



basic education

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)**

2022

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 | B ✓✓ | (2) |
| 1.2 | B ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | A ✓✓ | (2) |
| 1.5 | D ✓✓ | (2) |
| 1.6 | C ✓✓ | (2) |
| 1.7 | D ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | A ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | [20] |

QUESTION 2/VRAAG 2

2.1

Marking criteria/Nasienkriteria:
 If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
*Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per word/frase.*

A body will remain in its state of rest or motion at constant velocity unless a (non-zero) resultant/net force/unbalanced force acts on it. ✓✓

'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.

OR/OF

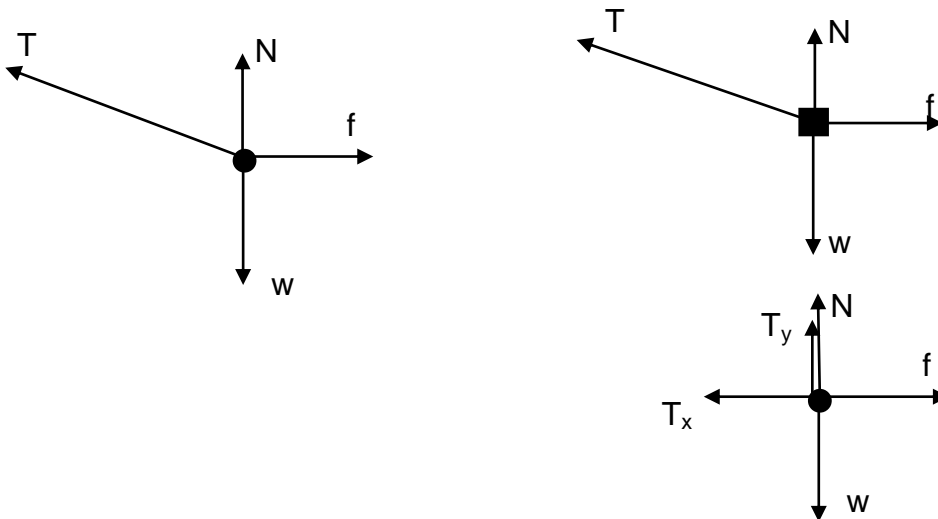
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net force acts on it. ✓✓

'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto krag daarop inwerk.

(2)

2.2

ACCEPT/AANVAAR



	Accepted symbols/Aanvaarde simbole
N ✓	F_N /Normal/Normal force/Normaal/Normaalkrag/ F_{buoyant}
f ✓	F_f/f_k /frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag/300 N
w ✓	F_g/mg /Weight/Gewig/ $F_{\text{Earth on man}}$ / $F_{\text{Aarde op man}}$ / F_w /Gravitational force/Gravitasiekrag/686 N
T ✓	Tension/Spanning/ F_{Tension} / F_{Spanning} / F_T / F_S / ACCEPT/ AANVAAR F/F_{applied} / F_{toegepas}

Notes/Aantekeninge

- Mark is awarded for label and arrow./Punt word toegeken vir byskrif en pyltjie.
- Do not penalise for length of arrows./Moenie vir die lengte van die pyltjies penaliseer nie.
- Deduct 1 mark for any additional force /Trek 1 punt af vir enige addisionele krag
- If T is not shown but T_y and T_x are shown give 1 mark for both.
Indien T nie aangetoon is nie maar T_y en T_x is getoon, ken 1 punt toe vir beide.

(4)

2.3

<p>OPTION 1/OPSIE 1</p> $F_{\text{net}} = ma$ $T \cos 50^\circ - F_f = ma \quad \left. \vphantom{\begin{matrix} F_{\text{net}} = ma \\ T \cos 50^\circ - F_f = ma \end{matrix}} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{T \cos 50^\circ - 300} \checkmark = 0 \checkmark \quad \text{OR/OF} \quad \underline{T \cos 50^\circ = 300} \checkmark \checkmark$ $T = 466,72 \text{ N} \checkmark (468,75 \text{ N})$	<p>OR/OF</p> $F_{\text{net}} = 0 \checkmark \checkmark$ $T \cos 50^\circ = F_f \checkmark \checkmark$
<p>OPTION 2/OPSIE 2</p> $W_{\text{net}} = \Delta E_k \checkmark$ $\underline{T \Delta x \cos 0^\circ + f \Delta x \cos 180^\circ} = 0 \checkmark$ $\underline{T \cos 50^\circ - 300} \checkmark = 0$ $T = 466,72 \text{ N} \checkmark (468,75 \text{ N})$	<p>OR/OF</p> $W_{\text{net}} = 0 \checkmark \checkmark$ $\underline{T \Delta x \cos 50^\circ = -f \Delta x \cos 180^\circ} \checkmark \checkmark$
<p>NOTE/AANTEKENING</p> <p>Can use $\sin 40^\circ$ instead of $\cos 50^\circ$. <i>Kan ook $\sin 40^\circ$ i.p.v. $\cos 50^\circ$ gebruik.</i></p>	

(4)

2.4 Increases/Neem toe \checkmark

F_{net} increases / F_{net} is not zero / $T_x > f$ / $\underline{T \cos 50^\circ} > f \checkmark$
 F_{net} neem toe / F_{net} is nie nul nie / $T_x > f$ / $\underline{T \cos 50^\circ} > f$

(2)

2.5

<p>Marking criteria Options 1 & 2/Nasienkriteria Opsies 1 & 2</p> <ul style="list-style-type: none"> • Substitution to calculate a/Vervanging om a te bereken \checkmark • Formula to calculate $F_{\text{up/water}}$/Formule om $F_{\text{op/water}}$ te bereken \checkmark • Substitution to calculate $F_{\text{up/water}}$/Vervanging om $F_{\text{op/water}}$ te bereken $\checkmark \checkmark$ • Final answer/Finale antwoord: 679,20 N \checkmark 	
<p>OPTION 1/OPSIE 1</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF:</p> $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{0 = (16)^2 + 2a(0,8)} \checkmark$ $a = -160 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ $F_g - F_{\text{up/op}} = ma \quad \left. \vphantom{\begin{matrix} F_{\text{net}} = ma \\ F_g - F_{\text{up/op}} = ma \end{matrix}} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{(4)(9,8) - F_{\text{up/op}}} \checkmark = (4)(-160) \checkmark$ $F_{\text{up/op}} = -679,20 \text{ N}$ $F_{\text{up/op}} = 679,20 \text{ N} \checkmark$	<p>UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{0 = (-16)^2 + 2a(-0,8)} \checkmark$ $a = 160 \text{ m}\cdot\text{s}^{-2}$ $F_{\text{net}} = ma$ $-F_g + F_{\text{up/op}} = ma \quad \left. \vphantom{\begin{matrix} F_{\text{net}} = ma \\ -F_g + F_{\text{up/op}} = ma \end{matrix}} \right\} \checkmark \text{ Any one/Enige een}$ $\underline{-(4)(9,8) + F_{\text{up/op}}} \checkmark = (4)(160) \checkmark$ $F_{\text{up/op}} = 679,20 \text{ N} \checkmark$

