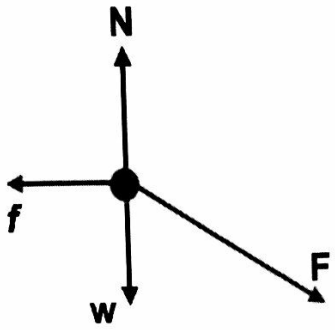
QUESTION 1/*VRAAG 1*

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)

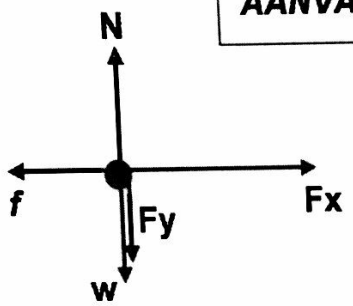
[20]

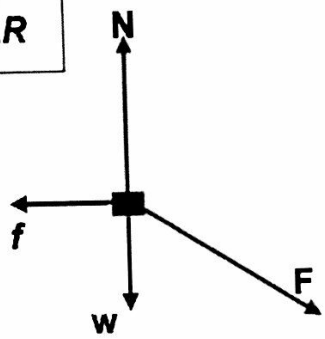
QUESTION 2/VRAAG 2

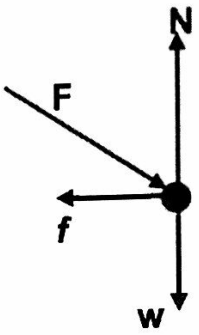
2.1.1



ACCEPT/
AANVAAR







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

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

✓ any one
enige een

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

OR/OF

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

✓ any one
enige een

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

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

✓ any one
enige een

$\underline{90 \sin 50° - f = 0}$ ✓
$f = 68,94$ 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 *IPOSITIEWE 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}

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

$F = 103,11$N ✓ (103,05 N – 103,11N)

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

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

$F_{net}.\Delta t = \Delta p$ ✓

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

$F = 103,11$ 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

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

$\tan 40° = \frac{F_y}{78{,}94}$

$F_y = 66{,}24$ N

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

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

$F = 103{,}05$ 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

$W_{net} = \Delta K$

$W_F + W_f = \Delta K$ ✓

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

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

$F = 103.06$ N✓

(6)

2.2

OPTION 1/*OPSIE 1*

$F = G\frac{m_1 m_2}{r^2}$ ✓

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

$m_{planet} = 1{,}08 \times 10^{22}$ kg ✓

OPTION 2/*OPSIE 2*

$w = mg$

$20 = (10)(g)$ ✓

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

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

✓ Any one
Enige een

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

$M = 1{,}08 \times 10^{22}$ kg ✓

(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 $m \cdot s^{-2}$.
NOTE: 2 OR ZERO/ *2 of nul*

3.2.1

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

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

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

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

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.

3.2.2

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

$\Delta E = \Delta K + \Delta U$
$\frac{1}{2} mv_f^2 + mgh_i = \frac{1}{2} mv_f^2 + mgh_f$ } 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
$\Delta y = v_i\Delta t + \frac{1}{2}(g)\Delta t^2$ ✓
$= (14,99)(0,94) + \frac{1}{2}(9,8)(0,94)^2$ ✓
= 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*

$K = \frac{1}{2} mv^2$✓ (or $E_K = \frac{1}{2} mv^2$)

Total kinetic energy before collision:/*Totale kinetiese energie voor botsing:*

$\frac{1}{2}(0,45)(9)^2 + 0$✓= 18,225J

Total kinetic energy after collision:/ *Totale kinetiese energie na botsing:*

$\frac{1}{2}(0,45 + 0,20)(6,23)^2$✓ = 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)

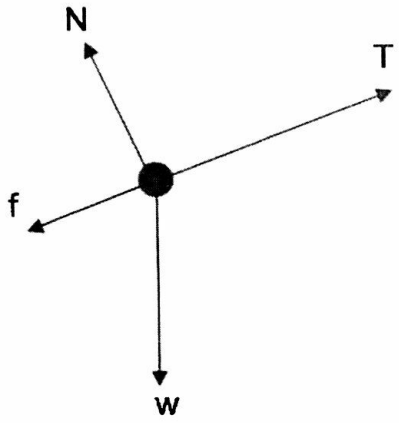
[11]

