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# basic education

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Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**SENIOR CERTIFICATE EXAMINATIONS/  
NATIONAL SENIOR CERTIFICATE EXAMINATIONS  
SENIORSERTIFIKAAT-EKSAMEN/  
NASIONALE SENIORSERTIFIKAAT-EKSAMEN**

**PHYSICAL SCIENCES: PHYSICS (P1)  
FISIESE WETENSKAPPE: FISIKA (V1)**

**2019**

**MARKING GUIDELINES/NASIENRIGLYNE**

**MARKS/PUNTE: 150**

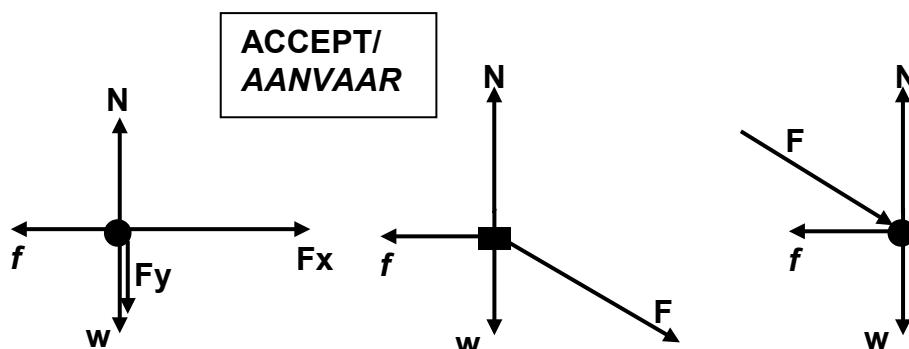
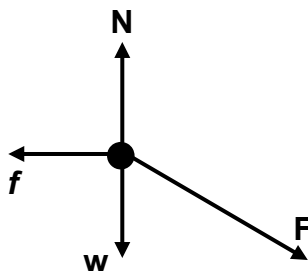
**These marking guidelines consist of 28 pages./  
Hierdie nasienriglyne bestaan uit 28 bladsye.**

**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



Accepted labels/Aanvaarde benoemings	
F	$F_A/90\text{ N}/F_{90}$
w	$F_g / F_w/\text{weight} / mg / \text{gravitational force}$ $F_g / F_w/\text{gewig} / mg / \text{gravitasiekrag}$
f	(Kinetic) Friction / $F_f / f_k / \text{wrywing} / F_w$
N	$F_{\text{Normal}} / \text{Normal}/\text{Normaal} / F_N$

**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  $\frac{3}{4}$*
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks:  $\frac{3}{4}$*
- 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

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \cos 40^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\underline{90 \cos 40^\circ - f = 0} \checkmark$$

$$f = 68,94 \text{ N} \checkmark$$

OR/OF

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \cos 320^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\underline{90 \cos 320^\circ - f = 0} \checkmark$$

$$f = 68,94 \text{ N} \checkmark$$

$$\left. \begin{array}{l} F_{\text{net}} = ma \\ F_{\text{net}} = 0 \\ F_x = f \\ F_x - f = 0 \\ F \sin 50^\circ - f = 0 \end{array} \right\} \begin{array}{l} \checkmark \text{ any one} \\ \text{enige een} \end{array}$$

$$\underline{90 \sin 50^\circ - f = 0} \checkmark$$

$$f = 68,94 \text{ N} \checkmark$$

(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 / POSITIEWE NASIEN VANAF 2.1.3  
OPTION 1/OPSIE 1**

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

$$\underline{2 = 0} \checkmark + \underline{a(3)} \checkmark$$

$$a = 0,67 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$\underline{F \cos 40^\circ} \checkmark - \underline{68,94} \checkmark = 15 (0,67)$$

$$F = 103,11 \text{ N} \checkmark (103,05 \text{ N} - 103,11 \text{ N})$$

$$F_{\text{net}} = ma \checkmark$$

$$F \cos 320^\circ - f = 15(0,67)$$

$$\underline{F \cos 320^\circ} \checkmark - \underline{68,94} \checkmark = 15(0,67)$$