OPTION 2/OPSIE 2

**DOWNWARDS AS POSITIVE/
 AFWAARTS AS POSITIEF**

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

$$0,8 = \left(\frac{16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

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

$$0 = 16 + a(0,1) \checkmark$$

$$a = -160 \text{ m}\cdot\text{s}^{-2}$$

OR/OF

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

$$0,8 = (16)(0,1) + \frac{1}{2}(a)(0,1)^2 \checkmark$$

$$a = -160 \text{ m}\cdot\text{s}^{-2}$$

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

$$F_g - F_{\text{up/op}} = ma \checkmark \text{ Any one/Enige een}$$

$$(4)(9,8) - F_{\text{up/op}} \checkmark = (4)(-160) \checkmark$$

$$F_{\text{up/op}} = -679,20 \text{ N}$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

**UPWARDS AS POSITIVE/
 OPWAARTS AS POSITIEF**

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

$$-0,8 = \left(\frac{-16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

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

$$0 = -16 + a(0,1) \checkmark$$

$$a = 160 \text{ m}\cdot\text{s}^{-2}$$

OR/OF

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

$$-0,8 = (-16)(0,1) + \frac{1}{2}(a)(0,1)^2 \checkmark$$

$$a = 160 \text{ m}\cdot\text{s}^{-2}$$

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

$$-F_g + F_{\text{up/op}} = ma \checkmark \text{ Any one/Enige een}$$

$$-(4)(9,8) + F_{\text{up/op}} \checkmark = (4)(160) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

USING ENERGY PRINCIPLES/GEbruik VAN ENERGIe BEGINSELS

Marking criteria OPTIONS 3 to 5/Nasienkriteria OPSIES 3 to 5

- Formula / Formule \checkmark
- Substitution / Vervanging $\checkmark\checkmark\checkmark$
- Final answer/Finale antwoord: 679,20 N \checkmark

OPTION 3/OPSIE 3

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

$$F_{\text{net}} \Delta x \cos \theta = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \checkmark \text{ Any one/Enige een}$$

$$(4)(9,8)(0,8) \cos 0^\circ \checkmark + F_{\text{up/op}}(0,8) \cos 180^\circ \checkmark = \frac{1}{2}(4)(0 - 16^2) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

OPTION 4/OPSIE 4

$$W_{\text{nc}} = \Delta K + \Delta U$$

$$F_{\text{up/op}} \Delta x \cos \theta = \frac{1}{2} m (v_f^2 - v_i^2) + mg(h_f - h_i) \checkmark \text{ Any one/Enige een}$$

$$F_{\text{up/op}}(0,8) \cos 180^\circ \checkmark = \frac{1}{2}(4)(0 - 16^2) \checkmark + (4)(9,8)(0 - 0,8) \checkmark$$

$$F_{\text{up/op}} = 679,20 \text{ N} \checkmark$$

OPTION 5/OPSIE 5

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

$$0,8 = \left(\frac{16 + 0}{2} \right) \Delta t$$

$$\Delta t = 0,1 \text{ s}$$

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

$$F_{\text{net}} \Delta t = (p_{\text{tube/band}})_f - (p_{\text{tube/band}})_i$$

$$(F_g - F_{\text{up/op}}) \Delta t = m(v_{\text{tube/band}(f)} - v_{\text{tube/band}(i)})$$

$$[(4)(9,8) - F_{\text{up/op}}](0,1) = (4)(0 - 16)$$

$$F_{\text{up/op}} = 679,20 \text{ N}$$

✓ Any one/Enige een

(5)
 [17]

QUESTION 3/VRAAG 3

3.1

Marking criteria/Nasienkriteria
 If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

An object which has been given an initial velocity and then it moves under the influence of the gravitational force only/ is in free fall. ✓✓
'n Voorwerp waaraan 'n beginsnelheid gegee is en wat dan slegs onder die invloed van die gravitasiekrag beweeg/in vryval is.

(2)

3.2.1

<p>OPTION 1/ OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $0 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓</p>	<p>OPTION 2/ OPSIE 2 Motion from top/Beweging van bo UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-15 = 0 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $15 = 0 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓</p>
<p>OPTION 3/ OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $-15 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 3,06$ s $\Delta t_{up} = 1,53$ s ✓</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f = v_i + a\Delta t$ ✓ $15 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 3,06$ s $\Delta t_{up} = 1,53$ s ✓</p>	<p>OPTION 4/ OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (15)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 3,06$ s $\Delta t_{up} = 1,53$ s ✓</p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (-15)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 3,06$ s $\Delta t_{up} = 1,53$ s ✓</p>

(3)

Marking criteria OPTIONS 5 to 7/Nasienkriteria OPSIES 5 tot 7	
<ul style="list-style-type: none"> Any formula relating Δy and Δt/ OR/OF $F_{\text{net}}\Delta t = m\Delta v$ ✓ Substitution to calculate Δt/ <i>Vervanging om Δt te bereken</i> ✓ Final answer/<i>finale antwoord</i>: 1,53 s ✓ 	
<p>OPTION 5/OPSIE 5</p> $(E_{\text{mech}})_{\text{Top/Bo}} = (E_{\text{mech}})_{30\text{ m}}$ $(E_{\text{P}} + E_{\text{K}})_{\text{Top/Bo}} = (E_{\text{P}} + E_{\text{K}})_{30\text{ m}}$ $(mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} = (mgh + \frac{1}{2}mv^2)_{30\text{ m}}$ $(9,8)h + 0 = 0 + (\frac{1}{2})(15)^2$ $\Delta h = 11,48\text{ m}$	<p>OPTION A/OPSIE A UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $11,48 = (15)\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$
<p>OPTION 6/OPSIE 6</p> $W_{\text{nc}} = \Delta K + \Delta U$ $W_{\text{nc}} = \Delta K + mg(h_f - h_i)$ $0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ $0 = \frac{1}{2}(0 - 15^2) + (9,8)\Delta h$ $\Delta h = 11,48\text{ m}$	<p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF</p> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$ $11,48 = (-15)\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$
<p>OPTION 7/OPSIE 7</p> $W_{\text{net}} = \Delta E_{\text{k}}$ $w\Delta y \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(9,8)\Delta y \cos 180^\circ = 0 - \frac{1}{2}(15)^2$ $\Delta y = 11,48\text{ m}$	<p>OPTION B/OPSIE B</p> $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$ $11,48 = \left(\frac{15 + 0}{2}\right)\Delta t \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$
<p>OPTION 8/OPSIE 8 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$ $\Delta y = \left(\frac{15 + 0}{2}\right)\Delta t$ $\Delta y = 7,5 \Delta t$ $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (15)^2 + 2(-9,8)(7,5\Delta t) \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$ <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF</p> $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $\Delta y = \left(\frac{-15 + 0}{2}\right)\Delta t$ $\Delta y = -7,5\Delta t$ $v_f^2 = v_i^2 + 2a\Delta y \checkmark$ $0 = (-15)^2 + 2(9,8)(-7,5\Delta t) \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$	<p>OPTION 9/OPSIE 9 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF</p> $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ $-(9,8)\Delta t = 0 - 15 \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$ <p>✓ Any one/ <i>Enige een</i></p> <p>DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF</p> $F_{\text{net}}\Delta t = m\Delta v$ $F_{\text{net}}\Delta t = m(v_f - v_i)$ $(9,8)\Delta t = 15 - 0 \checkmark$ $\Delta t = 1,53\text{ s} \checkmark$ <p>✓ Any one/ <i>Enige een</i></p>

