *to the right/na regs* ✓

Question 8 -circuits

8.1 $Emf = Vexternal + V_{internal}$

$17 = 14 - Vinternal$ ✓

$V_{int} = 3V$

$I = \frac{Vinternal}{r} = \frac{3}{0,5} = 6A$ ✓C ✓ **(4)**

8.2

Rt = $\frac{Vt}{It}$ ✓ Rt = $\frac{14}{6}$ ✓ = 2,3333Ω Rp = Rt – Rs Rp = 2,3333 – 1✓ = 1,3333Ω $\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2+R3}$ ✓ $\frac{1}{1,3333}$ ✓= $\frac{1}{2} + \frac{1}{1+x}$ ✓ x = 3 or 2,97 Ω✓	Or Emf = IR + Ir✓ 17 = 6R + 6(0,5) ✓ Rt = 2,3333Ω Rp = Rt – Rs Rp = 2,3333 – 1✓ = 1,3333Ω $\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2+R3}$ ✓ $\frac{1}{1,3333}$ ✓ = $\frac{1}{2} + \frac{1}{1+x}$ ✓ x = 3 or 2,97 Ω✓	Vy = I.R✓ = 6 x 1 ✓ = 6 V Vp = Vt – Vs = 14 – 6 = 8 V I_M = V/R = 8/2 ✓ = 4 A Thus I other branch = 6 – 4 = 2A $V_{1Ω}$ = I.R = 2(1) ✓ = 2V V_2 = 8 – 2 ✓ V_2 = 6V R = V/I = 6/2✓ = 3 Ω✓	Vy = I.R✓ = 6 x 1 ✓ = 6 V Vp = Vt – Vs = 14 – 6 = 8 V I_M = V/R = 8/2 ✓ = 4 A Thus I other branch = 6 – 4✓ = 2A or R_{1+N} = V/I = 8/2✓ = 4 Ω RN = 4 – 1 ✓ = 3 Ω✓

Question 9 – Ohm's law circuit

9.1 The energy transferred to / work done on ✓ each coulomb (of charge) / per C charge ✓ passing through the battery.

(2)

9.2 Gradient/*helling* = $\frac{3,6 - 0,5}{9 - 0}$ = 0,37 (V^{-1})

✓ ✓

Note/*Aantekening*:
- Accept any correct values from graph to calculate the gradient.
- *Aanvaar enige korrekte waarde vanaf grafiek om helling te bereken.*

(3)

9.3 $\frac{1}{emf}$ ✓

1/I ÷ R will equal to voltage. However- keep in mind that you have 3 different voltages in this section (EMF, Vext and Vint) and the only p.d that remains constant, like the gradient does, it the EMF.

(1)

9.4.1 **POSITIVE MARKING FROM QUESTION**

OPTION /OPSIE 1	**OPTION / OPSIE 2**
$\frac{1}{emf}$ = 0,37 ✓ ε (emf) = 2,70 V ✓ **Range/*Aanvaar*:** 2,67 – 2,70 V	emf = 2(0) + 2r emf = 0,26(9) + 0,26r 0 = - 2,34 + 1,74r r = 1,34 Ω ε = 2(0) + 2r = 2(1,34) = 2,67 V ✓

(2)

9.4.2 **POSITIVE MARKING FROM QUESTION**

OPTION / OPSIE 1	**OPTION / OPSIE 2**
Emf = I(R + r) y = mx + c: $\frac{1}{I} = \frac{1}{emf}R + \frac{r}{emf}$ y intercept / afsnit = $\frac{r}{emf}$ 0,5 ✓ = $\frac{r}{2,70}$ ✓ R = 1,35 Ω ✓ Range/ *aanvaar*: 1,34 - 1,35 Ω	Any two equation using values from the graph/ *Enige twee vergelykings waar waardes van grafiek gebruik is*: choose any point eg (2,2;1,3) Emf = IR + Ir 1/0,37 = 1/1,3 (2,2) + 1,3r r = 1,38 Ω

(3)

Question 10 – electrodynamics

10.1.1 AC generator/*WS generator*✓ (1)

10.1.2 Q- Carbon brush / *Koolstofborseltjies*✓
R- Slip ring / *Sleepring*✓ (2)

10.2.1 Graph A represents direct current. ✓
Grafiek A verteenwoordig gelykstoom
Graph B represents alternating current. ✓
Grafiek B verteenwoordig wisselstroom (2)

10.2.2 $f = \frac{\text{no of ocillations}}{\text{time}} / \frac{\text{aantal ossilasies}}{\text{tyd}}$
$= 1,5/0,03$✓
$= 50$ Hz✓ (2)

10.3.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$200 = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = 282,84$ V ✓ (3)

10.3.2 $V_{rms} = I_{rms} \times R$✓
$200 = I_{rms} \times 10$✓
$I_{rms} = 20$ A✓ (3)

10.3.3 **OPTION 1 / OPSIE 1**
$P_{ave} = I_{rms}V_{rms}$✓
$= 20 \times 200$✓
$= 4000$ W✓

OPTION 2 / OPSIE 2
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓
$= \frac{200^2}{10}$ ✓
$= 4000$ W ✓

OPTION 3 / OPSIE 3
$P_{ave} = I_{rms}^2 R$ ✓
$= (20)^2(10)$ ✓
$= 4000$ W ✓

(3)

Question 11 – photoelectric effect

11.1 Minimum energy required to release (photo) electrons from a metal surface.✓✓

(2)

11.2

OPTION / OPSIE 1	OPTION / OPSIE 2
$W_o = hf$ ✓ $= \frac{hc}{\lambda}$ ✓ $= \frac{(6,63\times10^{-34})(3\times10^{8})}{500\times10^{-9}}$ ✓ $= 3,978 \times 10^{-19}$J ✓	$f = \frac{c}{\lambda}$ ✓ $= \frac{3\times10^{8}}{500\times10^{-9}}$ ✓ $= 6\times10^{14}$ Hz $W_o = hf$ ✓ $= (6,63\times10^{-34})(6\times10^{14})$ ✓ $= 3,98\times10^{-19}$ J✓

(5)

11.3 **POSITIVE MARKING FROM QUESTION**

OPTION / OPSIE 1	OPTION / OPSIE 2
$E = W_o + E_{k(max)}$ ✓ $\frac{hc}{\lambda} = W_o + E_{k(max)}$ $\frac{(6,63\times10^{-34}\text{✓})(3\times10^{8}\text{✓})}{400\times10^{-9}\text{✓}} = 3,978 \times 10^{-19} + E_{k(max)}$ $E_{k(max)} = 9,95 \times 10^{-20}$ J ✓ **Range/** ***aanvaar*****:** $9,93 \times 10^{-20}$ J to $9,95 \times 10^{-20}$ J	$f = \frac{c}{\lambda}$ $= \frac{3\times10^{8}}{400\times10^{-9}}$ ✓ $= 7,5\times10^{14}$ Hz $E = hf$ $= (6,63\times10^{-34})(7,5\times10^{14})$✓ $= 4,97\times10^{-19}$ J $E = W_o + E_{k(max)}$ ✓ $4,97 \times 10^{-19} = 3,98 \times 10^{-19} + E_{k(max)}$ ✓ $E_{k(max)} = 9,93 \times 10^{-20}$ J ✓

(5)

11.4.1 Increase

11.4.2 remains the same