$$F = 103,11 \text{ N} \checkmark$$

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

$$F_{\text{net}} \cdot \Delta t = \Delta p \checkmark$$

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

$$F = 103,11 \text{ N} \checkmark$$

**POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3  
OPTION 3 / OPSIE 3**

$$F_{\text{net}} = ma$$

$$F_x - f_k = ma$$

✓ any one  
enige een

$$F_x - 68,94 \checkmark = 15 \frac{(2-0) \checkmark}{3 \checkmark}$$

$$F_x = 78,94 \text{ N}$$

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

$$\tan 40^\circ = \frac{F_y}{78,94}$$

$$F_y = 66,24 \text{ N}$$

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

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

$$F = 103,05 \text{ N} \checkmark$$

**POSITIVE MARKING FROM 2.1.3 / POSITIEWE NASIEN VANAF 2.1.3  
OPTION 4 / OPSIE 4**

$$\Delta x = \frac{v_i + v_f}{2} \Delta t$$

$$= \frac{(2+0) \checkmark}{2} (3) \checkmark$$

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

$$W_{\text{net}} = \Delta K$$

$$W_F + W_f = \Delta K \checkmark$$

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

$$\underline{F(3) \cos 40^\circ} \checkmark + \underline{68,94(3) \cos 180^\circ} \checkmark = \frac{1}{2} (15)(2^2) - \frac{1}{2} (15)(0)^2$$

$$F = 103,06 \text{ N} \checkmark$$

(6)

2.2

**OPTION 1/OPSIE 1**

$$F = G \frac{m_1 m_2}{r^2} \checkmark$$

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

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

**OPTION 2/OPSIE 2**

$$w = mg$$

$$20 = (10)(g) \checkmark$$

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

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

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

$$M = 1,08 \times 10^{22} \text{ kg} \checkmark$$

✓ Any one  
Enige een

(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  $9,8 \text{ m}\cdot\text{s}^{-2}$ . ✓✓

*Beweging in lug met 'n versnelling van  $9,8 \text{ m}\cdot\text{s}^{-2}$ .*

NOTE: 2 OR ZERO/ 2 of nul

(2)

- 3.2.1

**OPTION 1/OPSIE 1**

**Upwards positive/Opwaarts positief:**

$$v_f = v_i + a\Delta t \quad \checkmark$$

$$0 = v_i + (-9,8)(1,53) \quad \checkmark$$

$$\therefore v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \quad (15 \text{ m}\cdot\text{s}^{-1}) \quad \checkmark$$

**Downwards positive/Afwaarts positief**

$$v_f = v_i + a\Delta t \quad \checkmark$$

$$0 = v_i + (9,8)(1,53) \quad \checkmark$$

$$\therefore v_i = -14,99 \text{ m}\cdot\text{s}^{-1}$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \quad (15 \text{ m}\cdot\text{s}^{-1}) \quad \checkmark$$

**OPTION 2/OPSIE 2**

$$F_{\text{net}} = ma$$

$$= 9,8 \text{ (m)}$$

$$F_{\text{net}} \Delta t = m\Delta v \quad \checkmark$$

$$(9,8)(\text{m})(1,53) = (\text{m})(v_f - 0) \quad \checkmark$$

$$v_f = 14,99 \text{ m}\cdot\text{s}^{-1} \quad (15 \text{ m}\cdot\text{s}^{-1}) \quad \checkmark$$

**OPTION 3/OPSIE 3**

**Upwards positive/Opwaarts positief:**

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

$$0 = v_i(3,06) + \frac{1}{2}(-9,8)(3,06)^2 \quad \checkmark$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \quad \checkmark \quad (15 \text{ m}\cdot\text{s}^{-1})$$

**Downwards positive/Afwaarts positief**

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

$$0 = v_i(3,06) + \frac{1}{2}(9,8)(3,06)^2 \quad \checkmark$$

$$v_i = 14,99 \text{ m}\cdot\text{s}^{-1} \quad \checkmark \quad (15 \text{ m}\cdot\text{s}^{-1})$$

NOTE: initial and final velocities can be swapped 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)



3.2.2

**OPTION 1/OPSIE 1****POSITIVE MARKING FROM 3.2.1/ Positiewe nasien vanaf 3.2.1****Upwards positive/Opwaarts positief:**

$$\begin{aligned}\Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{14,99 (1,53) + \frac{1}{2} (-9,8)(1,53)^2} \checkmark \\ &= 11,47 \text{ m} \checkmark (11,46-11,48)\end{aligned}$$

Maximum height is/Maksimum hoogte is 11,47 m

**Downwards positive/Afwaarts positief**

$$\begin{aligned}\Delta y &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{-14,99 (1,53) + \frac{1}{2} (9,8)(1,53)^2} \checkmark \\ &= -11,47 \text{ m} (11,46-11,48)\end{aligned}$$

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:**

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0 &= \underline{(14,99)^2 + 2(-9,8)(\Delta y)} \checkmark \\ \Delta y &= 11,47 \text{ m} \cdot \checkmark (11,46-11,48)\end{aligned}$$