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1/ POSITIEWE NASIEN VANAF VRAAG 3.2.1	
Marking criteria/Nasienkriteria <ul style="list-style-type: none"> • Formula to calculate Δy/Formule om Δy te bereken ✓ • Substitution to calculate Δy/Vervanging om Δy te bereken ✓ • Substitution of/Vervanging van 30 m ✓ • Final answer/Finale antwoord: 41,48 m ✓ 	
NOTE/AANTEKENING v_f and v_i can be swapped v_f en v_i kan omgeruil word	
OPTION 1/OPSIE 1 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $= \frac{(15)(1,53) + \frac{1}{2}(-9,8)(1,53)^2}{}$ ✓ $= 11,48 \text{ m}$ Height/hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $= \frac{(-15)(1,53) + \frac{1}{2}(9,8)(1,53)^2}{}$ ✓ $= -11,48 \text{ m}$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓	OPTION 2/OPSIE 2 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (15)^2 + (2)(-9,8)\Delta y$ ✓ $\Delta y = 11,48 \text{ m}$ Height/hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (-15)^2 + (2)(9,8)\Delta y$ ✓ $\Delta y = -11,48 \text{ m}$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓
OPTION 3/OPSIE 3 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $\Delta y = \left(\frac{15+0}{2} \right) (1,53)$ ✓ $= 11,48 \text{ m}$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $\Delta y = \left(\frac{-15+0}{2} \right) (1,53)$ ✓ $= -11,48 \text{ m}$ Height/Hoogte = $11,48 + 30$ ✓ $= 41,48 \text{ m}$ ✓	OPTION 4/OPSIE 4 UPWARDS AS POSITIVE/ OPWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \frac{(-15)^2 + (2)(-9,8)(-30)}{}$ ✓ $v_f = -28,51 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $\frac{(-28,51)^2 = (0)^2 + (2)(-9,8)\Delta y}{}$ ✓ $\Delta y = 41,48 \text{ m}$ Height/Hoogte = 41,48 m ✓ DOWNWARDS AS POSITIVE/ AFWAARTS AS POSITIEF $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \frac{(15)^2 + (2)(9,8)(30)}{}$ ✓ $v_f = 28,51 \text{ m}\cdot\text{s}^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ $\frac{(28,51)^2 = (0)^2 + (2)(9,8)\Delta y}{}$ ✓ $\Delta y = 41,48 \text{ m}$ Height/Hoogte = 41,48 m ✓

<p>OPTION 5/ OPSIE 5</p> $(E_{\text{mech}})_{\text{Top/Bo}} = (E_{\text{mech}})_{30\text{ m}}$ $(E_P + E_K)_{\text{Top/Bo}} = (E_P + E_K)_{30\text{ m}}$ $(mgh + \frac{1}{2}mv^2)_{\text{Top/Bo}} = (mgh + \frac{1}{2}mv^2)_{30\text{ m}}$ $(9,8)h + 0 = (9,8)(30) + (\frac{1}{2})(15)^2$ $h = 41,48\text{ m}$	<p>✓ Any one/Enige een</p>
<p>OPTION 6/OPSIE 6</p> $W_{\text{net}} = \Delta E_k$ $w\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ $(9,8)(\Delta x)\cos 180^\circ = \frac{1}{2}(0 - 15^2)$ $\Delta x = 11,47\text{ m}$ <p>Height above the ground/hoogte bokant grond = <u>30</u> + 11,47 = 41,48 m ✓</p>	<p>✓ Any one/Enige een</p>
<p>OPTION 7/OPSIE 7</p> $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ $0 = (9,8)(h_f - 0) + \frac{1}{2}(0 - 15^2)$ $h = 11,47\text{ m}$ <p>Height above the ground/hoogte bokant grond = <u>30</u> + 11,47 = 41,48 m ✓</p>	<p>✓ Any one/Enige een</p>

(4)

3.3

<p>POSITIVE MARKING FROM QUESTION 3.2.2/ POSITIEWE NASIEN VANAF VRAAG 3.2.2</p> <p>Marking criteria/Nasienkriteria</p> <ul style="list-style-type: none"> • Formula/Formule ✓ • Substitute to calculate Δy_B / Vervang om Δy_B te bereken ✓ • Substitute to calculate Δy_C / Vervang om Δy_C te bereken ✓ • Substitute/Vervang $\Delta t + 0,5$ or/of $\Delta t - 0,5$ ✓ • Equating y_B and y_C ✓ • Final answer/Finale antwoord: 1,71 s ✓
<p>OPTION 1/OPSIE 1</p> <p>UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF</p> <p>Take y_C as height of disc above ground at meeting point / neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt.</p> $\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $y_C - 30 = \underline{15\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ $y_C = 15\Delta t - 4,9\Delta t^2 + 30 \dots (1)$ <p>Take y_B as height of ball above ground at meeting point/Neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt.</p> $\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $y_B - 0 = \underline{40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2}$ $y_B = 44,9t - 21,225 - 4,9t^2 \dots (2)$ <p>At meeting point/By ontmoetingspunt.</p> $y_C = y_B$ $\underline{15\Delta t - 4,9\Delta t^2 + 30 = 44,9t - 21,225 - 4,9t^2}$ $\Delta t = 1,71\text{ s}$

**DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF**

Take y_C as height of disc above ground at meeting point/*neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt.*

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

$$y_C - 30 = \frac{-15 \Delta t + \frac{1}{2}(9,8) \Delta t^2}{\Delta t} \checkmark$$

$$y_C = -15 \Delta t + 4,9 \Delta t^2 + 30 \dots (1)$$

Take y_B as height of ball above ground at meeting point/*neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt.*

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

$$y_B - 0 = \frac{-40(\Delta t - 0,5) + \frac{1}{2}(9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

$$y_B = -44,9t + 21,225 + 4,9t^2 \dots (2)$$

At meeting point/*By ontmoetingspunt.*

$$y_C = y_B \therefore \frac{-15 \Delta t + 4,9 \Delta t^2 + 30}{\Delta t} = \frac{-44,9t + 21,225 + 4,9t^2}{\Delta t} \checkmark$$
$$\Delta t = 1,71 \text{ s } \checkmark$$