QUESTION 5/VRAAG 5

5.1 Tension/*Spanning*✓ (1)

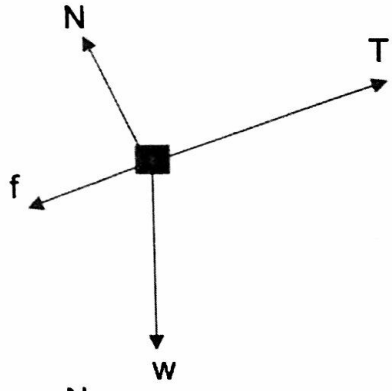
5.2 There is friction/ tension in the system ✓
Daar is wrywing/spanning in die sisteem
OR/*OF*
Friction/tension is a non-conservative force ✓
Wrywing/spanning 'n 'n nie-konserwatiewekrag
OR/*OF*
The system is not isolated because there is friction/tension ✓
Die sisteem in nie geïsoleerd nie omdat daar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

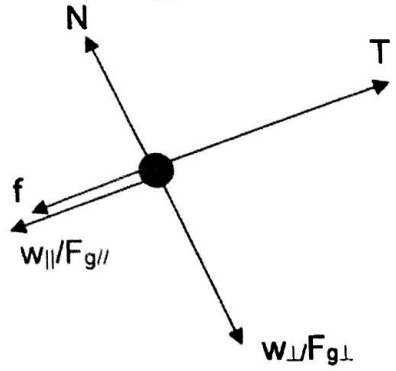
5.3



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)/$F_{normaL}/F_N/F_{normaal}/F_{reaction/reaksie}$	✓
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

$W = F\Delta x\cos\theta$✓
$W_f = [178,22(4)\cos 180°]$ ✓
$= -712,88$ 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*

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

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:

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

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

$W_{gravity/gravitasie} = -\Delta\, mgh = -mg(h_f - h_0)$
$= mg\Delta y\cos\theta$
$= ((70)(9,8)\,4(\sin 30°).\cos 180°$

$W_{gravity/gravitasie} = mg\sin\theta\Delta x\cos\theta$
$= (70)(9,8)\,(\sin 30°)(4).\cos 180°$

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 5.4 / *POSITIEWE NASIEN VANAF 5.4*
$W_{nc} = \Delta E_K + \Delta E_p$ ✓
$W_T + W_f = \Delta E_K + \Delta E_p$
$(700)(4)\cos 0°$✓ + (-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
$F_{net} = F_T - [mg\sin\theta + f_k]$
$= \underline{700 - [(70 \times 9{,}8 \sin 30°) + 178{,}22]}$ ✓
$= 178{,}78\ N$
$W_{net} = \Delta E_K$✓
$F_{net} . \Delta x\cos\theta = \Delta E_K$
$\underline{(178{,}78)(4)\cos 0°}$ ✓=.$\underline{\frac{1}{2}\,70(v_f^2 - 0)}$✓
$v_f = 4{,}52\ m\cdot s^{-1}$✓ (5)

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

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

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

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

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

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.* $^3/_4$

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

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

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

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

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

= 36 Ω

$P = I^2R = \frac{V^2}{R}$ ✓

$I^2(36+2) = \frac{(12)^2}{38}$ ✓

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(RA+r)

= 0,316(26) ✓

= 8,216 V (8,32 V)

VII = (12 – 8,216) ✓

= 3,784 V(3,68 V)

∴ VC = 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

VII = VC ✓

V = IRII

= (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*

IA = IB + IC

= 2 IB

0,316 = 2IB✓

IB = 0,158 A

V = 0,158 (24) ✓

= 3,79 V✓

(3)

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

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

$P = I^2 R$ OR For a given resistance, power is directly proportional to I^2 ✓

OF *vir 'n gegewe resistor is drywing direk eweredig aan* I^2

In the circuit, the current in light bulb C is less than the optimum current required (0,5 A). ✓ The output power will be less✓

In die stroombaan is die stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Die uitsetdrywing sal minder wees.

OPTION 3/*OPSIE 3*

P = IV OR Power is directly proportional/equal to product of V and I. ✓

OF Drywing is direk eweredig/gelyk aan die produk van V en I.

The voltage across light bulb C, as well as the current in the bulb are 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 minder as die optimum waardes, dus is die drywing minder en die helderheid minder. (3)

NOTE: No mark if only equation is given.

LW: Geen punte indien slegs die vergelyking gegee is nie.

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*

$$I_{rms} = \frac{V_{rms\ /\ wgk}}{R}$$
$$= \frac{(220{,}62)}{40}$$
$$= 5{,}515$$

✓ for any/ *vir enige*

$$P_{ave} = I^2_{rms}R$$
$$= (5{,}515)^2(40) \checkmark$$
$$= 1216{,}61 \text{ W} \checkmark$$

OR

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

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*

$E = h\frac{c}{\lambda}$ ✓

$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{5 \times 10^{-7}}$ ✓

$= 3,98 \times 10^{-19}$ J✓

OPTION 2/*OPSIE 2*

$c = f\lambda$

$3 \times 10^{8} = f(5 \times 10^{-7})$

$f = 6 \times 10^{14}$ 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*

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