Maximum height reached is/Maksimum hoogte bereik is 11,47 m

**Downwards positive/Afwaarts positief:**

$$\begin{aligned}v_f^2 &= v_i^2 + 2a\Delta y \checkmark \\ 0 &= \underline{(-14,99)^2 + 2(9,8)(\Delta y)} \checkmark \\ \Delta y &= -11,47 \text{ m} \cdot (11,46-11,48)\end{aligned}$$

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:**

$$\begin{aligned}\Delta y &= \left( \frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left( \frac{(14,99 + 0)}{2} \right) (1,53) \checkmark\end{aligned}$$

$$\Delta y = 11,47 \text{ m} \checkmark$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m

**Downwards positive/Afwaarts positief:**

$$\begin{aligned}\Delta y &= \left( \frac{v_i + v_f}{2} \right) \Delta t \checkmark \\ &= \left( \frac{(-14,99 + 0)}{2} \right) (1,53) \checkmark\end{aligned}$$

$$\Delta y = -11,47 \text{ m} (11,46-11,48)$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m ✓

**OPTION 4/OPSIE 4****POSITIVE MARKING FROM 3.2.1**

$$\Delta E = \Delta K + \Delta U$$

$$\frac{1}{2} m v_i^2 + m g h_i = \frac{1}{2} m v_f^2 + m g h_f$$

1 mark for any ✓  
1 punt vir enige

$$\frac{1}{2} (14,994)^2 + (9,8)(0) = 0 + 9,8 h_f \checkmark$$

$$h_f = 11,47 \text{ m} \checkmark (11,46-11,48)$$

Maximum height reached is /Maksimum hoogte bereik is 11,47 m

**OR/OF**

$$\Delta K = - \Delta U \checkmark$$

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

$$\frac{1}{2} (0 - 14,99^2) = - 9,8 (h_f - 0) \checkmark$$

$$h_f = 11,47 \text{ m} (11,46-11,48)$$

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:**

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

$$= (14,99) (4) + \frac{1}{2} (- 9,8)(4)^2 \checkmark$$

$$= -18,4 \text{ m}$$

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**

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

$$= (-14,99) (4) + \frac{1}{2} (9,8)(4)^2 \checkmark$$

$$= 18,4 \text{ m}$$

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:**

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

$$= (14,99) + (-9,8) (4)$$

$$= -24,2 \text{ m}\cdot\text{s}^{-1}$$

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

$$(-24,2)^2 = (14,99)^2 + 2(-9,8)(\Delta y) \checkmark$$

$$\Delta y = -18,4 \text{ m}$$

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:**

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

$$= (-14,99) + (9,8) (4)$$

$$= 24,2 \text{ m}\cdot\text{s}^{-1}$$

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

$$(24,2)^2 = (-14,99)^2 + 2(9,8)(\Delta y) \checkmark$$

$$\Delta y = 18,4 \text{ m}$$

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:**

$$\Delta y = \left( \frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left( \frac{(14,99 - 24,2)}{2} \right) (4) \checkmark$$

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

$$= (14,99) + (-9,8) (4)$$

$$= -24,2 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta y = -18,4 \text{ m}$$

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:**

$$\Delta y = \left( \frac{v_i + v_f}{2} \right) \Delta t \checkmark$$

$$= \left( \frac{(-14,99 + 24,2)}{2} \right) (4) \checkmark$$

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

$$= (-14,99) + (9,8) (4)$$

$$= 24,2 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta y = 18,4 \text{ m}$$

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*

$$= 2(1,53) = 3,06 \text{ s}$$

$\therefore$  time from reference point to ground/*tyd vanaf verwysingspunt tot by grond*

$$= (4 - 3,06) = 0,94 \text{ s}$$

$$\Delta y = v_i \Delta t + \frac{1}{2} (g) \Delta t^2 \checkmark$$

$$= (14,99)(0,94) + \frac{1}{2}(9,8)(0,94)^2 \checkmark$$

= 18,43 m  $\checkmark$  downwards (below the edge of the roof) /*afwaarts (onder die kant van die dak.*

(3)

3.4

No/Nee  $\checkmark$ 

The motion of the ball is only dependent on its initial velocity  $\checkmark \checkmark$  /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.  $\checkmark$

*Die bal sal nog steeds in die lug wees.*

OR/OF

The ball is still falling.  $\checkmark$

*Die bal is steeds besig om te val.*

OR/OF

The ball would not have reached the ground.  $\checkmark$

*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.  $\checkmark$

*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

*LW: Indien leerders twee afsonderlike antwoorde gee vir 3.2 en 3.3, sien as geheel na. Dus, indien een verkeerd is, 0/3*