OPTION 2/OPSIE 2

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF:

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

$$= \frac{15 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{\Delta t} \checkmark$$

$$= 15 \Delta t - 4,9 \Delta t^2 \dots (1)$$

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

$$= \frac{40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

Δy_C in terms of/*in terme van Δy_B :*

$$30 + \Delta y_C = 40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2$$

$$\Delta y_C = -4,9 \Delta t^2 + 44,9 \Delta t - 51,225 \dots (2)$$

Equate (1) and (2)/*Stel (1) en (2) gelyk:*

$$\frac{15 \Delta t}{\Delta t} = \frac{44,9 \Delta t - 51,225}{\Delta t} \checkmark$$

$$\Delta t = 1,71 \text{ s } \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF:

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

$$= \frac{-15 \Delta t + \frac{1}{2}(9,8) \Delta t^2}{\Delta t} \checkmark$$

$$= 4,9 \Delta t^2 - 15 \Delta t \dots (1)$$

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

$$= \frac{-40(\Delta t - 0,5) + \frac{1}{2}(9,8)(\Delta t - 0,5)^2}{\Delta t} \checkmark$$

Δy_C in terms of/*in terme van Δy_B :*

$$30 + \Delta y_C = (-40)(t - 0,5) + \frac{1}{2}(9,8)(\Delta t - 0,5)^2$$

$$\Delta y_C = 4,9 \Delta t^2 - 44,9 \Delta t + 51,225 \dots (2)$$

Equate (1) and (2)/*Stel (1) en (2) gelyk:*

$$\frac{-15 \Delta t}{\Delta t} = \frac{-44,9 \Delta t + 51,225}{\Delta t} \checkmark$$

$$\Delta t = 1,71 \text{ s } \checkmark$$

OPTION 3/OPSIE 3

UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{15(\Delta t + 0,5)} + \frac{1}{2}(-9,8)(\Delta t + 0,5)^2 \checkmark \\ &= -4,9t^2 + 10,1\Delta t + 6,275 \dots (1)\end{aligned}$$

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{40\Delta t + \frac{1}{2}(-9,8)\Delta t^2} \checkmark\end{aligned}$$

Δy_C in terms of/in terme van Δy_B :

$$\begin{aligned}30 + \Delta y &= 40\Delta t + \frac{1}{2}(-9,8)t^2 \\ \Delta y &= -4,9\Delta t^2 + 40t - 30 \dots (2)\end{aligned}$$

Equate (1) and (2)/Stel (1) en (2) gelyk:

$$\underline{10,1\Delta t + 6,275 = 40\Delta t - 30} \checkmark$$

$$\Delta t = 1,21 \text{ s}$$

$$\Delta t_{\text{TOT}} = 1,21 + 0,5$$

$$= 1,71 \text{ s} \checkmark$$

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= \underline{-15(\Delta t + 0,5)} + \frac{1}{2}(9,8)(\Delta t + 0,5)^2 \checkmark \\ &= 4,9\Delta t^2 - 10,1\Delta t + 6,275 \dots (1)\end{aligned}$$

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-40\Delta t + \frac{1}{2}(9,8)\Delta t^2} \checkmark\end{aligned}$$

Δy_C in terms of/in terme van Δy_B :

$$\begin{aligned}30 + \Delta y &= -40\Delta t + \frac{1}{2}(9,8)t^2 \\ \Delta y &= -4,9\Delta t^2 - 40\Delta t - 30 \dots (2)\end{aligned}$$

Equate (1) and (2)/Stel (1) en (2) gelyk:

$$\underline{-10,1\Delta t + 6,275 = -40\Delta t - 30} \checkmark$$

$$\Delta t = 1,21 \text{ s}$$

$$\Delta t_{\text{TOT}} = 1,21 + 0,5$$

$$= 1,71 \text{ s} \checkmark$$

OPTION 4/OPSIE 4	
<p>Marking criteria:</p> <ul style="list-style-type: none"> • Formula: $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ • Substitute to calculate Δy_B ✓ • Substitute to calculate Δy_C ✓ • Substitute $\Delta t = 0,5$ ✓ • Adding Δy_B and Δy_C ✓ • Final answer: 1,71 s ✓ 	<p>Nasienkriteria:</p> <ul style="list-style-type: none"> • Formule: $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ • Vervang om Δy_B te bereken ✓ • Vervang om Δy_C te bereken ✓ • Vervang $\Delta t = 0,5$ ✓ • Som van Δy_B en Δy_C ✓ • Finale antwoord: 1,71 s ✓
<p>UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF</p> <p>Displacement of C after 0,5 s/Verplasing van C na 0,5 s</p> $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= 15(0,5) + \frac{1}{2}(-9,8)(0,5)^2$ $\Delta y_C = 6,28 \text{ m}$ <p>Velocity of C after 0,5 s/ Snelheid van C na 0,5 s</p> $v_f = v_i + a \Delta t$ $= 15 + (-9,8)(0,5)$ $= 10,10 \text{ m} \cdot \text{s}^{-1}$ <p>Displacement of C at meeting point/Verplasing van C by ontmoetingspunt</p> $\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= \frac{10,1 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{}$ $= 10,1 \Delta t - 4,9 \Delta t^2$ <p>Displacement of B at meeting point/Verplasing van B by ontmoetingspunt</p> $\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= \frac{40 \Delta t + \frac{1}{2}(-9,8) \Delta t^2}{}$ $= 40t - 4,9t^2$ <p>At meeting point/By ontmoetingspunt:</p> $\Delta y_C + \Delta y_B = -[10,1 \Delta t - 4,9 \Delta t^2] + 40 \Delta t - 4,9 \Delta t^2$ $36,28 = -10,10 \Delta t + 40 \Delta t$ $\Delta t = 1,21 \text{ s}$ $\Delta t_{\text{tot}} = 1,21 + 0,5 = 1,71 \text{ s} \checkmark$	

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF

Displacement of C after 0,5 s/Verplasing van C na 0,5 s

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark \\ &= -15(0,5) + \frac{1}{2}(9,8)(\underline{0,5})^2 \\ \Delta y_C &= -6,28 \text{ m}\end{aligned}$$

Velocity of C after 0,5 s/ Snelheid van C na 0,5 s

$$\begin{aligned}v_f &= v_i + a \Delta t \\ &= -15 + (9,8)(0,5) \\ &= -10,10 \text{ m}\cdot\text{s}^{-1}\end{aligned}$$

Displacement of C at meeting point/Verplasing van C by ontmoetingspunt

$$\begin{aligned}\Delta y_C &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-10,1 \Delta t + \frac{1}{2}(9,8) \Delta t^2} \checkmark \\ &= -10,1 \Delta t + 4,9 \Delta t^2\end{aligned}$$

Displacement of B at meeting point/Verplasing van B by ontmoetingspunt

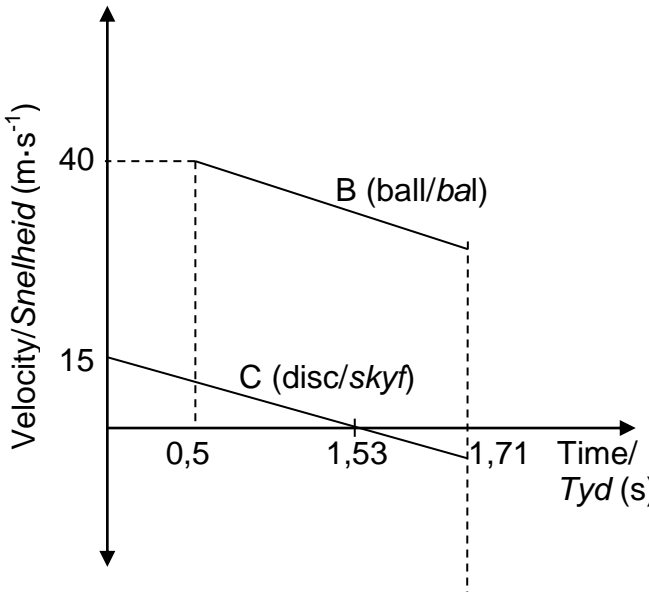
$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= \underline{-40 \Delta t + \frac{1}{2}(9,8) \Delta t^2} \checkmark \\ &= -40t + 4,9t^2\end{aligned}$$

At meeting point/By ontmoetingspunt:

$$\begin{aligned}\underline{\Delta y_C + \Delta y_B} &= \underline{-[-10,1 \Delta t + 4,9 \Delta t^2] - 40 \Delta t + 4,9 \Delta t^2} \checkmark \\ -36,28 &= 10,10 \Delta t - 40 \Delta t \\ \Delta t &= 1,21 \text{ s} \\ \Delta t_{\text{tot}} &= 1,21 + 0,5 = 1,71 \text{ s} \checkmark\end{aligned}$$

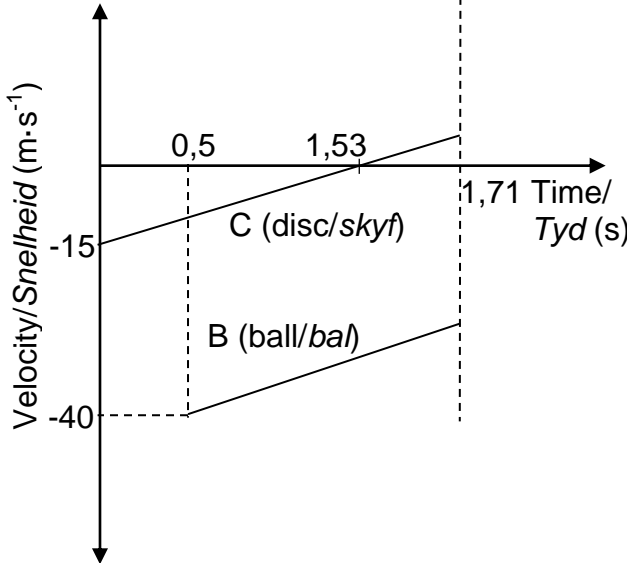
(6)

3.4 **POSITIVE MARKING FROM QUESTIONS 3.2.1 AND 3.3 /
 POSITIEWE NASIEN VANAF VRAE 3.2.1 EN 3.3.
 UPWARDS AS POSITIVE/OPWAARTS AS POSITIEF**



- Marking criteria:**
- Initial velocities 40 and 15 and straight lines ✓
 - B starting at 0,5 s ✓
 - Parallel lines with negative gradient ✓
 - Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
 - Time at which B hits C (answer from 3.3) 1,71 s ✓
- Nasienkriteria:**
- Aanvanklike snelhede 40 en 15 en reguitlyne ✓
 - B begin by 0,5 s ✓
 - Parallele lyne met negatiewe gradiënt ✓
 - Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1) 1,53 s ✓
 - Tyd wanneer B vir C tref (antwoord van 3.3) 1,71s ✓

DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF



- Marking criteria:**
- Initial velocities -40 and -15 and straight lines ✓
 - B starting at 0,5 s ✓
 - Parallel lines with positive gradient ✓
 - Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
 - Time at which B hits C (answer from 3.3) 1,71 s ✓
- Nasienkriteria:**
- Aanvanklike snelhede -40 en -15 en reguitlyne ✓
 - B begin by 0,5 s ✓
 - Parallele lyne met positiewe gradiënt ✓
 - Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1) 1,53 s ✓
 - Tyd wanneer B vir C tref (antwoord van 3.3) 1,71s ✓

(5)
 [20]

QUESTION 4 / VRAAG 4

- 4.1 A system on which the resultant/net external force is zero. /'n Sisteem waarop die resultante/netto eksterne krag nul is. ✓✓ (2 or/of 0) (2)
- 4.2 1. According to Newton 3rd Law ✓ the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓
- OR
2. The toy cart exerts a force on the rocket to the right ✓ and the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓
- OR
3. The rocket experiences a change in momentum to the right ✓, the toy cart experiences a change in momentum to the left. ✓
- OR
4. $\Delta p_{\text{toy cart}} = -\Delta p_{\text{rocket}}$ ✓✓
- OR
5. Total momentum is conserved / remains constant. ✓
The momentum of the rocket increases. Therefore, the momentum of the toy cart must decrease. ✓
- OR
6. The rocket experiences an impulse to the right ✓ therefore, the toy cart experiences an impulse to the left. ✓
- OR
7. $\text{Impulse}_{\text{rocket}} = -\text{Impulse}_{\text{toy cart}}$ ✓✓
1. Volgens Newton se derde wet ✓ oefen die vuurpyl 'n krag op die speelgoedwaentjie na links uit/ teen die bewegingsrigting. ✓
- OF
2. Die speelgoedwaentjie oefen 'n krag op die vuurpyl na regs ✓ en die vuurpyl oefen 'n krag op die speelgoedwaentjie na links/teen die bewegingsrigting ✓.
- OF
3. Die vuurpyl ondervind 'n verandering in momentum na regs ✓, die speelgoedwaentjie ondervind 'n verandering in momentum na links. ✓
- OF
4. $\Delta p_{\text{speelgoedwaentjie}} = -\Delta p_{\text{vuurpyl}}$
- OF
5. Totale momentum bly behoue. ✓
Die momentum van die vuurpyl neem toe. Dus moet die momentum van die speelgoedwaentjie af neem. ✓
- OF
6. Die vuurpyl ondervind 'n impuls na regs ✓ dus ondervind die speelgoedwaentjie 'n impuls na links. ✓
- OF
7. $\text{Impuls}_{\text{vuurpyl}} = -\text{Impuls}_{\text{speelgoedwaentjie}}$ ✓✓ (2)