(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**

$$\sum p_i = \sum p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

1 mark for any  
1 punt vir enige

$$\{0,45(9) + 0,20(0)\} \checkmark = (0,45 + 0,20)v \checkmark$$

$$v = 6,23 \text{ m}\cdot\text{s}^{-1} \checkmark$$

**OR**

$$\Delta p_{\text{ball/bal}} = - \Delta p_{\text{cont/houer}} \checkmark$$

$$0,45(v - 9) \checkmark = - 0,2(v - 0) \checkmark$$

$$v = 6,23 \text{ m}\cdot\text{s}^{-1} \checkmark$$

If – sign omitted from formula 0/4  
Indien – teken weggelaat uit  
formula 0/4

**OPTION 2/OPSIE 2**

$$\sum p_i = \sum p_f$$

$$p_{f \text{ Total}} = p_{i \text{ Total}}$$

1 mark for any ✓  
1 punt vir enige

(Thus change in total momentum = 0 /Dus verandering in momentum is=0)

$$0 \checkmark = (0,65v_f) - (9)(0,45) \checkmark$$

$$v_f = 6,23 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

4.3

**POSITIVE MARKING FROM 4.2/POSITIEWE NASIEN VANAF 4.2**

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

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

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

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

$$\frac{1}{2} (0,45 + 0,20)(6,23)^2 \checkmark = 12,614\text{J}$$

$$\sum K_{\text{before/voor}} \neq \sum K_{\text{after/na}}$$

Collision is inelastic. / *Botsing is onelasties* ✓✓If start with/ *indien begin met*  $\sum E_{Ki} = \sum E_{Kf}$  4/5 max/maksNo calculation/ *geen berekening*: 0Do 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/Spinning ✓

(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 is 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 ✓

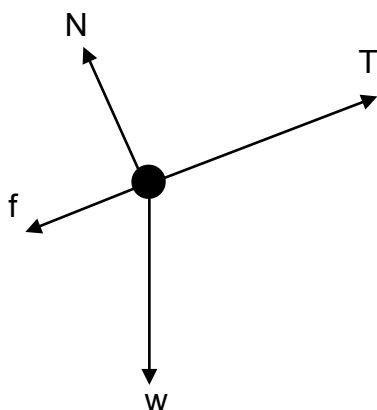
*Die toegepaste krag is nie-konservatief*

OR

It is not an isolated system ✓

(1)

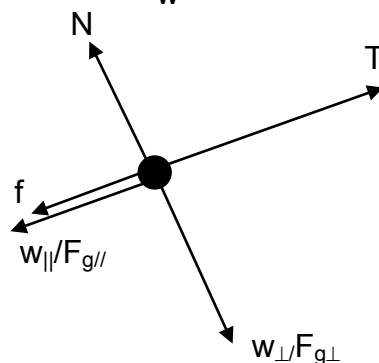
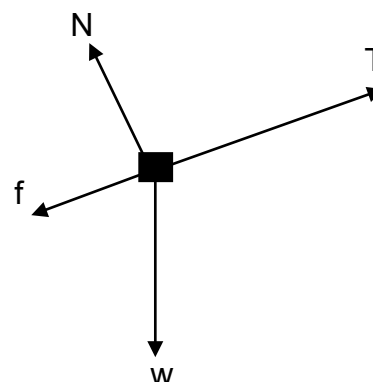
5.3



NOTE: maximum  $\frac{3}{4}$  if friction and tension are not on a straight line

LW: maksimum  $\frac{3}{4}$  indien wrywing en spanning nie in 'n reguitlyn nie.

ACCEPT/AANVAAR



NOTE: maximum  $\frac{3}{4}$  if N and  $w_{\perp}$  are not on a straight line

LW: maksimum  $\frac{3}{4}$  indien N en  $w_{\perp}$  nie in 'n reguitlyn nie.

<b>Accepted labels/Aanvaarde benoemings</b>		
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  $\frac{3}{4}$
- If force(s) do not make contact with body / Indien krag(te) nie met die voorwerp kontak maak nie: Max/Maks:  $\frac{3}{4}$

Deduct 1 mark for an arrow/arrows omitted / trek 1 punt af indien pyl/pyle weggelaat

(4)

5.4

$$W = F\Delta x \cos\theta \checkmark$$

$$W_f = [178,22(4)\cos 180^\circ] \checkmark$$

$$= -712,88 \text{ J} \checkmark$$

(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
--	--

$$-712,88 + (70)(9,8)(\sin 30^\circ)(4) \cos 180^\circ \checkmark + (700 \times 4 \times \cos 0^\circ) \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