4.3

<p>OPTION 1/OPSIE 1 RIGHT AS POSITIVE/REGS AS POSITIEF</p> $\left. \begin{aligned} \sum p_i &= \sum p_f \\ (m_1 + m_2)v_i &= m_1v_{1f} + m_2v_{2f} \\ mv_i &= m_1v_{1f} + m_2v_{2f} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $(20 + m_2)2,5 \checkmark = 20(0,6) \checkmark + m_2(30) \checkmark$ $m_2 = 1,38 \text{ kg} \checkmark$
<p>LEFT AS POSITIVE/LINKS AS POSITIEF</p> $\left. \begin{aligned} \sum p_i &= \sum p_f \\ (m_1 + m_2)v_i &= m_1v_{1f} + m_2v_{2f} \\ mv_i &= m_1v_{1f} + m_2v_{2f} \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $(20 + m_2)(-2,5) \checkmark = 20(-0,6) \checkmark + m_2(-30) \checkmark$ $m_2 = 1,38 \text{ kg} \checkmark$
<p>OPTION 2/OPSIE 2 RIGHT AS POSITIVE/REGS AS POSITIEF</p> $\left. \begin{aligned} \Delta p_{\text{toy cart/speelgoedwaentjie}} &= -\Delta p_{\text{rocket/vuurpyl}} \\ m_1(v_{1(f)} - v_{1(i)}) &= -m_2(v_{2(f)} - v_{2(i)}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $(20) \checkmark (0,6 - 2,5) \checkmark = - (m)(30 - 2,5) \checkmark$ $m_2 = 1,38 \text{ kg} \checkmark$
<p>LEFT AS POSITIVE/LINKS AS POSITIEF</p> $\left. \begin{aligned} \Delta p_{\text{toy cart/speelgoedwaentjie}} &= -\Delta p_{\text{rocket/vuurpyl}} \\ m_1(v_{1(f)} - v_{1(i)}) &= -m_2(v_{2(f)} - v_{2(i)}) \end{aligned} \right\} \checkmark \text{ Any one/Enige een}$ $(20) \checkmark [-0,6 - (-2,5)] \checkmark = - (m)[-30 - (-2,5)] \checkmark$ $m_2 = 1,38 \text{ kg} \checkmark$

(5)
 [9]

QUESTION 5/VRAAG 5

5.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 punt per word/frase.

The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓

Die netto/totale arbeid op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.

OR/OF

The work done on an object by a net force is equal to the change in the object's kinetic energy.

Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

5.2

F_{net} opposite to direction of displacement Δx . ✓ / Both frictional force and gravitational force are in opposite direction of displacement Δx .

F_{net} teenoorgesteld tot rigting van verplasing Δx . / Beide wrywingskrag en gravitasie krag is teenoorgesteld tot die verplasing Δx .

OR/OF

ΔK is negative. / The final K is zero. / E_k decreases.

ΔK is negatief. / Die finale K is nul. / E_k neem af.

OR/OF

$W_{net} = F_{net} \Delta x \cos \theta$ and/en $\theta = 180^\circ / \cos \theta = -1$

(1)

5.3

OPTION 1/OPSIE 1

$$\begin{aligned}
 W_{net} &= \Delta K \\
 W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 mgsin\theta\Delta x \cos\theta + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2
 \end{aligned}
 \left. \vphantom{\begin{aligned} W_{net} &= \Delta K \\ W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ mgsin\theta\Delta x \cos\theta + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned}} \right\} \checkmark \text{ Any one/Enige een}$$

$$\begin{aligned}
 (30\,000)(9,8)\sin 28^\circ \Delta x \cos 180^\circ \checkmark + (31\,000)\Delta x \cos 180^\circ \checkmark \\
 = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark \\
 \Delta x = 96,64 \text{ m } \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 W_{nc} &= \Delta K + \Delta U \\
 W_f &= \Delta K + mg(h_f - h_i) \\
 f\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i
 \end{aligned}
 \left. \vphantom{\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_f &= \Delta K + mg(h_f - h_i) \\ f\Delta x \cos\theta &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \end{aligned}} \right\} \checkmark \text{ Any one/Enige een}$$

$$\begin{aligned}
 31\,000\Delta x \cos 180^\circ \checkmark = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark + 30\,000(9,8)(\Delta x \sin 28^\circ - 0) \checkmark \\
 \Delta x = 96,64 \text{ m } \checkmark
 \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}
 W_{net} &= \Delta K \\
 W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 -\Delta E_p + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 -mg(h_f - h_i) + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2
 \end{aligned}
 \left. \vphantom{\begin{aligned} W_{net} &= \Delta K \\ W_w + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ -\Delta E_p + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ -mg(h_f - h_i) + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned}} \right\} \checkmark \text{ Any one/Enige}$$

$$\begin{aligned}
 -(30\,000)(9,8)(\Delta x \sin 28^\circ - 0) \checkmark + (31\,000)\Delta x \cos 180^\circ \checkmark = \frac{1}{2}(30\,000)(0^2 - 33^2) \checkmark \\
 \Delta x = 96,64 \text{ m } \checkmark
 \end{aligned}$$

<p>OPTION 4/OPSIE 4</p> $W_{\text{net}} = \Delta K$ $W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $mg\Delta x \cos\theta + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(30\,000)(9,8)\Delta x \cos 118^\circ + (31\,000)\Delta x \cos 180^\circ = \frac{1}{2}(30\,000)(0^2 - 33^2)$ $\Delta x = 96,64 \text{ m}$	<p>} ✓ Any one/Enige</p>
<p>OPTION 5/OPSIE 5</p> $F_{\text{net}} = ma$ $F_{\text{net}} = F_{w//} + f$ $= (30\,000)(9,8)\sin 28^\circ + 31\,000$ $= 169\,024,64 \text{ N}$ $W_{\text{net}} = \Delta E_k$ $F_{\text{net}}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $169\,024,64\Delta x \cos 180^\circ = \frac{1}{2}(30\,000)(0^2 - 33^2)$ $\Delta x = 96,64 \text{ m}$	<p>} ✓ Any one/Enige een</p>

(5)

5.4 Ascending/Opgaande ✓

1. Ascending/Opgaande: $F_{\text{net(A)}} = F_{w//} + f$
 Descending/Afgaande: $F_{\text{net(D)}} = F_{w//} - f$
 $F_{\text{net(A)}} > F_{\text{net(D)}}$ ✓

OR/OF

2. Ascending: $F_{w//}$ and f are both acting in the opposite to direction of displacement.
 Descending: only f is acting in the opposite direction of displacement.
 Net force for ascending greater than net force for descending. ✓

*Opgaande: $F_{w//}$ en f werk beide teen die rigting van verplasing.
 Afgaande: slegs f werk teen die rigting van verplasing.
 Die netto krag opgaande is groter as die netto krag afgaande.*

OR/OF

3. Ascending: F_{net} acts opposite to the direction of motion. ✓
 Descending: F_{net} acts downwards in the direction of motion. ✓

*Opgaande: F_{net} werk teen die bewegingsrigting.
 Afgaande: F_{net} werk afwaarts in die bewegingsrigting.*

OR/OF

4. Ascending: $F_{w(//)}$ acts opposite to the direction of motion
 Descending: $F_{w(//)}$ acts downwards in the direction of motion
 Net force for ascending greater than net force for descending. ✓

*Opgaande: $F_{w(//)}$ werk teen die bewegingsrigting.
 Afgaande: $F_{w(//)}$ werk afwaarts in die bewegingsrigting.
 Die netto krag opgaande is groter as die netto krag afgaande.*

(3)
 [11]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienkriteria

If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.

Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

The (apparent) 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 propagation. ✓✓

Die (skynbare) 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 as a result of the relative motion between a source and an observer/listener.

'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/ luisteraar.

(2)

6.2

$$v = f\lambda \checkmark$$

$$340 = (880)\lambda \checkmark$$

$$\lambda = 0,39 \text{ m } (0,386) \checkmark$$

(3)

6.3

OPTION 1/OPSIE 1

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S \checkmark \quad \text{OR/OF} \quad f_L = \frac{v + v_L}{v} f_S$$

$$f_L = \frac{340 + 10}{340} 880 \checkmark$$

$$f_L = 905,88 \text{ Hz} \checkmark$$

POSITIVE MARKING FROM QUESTION 6.2/

POSITIEWE NASIEN VANAF VRAAG 6.2

OPTION 2/OPSIE 2

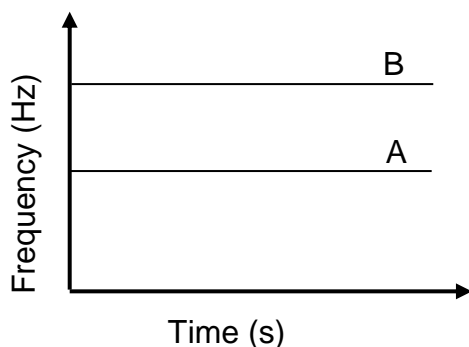
$$v = f\lambda \checkmark$$

$$340 + 10 \checkmark = f_L(0,39) \checkmark$$

$$f_L = 897,44 \text{ Hz} \checkmark$$

(4)

6.4



Marking criteria/Nasienkriteria

B parallel with A and above A. ✓✓

B parallel aan A en bokant A. **2 or/of 0**

(2)

[11]

QUESTION 7/VRAAG 7

7.1.1

Marking criteria/Nasienkriteria:

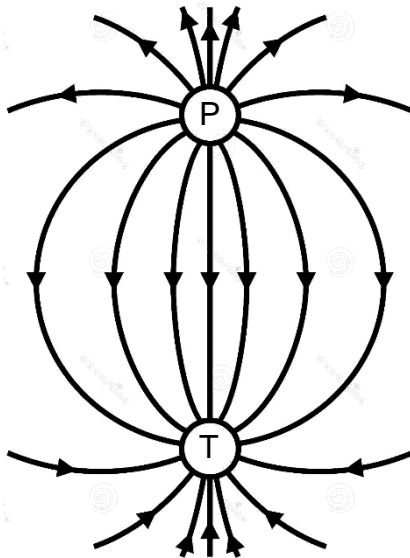
If any of the underlined key words/phrases in the correct context are omitted:
 - 1 mark per word/phrase.
 Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
 1 punt per word/frase.

The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes) of the charges ✓ and inversely proportional to the square of the distance (r) between them. ✓

Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.1.2



Criteria for graph/Kriteria vir grafiek:	
Correct shape Korrekte vorm	✓
Correct direction from P to T. Korrekte rigting van P na T.	✓
Lines must not cross and must touch spheres. Lyne mag nie kruis nie en moet die sferes raak.	✓
NOTE/AANTEKENING: If the net electric field pattern is drawn for two like charges: Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is:	0/3

(3)

7.1.3 positive/ positief ✓

(1)

7.1.4

Marking criteria/Nasienkriteria

- Equation for Coulomb's law./Vergelyking vir Coulomb se wet. ✓
- Correct substitution into Coulomb's equation for for F_{TP} . ✓
 Korrekte vervanging in Coulomb se vergelyking vir F_{TP} .
- Correct substitution into Coulomb's equation for F_{TS} . ✓
 Korrekte vervanging in Coulomb se vergelyking vir F_{TS} .
- Correct substitution into resultant force equation (Pythagoras equation). ✓
 Korrekte vervanging in resultante krag vergelyking (Pythagoras vergelyking).
- Substitute into $Q = ne$. /Vervang in $Q = ne$. ✓
- Final answer/Finale antwoord: $3,05 \times 10^{13}$ ✓

$$F_{\text{net}}^2 = F_{TP}^2 + F_{TS}^2$$

$$= \left(\frac{kQ_1 Q_2}{r^2} \right)^2 + \left(\frac{kQ_1 Q_2}{r^2} \right)^2$$

$$10^2 = \left(\frac{(9 \times 10^9)(3 \times 10^{-6})(3 \times 10^{-6})}{0,1^2} \right)^2 + \left(\frac{(9 \times 10^9)(3 \times 10^{-6})Q_2}{0,15^2} \right)^2$$

$$Q_S = 4,887 \times 10^{-6} \text{ C}$$

$$\downarrow Q_S = ne$$

$$\frac{4,887 \times 10^{-6}}{1,6 \times 10^{-19}} = n \quad n = 3,05 \times 10^{13} \text{ electrons/elektrone}$$

(6)

7.2.1 E is directly proportional to $\frac{1}{r^2}$. /E is direk eweredig aan $\frac{1}{r^2}$. ✓

OR/OF

$$E \propto \frac{1}{r^2}$$

(1)

7.2.2

$\text{Gradient} = \frac{\Delta E}{\Delta \frac{1}{r^2}}$ $680 \checkmark = \frac{E_A - (0)}{\frac{1}{0,04^2} - (0)} \checkmark$ $E_A = 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$	<p>ACCEPT/AANVAAR</p> $E = \frac{kQ}{r^2} \checkmark$ $E_A = \frac{680}{0,04^2} \checkmark$ $= 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$ <p>OR/OF</p> $y = mx + c / y = mx \checkmark$ $E_A = 680 \checkmark \left(\frac{1}{0,04^2} \right) \checkmark$ $= 4,25 \times 10^5 \text{ N} \cdot \text{C}^{-1} \checkmark$
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(4)

7.2.3 Greater than / Groter as ✓

The gradient is equal to kQ ./The gradient is proportional to Q . ✓
Graph of sphere B has a steeper gradient than graph of sphere A. ✓
*Die gradiënt is gelyk aan kQ ./Die gradiënt is proporsioneel aan Q .
Grafiek vir sfeer B het 'n steiler gradiënt as die grafiek vir sfeer A.*

OR/OF

For the same $\frac{1}{r^2}$, E is greater for sphere B. ✓✓

Vir dieselfde $\frac{1}{r^2}$, is E groter vir sfeer B.