**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:

$$W_{gravity/gravitasie} = mg\Delta x \cos\theta$$

$$= (70)(9,8)(4) \cdot (\cos 120^\circ)$$

↓

$$\therefore -712,88 + (70)(9,8)(4) \cos 120^\circ \checkmark + (700 \times 4 \times \cos 0^\circ) \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

$$W_{gravity/gravitasie} = -\Delta mgh = -mg(h_f - h_0)$$

$$= mg\Delta y \cos\theta$$

$$= ((70)(9,8) 4(\sin 30^\circ) \cdot \cos 180^\circ$$

$$W_{gravity/gravitasie} = mg \sin\theta \Delta x \cos\theta$$

$$= (70)(9,8) (\sin 30^\circ)(4) \cdot \cos 180^\circ$$



**OPTION 2/OPSIE 2****POSITIVE MARKING FROM 5.4 / POSITIEWE NASIEN VANAF 5.4**

$$W_{nc} = \Delta E_K + \Delta E_p \checkmark$$

$$W_T + W_f = \Delta E_K + \Delta E_p$$

$$(700)(4) \cos 0^\circ \checkmark + (-712,88) = [(70)(9,8) 4(\sin 30^\circ) \cdot -0] \checkmark + \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

**OPTION 3**

$$F_{net} = F_T - [mg \sin \theta + f_k]$$

$$= 700 - [(70 \times 9,8 \sin 30^\circ) + 178,22] \checkmark$$

$$= 178,78 \text{ N}$$

$$W_{net} = \Delta E_K \checkmark$$

$$F_{net} \cdot \Delta x \cos \theta = \Delta E_K$$

$$(178,78)(4) \cos 0^\circ \checkmark = \frac{1}{2} 70(v_f^2 - 0) \checkmark$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(5)

5.5

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

$$F_{net} = ma$$

$$F_T - [mg \sin \theta + f_k] = ma$$

$$700 - [(70 \times 9,8 \sin 30^\circ) + 178,22] \checkmark = 70a$$

$$a = 2,554 \text{ ms}^{-2}$$

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

$$= 0 + 2(2,554)(4)$$

$$v_f = 4,52 \text{ m}\cdot\text{s}^{-1}$$

5.6

**POSITIVE MARKING FROM 5.4/POSITIEWE NASIEN VANAF 5.4**

$$2(-712,88) = -1425,76 \text{ J} \checkmark$$

OR/OF

Double the answer (in question 5.4).  $\checkmark$ *Dubbel die antwoord (in vraag 5.4)*(1)  
[15]

**QUESTION 6/VRAAG 6**

6.1.1

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

$$300 = v_i (10) \checkmark$$

$$v_i = 30 \text{ m} \cdot \text{s}^{-1} \checkmark$$

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

**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.  $\checkmark \checkmark$

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).  $\checkmark \checkmark$

'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  $\checkmark \checkmark$ 

Motor beweeg net verby die waarnemer

**Accept:**Car moves away from observer  $\checkmark \checkmark$ No relative motion between car and observer  $\checkmark \checkmark$ Car and observer at the same place/position  $\checkmark \checkmark$ **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**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \quad \checkmark \quad \text{OR/OF} \quad f_L = \frac{v}{v - v_s} f_s$$

$$932 = \frac{340}{340 - 30} f_s \quad \checkmark$$

$$f_s = 849,76 \text{ Hz} \quad \checkmark$$

(4)

**Notes/Aantekeninge:**

- Any other Doppler formula, e.g. /Enige ander Doppler formula b.v.

$$f_L = \frac{v - v_L}{v - v_s} f_s \quad \text{Max/Maks. } \frac{3}{4}$$

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 elektrostatische 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<sub>2</sub> is positive\_✓*

*The electric field due to q<sub>1</sub> points to the right because q<sub>1</sub> is negative. ✓ Since the net field is zero, field due to q<sub>2</sub> must point to the left away from q<sub>2</sub>, ✓ hence q<sub>2</sub> is positive.*

*q<sub>2</sub> is positief*

*Die elektriese veld as gevolg van q<sub>1</sub> is na regs gerig omdat q<sub>1</sub> negatief is. Aangesien die net veld nul is, moet die veld as gevolg van q<sub>2</sub> na links weg van q<sub>2</sub> wees.*

OR/OF

*q<sub>2</sub> is positive\_✓*

*Since E<sub>net</sub> is zero, E<sub>1</sub> and E<sub>2</sub> are in opposite directions ✓ therefore q<sub>1</sub> and q<sub>2</sub> are oppositely charged. ✓*

*q<sub>2</sub> is positief ✓*

*Omdat E<sub>net</sub> nul is, is E<sub>1</sub> en E<sub>2</sub> in teenoorgestelde rigtings ✓ daarom is q<sub>1</sub> en q<sub>2</sub> teenoorgesteld gelaai. ✓*

(3)

7.3

$E = k \frac{Q}{r^2} \checkmark$ $E_{\text{net}} = 0$ $\therefore k \frac{q_1}{r_1^2} = k \frac{q_2}{r_2^2} \text{ OR}$ $\frac{q_1}{r_1^2} = \frac{q_2}{r_2^2}$ $\frac{(9 \times 10^9)(3 \times 10^{-9})}{(0,1)^2} \checkmark = \frac{(9 \times 10^9)q_2}{(0,4)^2} \checkmark$ $q_2 = + 4,8 \times 10^{-8} \text{ C} \checkmark$	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

<p><b>POSITIVE MARKING FROM 7.3/POSITIEWE NASIEN VANAF 7.3</b></p> $F = \frac{kQ_1Q_2}{r^2} \checkmark$ $F = \frac{(9 \times 10^9)(3 \times 10^{-9})(4,8 \times 10^{-8})}{(0,3)^2} \checkmark$ $= 1,44 \times 10^{-5} \text{ N} \checkmark$	(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

$P = \frac{V^2}{R} \checkmark$ $6 = \frac{(12)^2}{R} \checkmark$ $R = 24 \Omega \checkmark$	$W = \frac{V^2 \Delta t}{R} \checkmark$ $6 = \frac{(12)^2 (1)}{R} \checkmark$ $R = 24 \Omega \checkmark$	$P = VI$ $6 = (12)(I)$ $\therefore I = 0,5 \text{ A}$ $P = I^2 R \checkmark$ $6 = (0,5)^2 R \checkmark$ $R = 24 \Omega \checkmark$	$P = VI \checkmark$ $6 = (12)(I)$ $\therefore I = 0,5 \text{ A}$ $V = IR$ $12 = (0,5)R \checkmark$ $R = 24 \Omega \checkmark$
---	--	--	---

(3)

- 8.1.3

**POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2**  
**OPTION 1/OPSIE 1**

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{24} + \frac{1}{24} \checkmark$$

$$R_{//} = 12 \Omega$$
  

$$R_{\text{ext}} = (R_s + R_{//})$$

$$R_{\text{ext}} = (24 + 12) \checkmark$$

$$= 36 \Omega$$
  

$$V = IR$$

OR

$$\varepsilon = I(R + r)$$

$$12 = I(36 + 2) \checkmark$$

$$I = 0,32 \text{ A} \checkmark (0,316 \text{ A})$$

$$R_{\text{tot}} = \left( R_s + \frac{R_1 R_2}{R_1 + R_2} \right)$$

$$R_{\text{tot}} = \left\{ 24 + \frac{(24)(24)}{48} \right\} \checkmark$$

$$= 36 \Omega$$

✓ any one  
Enige 1

**POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2  
OPTION 2/OPSIE 2**

$$R_{\text{ext}} = (R_s + R_{//})$$

$$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{24} + \frac{1}{24} \checkmark$$

$$R_{//} = 12 \Omega$$

$$R_{\text{ext}} = (24 + 12) \checkmark$$

$$= 36 \Omega$$

$$P = I^2 R = \frac{V^2}{R} \checkmark$$

$$I^2 (36 + 2) = \frac{(12)^2}{38} \checkmark$$

$$I = 0,32 \text{ A} \checkmark (0,316) \checkmark$$

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

$$R_{\text{ext}} = \left\{ 24 + \frac{(24)(24)}{48} \right\} \checkmark$$

$$= 36 \Omega$$

$$I^2 R \quad I^2 R = \frac{V^2}{R}$$

$$I^2 R^2 = V^2$$

$$V = IR$$

$$12 = I(38) \checkmark$$

$$I = 0,316 \text{ A} \checkmark$$

(5)

8.1.4

**POSITIVE MARKING FROM 8.1.3  
POSITIEWE NASIEN VANAF 8.1.3  
OPTION 1/OPSIE 1**

$$V = IR$$

$$V = I(R_A + r)$$

$$= 0,316(26) \checkmark$$

$$= 8,216 \text{ V} (8,32 \text{ V})$$

$$V_{//} = (12 - 8,216) \checkmark$$

$$= 3,784 \text{ V} (3,68 \text{ V})$$

$$\therefore V_C = 3,78 \text{ V} (3,68 \text{ V}) \checkmark$$

**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)*

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \text{ OR } R = \frac{R_1 R_2}{R_1 + R_2}$$

$$R = \frac{(24)(24)}{48}$$

$$= 12 \Omega$$

$$V_{//} = V_C \checkmark$$

$$V = IR_{//}$$

$$= (0,316)(12) \checkmark$$

$$= 3,79 \text{ V} (3,84 \text{ V}) \checkmark$$

(3)

**POSITIVE MARKING FROM 8.1.3  
POSITIEWE NASIEN VANAF 8.1.3  
OPTION 3/OPSIE 3**

$$I_A = I_B + I_C$$

$$= 2 I_B$$

$$0,316 = 2 I_B \checkmark$$

$$I_B = 0,158 \text{ A}$$

$$V = 0,158 (24) \checkmark$$

$$= 3,79 \text{ V} \checkmark$$

(3)

8.1.5 **OPTION 1/OPSIE 1**

The power rating (output voltage) of the bulb is 6 W, 12 V. /Die gloeilamp is gemerk 6W ; 12 V

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

[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 die potensiaalverskil oor gloeilamp C minder is as die benodigde spanning sal die uitset/drywing minder wees.

**OPTION 2/OPSIE 2**

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

The potential difference across light bulb C is less than the operating voltage.

✓ Thus for the same resistance, ✓ brightness decreases.

Die potensiaalverskil oor gloeilamp C is minder as die benodigde potensiaalverskil. Dus vir dieselfde weerstand, sal die helderheid afneem.

**OPTION 3/OPSIE 3**

$$P = I^2 R$$

For a given resistance ✓, power is directly proportional to  $I^2$  Since current decreases ✓, brightness decreases.]

[vir 'n gegewe resistor is drywing direk eweredig aan  $I^2$  Omdat stroom afneem sal die helderheid afneem]

**OPTION 4/OPSIE 4**

$$P = I^2 R$$

In the circuit, the total current in light bulb C is less than the optimum current required (0,5 A). ✓ Thus for the same resistance, ✓ the power will be less ✓ hence brightness will decrease.

In die stroombaan is die totale stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Dus vir dieselfde weerstand, is die drywing minder en die helderheid sal afneem.

**OPTION 5/OPSIE 5**

$$P = IV ✓ \quad [\text{Power is directly proportional/equal to product of } V \text{ and } I. ✓$$

Since current decreases ✓, brightness decreases/

drywing is direk eweredig/gelyk aan produk van V en I. Omdat stroom afneem sal die helderheid afneem]]

OR/OF

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

NOTE: No mark if only equation is given.

(3)



- 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

$$\begin{aligned}
 V_{\text{rms/wgk}} &= \frac{V_{\text{max/maks}}}{\sqrt{2}} \checkmark \\
 &= \frac{312}{\sqrt{2}} \checkmark \\
 &= 220,62 \text{ V} \checkmark
 \end{aligned}$$

(3)

9.4.1

**POSITIVE MARKING FROM 9.3/POSITIEWE NASIEN VANAF 9.3  
OPTION 1/OPSIE 1**

$$\begin{aligned}
 P_{\text{aver / gemid}} &= \frac{V_{\text{rms / wgk}}^2}{R} \checkmark \\
 &= \frac{(220,62)^2}{40} \checkmark \\
 &= 1216,83 \text{ W} \checkmark
 \end{aligned}$$

**POSITIVE MARKING FROM 9.3/POSITIEWE NASIEN VANAF 9.3  
OPTION 2/OPSIE 2**

$$\begin{aligned}
 I_{\text{rms}} &= \frac{V_{\text{rms / wgk}}}{R} \\
 &= \frac{(220,62)}{40} \\
 &= 5,515 \\
 P_{\text{ave}} &= I_{\text{rms}}^2 R \\
 &= (5,515)^2 (40) \checkmark \\
 &= 1216,61 \text{ W} \checkmark
 \end{aligned}$$

OR

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

✓ for any/ vir enige

**OPTION 3/OPSIE 3**

$$I_{\max} = \frac{V_{\max}}{R}$$

$$= \frac{312}{40}$$

$$= 7,80 \text{ A}$$

$$P_{\text{ave}} = \frac{I_{\max} V_{\max}}{2}$$

$$= \frac{(7,8)(312)}{2} \quad \checkmark$$

$$= 1216,80 \text{ W} \quad \checkmark$$

✓ for any/ vir enige

(3)

9.4.2

**OPTION 1/OPSIE 1**

$$I_{\max/\text{maks}} = \frac{V_{\max/\text{maks}}}{R} \quad \checkmark$$

$$= \frac{312}{40} \quad \checkmark$$

$$= 7,8 \text{ A} \quad \checkmark$$

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**

$$P_{\text{ave/gemid}} = V_{\text{rms/wgk}} I_{\text{rms/wgk}}$$

$$1\,216,83 = 220,62 I_{\text{rms/wgk}} \quad \checkmark$$

$$I_{\text{rms/wgk}} = 5,515 \text{ A}$$

$$I_{\text{rms/wgk}} = \frac{I_{\max/\text{maks}}}{\sqrt{2}}$$

$$5,515 = \frac{I_{\max/\text{maks}}}{\sqrt{2}} \quad \checkmark$$

$$I_{\max/\text{maks}} = 7,8 \text{ A} \quad \checkmark$$

✓ for any/ vir enige

**OPTION 3/OPSIE 3**

$$P_{\text{ave/gemid}} = I_{\text{rms/wgk}}^2 R$$

$$1\,216,83 = I_{\text{rms/wgk}}^2 (40) \quad \checkmark$$

$$I_{\text{rms/wgk}} = 5,515 \text{ A}$$

$$I_{\text{rms/wgk}} = \frac{I_{\max/\text{maks}}}{\sqrt{2}}$$

$$5,515 = \frac{I_{\max/\text{maks}}}{\sqrt{2}} \quad \checkmark$$

$$I_{\max/\text{maks}} = 7,8 \text{ A} \quad \checkmark$$

✓ 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

<b>OPTION 1/OPSIE 1</b>	<b>OPTION 2/OPSIE 2</b>
$E = h \frac{c}{\lambda} \checkmark$ $= \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{5 \times 10^{-7}} \checkmark$ $= 3,98 \times 10^{-19} \text{ J} \checkmark$	$c = f\lambda$ $3 \times 10^8 = f(5 \times 10^{-7})$ $f = 6 \times 10^{14} \text{ Hz}$ $E = hf$ $= (6,63 \times 10^{-34})(6 \times 10^{14}) \checkmark$ $= 3,98 \times 10^{-19} \text{ J} \checkmark$
<div style="border: 1px solid black; padding: 5px; display: inline-block;">✓ Both equations Beide vergelykings</div>	
<b>NOTE:</b> do not penalise if $v$ is used in place of $c$ .	

(3)

10.3

**OPTION 1/OPSIE 2**  
**POSITIVE MARKING FROM QUESTION 10.2/POSITIEWE NASIEN VANAF VRAAG 10.2**

$$E = W_0 + E_{k\max}$$

$$hf = W_0 + \frac{1}{2}mv_{\max}^2$$

$$h \frac{c}{\lambda} = W_0 + E_{K(\max/\text{maks})}$$

$$h \frac{c}{\lambda} = hf_0 + E_{K(\max/\text{maks})}$$

$$\underline{3,98 \times 10^{-19} = (6,63 \times 10^{-34})(5,55 \times 10^{14}) + E_{K(\max/\text{maks})}} \checkmark$$

$$E_{K(\max/\text{maks})} = 3,0 \times 10^{-20} \text{ J} \checkmark$$

$$E_{K(\max/\text{maks})} > 0 \checkmark$$

1 mark any one/1 punt vir enige

(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**

$$W_0 = hf_0 \checkmark$$

$$= (6,63 \times 10^{-34})(5,55 \times 10^{14}) \checkmark$$

$$= 3,68 \times 10^{-19} \text{ J}$$

$$E_{\text{photon}} > W_0 \checkmark$$

(The energy of the incident photon is greater than the work function of potassium. From the equation  $hf = W_0 + E_{K_{\text{max}}}$ , the ejected photoelectrons will move between the plates,  $\checkmark$  hence the ammeter registers a reading.

*Die energie van die invallende foton is hoër as die arbeidsfunksie van kalium. Vanaf die vergelyking  $hf = hf_0 + E_{K(\text{maks})}$ , sal die vrygestelde foto-elektrone tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing.)*

**OPTION 3/OPSIE 3**

$$c = f\lambda \checkmark$$

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

$$f = 6 \times 10^{14} \text{ Hz}$$

$$f > f_0 \checkmark$$

The frequency of the incident photon is higher than the threshold frequency. From the equation  $hf = hf_0 + E_{K(\text{maks})}$ , the ejected photoelectrons will be able to move between the plates  $\checkmark$  (for the given frequency), hence the ammeter registers a reading.

*Die frekwensie van die invallende foton is hoër as die drumpelfrekwensie. Vanaf die vergelyking  $hf = hf_0 + E_{K(\text{maks})}$ , sal die vrygestelde foto-elektrone tussen die plate kan beweeg en gevolglik registreer die ammeter 'n lesing.)*

10.4

The increase in intensity increases the number of photons per second.  $\checkmark$   
*Soos die intensiteit toeneem, neem die aantal fotone per sekonde toe.*

Since each photon releases one electron  $\checkmark$  the number of ejected electrons per second increases.  $\checkmark$

*Aangesien elke foton een elektron vrystel, neem die aantal vrygestelde elektrone per sekonde toe.*

ACCEPT: Flow of electrons per unit time increases  $\checkmark$  (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.*

(4)

(3)  
[12]**TOTAL/TOTAAL:****150**