(3)
[20]

QUESTION 8/VRAAG 8

8.1 A conductor (resistor) which obeys Ohm's law./'n Geleier wat Ohm se wet gehoorzaam. ✓✓ (2 or/of 0)

OR/OF

V always directly proportional to I at constant temperature. ✓✓ (2 or/of 0)
 V is altyd direk eweredig aan I by konstante temperatuur.

OR/OF

$\frac{V}{I} = \text{constant} / k / \text{constant at constant temperature}$. ✓✓ (2 or/of 0)

$\frac{V}{I} = \text{konstant} / k / \text{konstant bly by 'n konstante temperatuur}$.

OR/OF

A conductor for which the resistance remains constant at constant temperature when voltage or current change. ✓✓ (2 or/of 0)
'n Geleier waar die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander.

(2)

8.2.1

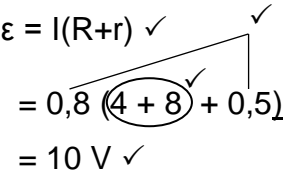
$$R = \frac{V}{I} \checkmark$$

$$4 = \frac{3,2}{I} \checkmark$$

$$I = 0,8 \text{ A} \checkmark$$

(3)

8.2.2

POSITIVE MARKING FROM QUESTION 8.2.1./ POSITIEWE NASIEN VANAF VRAAG 8.2.1.	
OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$\epsilon = I(R+r) \checkmark$  $= 0,8 (4 + 8) + 0,5 \checkmark$ $= 10 \text{ V} \checkmark$ <p>OR/OF</p> $\epsilon = I(R+r) \checkmark$ $= 0,8 (4 + 8) + 0,8 \times 0,5 \checkmark$ $= 10 \text{ V} \checkmark$	$V_8 = IR$ $= (0,8)(8)$ $= 6,4 \text{ V}$ $V_{\text{ext}} = \underline{3,2 + 6,4}$ $= 9,6 \text{ V}$ $V_{\text{int}} = Ir$ $= (0,8)(0,5) \checkmark$ $= 0,4 \text{ V}$ $\epsilon = I(R + r)$ $= V_{\text{ext}} + V_{\text{int}} \checkmark$ $= \underline{9,6 + 0,4} \checkmark$ $= 10 \text{ V} \checkmark$ <p style="text-align: right;">} \checkmark Any one/Enige een</p>

(4)

8.3.1

POSITIVE MARKING FROM QUESTION 8.2.2./ POSITIEWE NASIEN VANAF VRAAG 8.2.2.	
OPTION 1/OPSIE 1	OPTION 2 /OPSIE 2
$V_{\text{int}} = Ir$ $1,2 = I(0,5) \checkmark$ $I = 2,4 \text{ A}$ $R_{\text{ext}} = \frac{V}{I}$ $= \frac{8,8 \checkmark}{2,4 \checkmark}$ $= 3,67 \Omega (3,667)$ $R_p = \frac{12R}{12 + R}$ $3,67 = \frac{12R}{12 + R} \checkmark$ $R = 5,29 \Omega (5,28) \checkmark$ <p>OR/OF</p> $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{3,67} = \frac{1}{R} + \frac{1}{12} \checkmark$ $R = 5,29 \Omega (5,28) \checkmark$	$V_{\text{int}} = 10 - 8,8$ $= 1,2 \text{ V}$ $V_{\text{int}} = Ir$ $1,2 = I(0,5) \checkmark$ $I = 2,4 \text{ A}$ $I_{\text{series branch}} = \frac{V}{R}$ $= \frac{8,8 \checkmark}{8+4}$ $= 0,73 \text{ A} (0,733)$ $I_R = \underline{2,4 - 0,73} \checkmark$ $= 1,67 \text{ A} (1,667)$ $R = \frac{V}{I_R}$ $= \frac{8,8 \checkmark}{1,67 \checkmark}$ $= 5,27 \Omega (5,28) \checkmark$

(5)

8.3.2 There is a short circuit /*Daar is 'n kortsluiting.*

- The resistance of the connected wire is very low. / The total resistance decreases. ✓

Die weerstand van die verbindingsdrade is baie klein. /Die totale weerstand neem af.

- $I \propto \frac{1}{R}$, current delivered by the battery is very high. ✓

$I \propto \frac{1}{R}$, stroom gelewer deur die battery is baie groot.

- Higher current produces more heat. ✓

Hoër stroom produseer meer hitte.

OR/OF

Any one of the following equations can be used to explain the effect of current on heat/*Enigeen van die volgende vergelykings kan gebruik word om die effek van stroom op hitte te verdudidelik:*

$$W = I^2 R \Delta t / W = \frac{V^2}{R} \Delta t / W = VI \Delta t / P = I^2 R / P = \frac{V^2}{R} / P = VI$$

(3)
[17]

QUESTION 9/VRAAG 9

9.1.1 Electrical to mechanical/kinetic/rotational ✓
Elektries na meganies/kineties/rotasie (1)

9.1.2 DC/GS ✓ (1)

9.1.3 Ensures continuous rotation of the coil. ✓
Verseker aanhoudende rotasie van spoel.

OR/OF

Ensures change in direction of the current in the coil. ✓
Verseker verandering van rigting van stroom in spoel. (1)

9.2 **QUESTIONS 9.2.1 AND 9.2.2/VRAE 9.2.1 EN 9.2.2**

Only penalise once if subscripts are omitted.

Penaliseer slegs een keer indien onderskrifte uitgelaat is.

9.2.1

Marking criteria/Nasienkriteria:

- Correct formula to calculate resistance. ✓
Korrekte formule om weerstand te bereken.
- Substitute into formula to calculate resistance. ✓
Vervang in formule of weerstand te bereken.
- Final answer/*Finale antwoord*: 484 to/tot 493,83 Ω ✓

OPTION 1/OPSIE 1

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark$$

$$100 = \frac{220^2}{R} \checkmark$$

$$R = 484 \Omega \checkmark$$

OPTION 2/OPSIE 2

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$100 = 220 I_{\text{rms}}$$

$$I_{\text{rms}} = 0,45 \text{ A (0,455)}$$

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{R} \checkmark$$

$$0,45 = \frac{220}{R} \checkmark$$

$$R = 488,89 \Omega \checkmark$$

OPTION 3/OPSIE 3

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$100 = 220 I_{\text{rms}}$$

$$I_{\text{rms}} = 0,45 \text{ A (0,455)}$$

$$P_{\text{ave}} = I_{\text{rms}}^2 R \checkmark$$

$$100 = (0,45)^2 R \checkmark$$

$$R = 493,83 \Omega \checkmark$$

(3)

9.2.2

**POSITIVE MARKING FROM QUESTION 9.2.1/
 POSITIEWE NASIEN VANAF VRAAG 9.2.1.**

Marking criteria:

- Uses power of Y in circuit (80 W) to calculate I_{rms} of the circuit. ✓
- Determines V_{rms} across R_Z in the circuit. ✓
- Uses I_{rms} and V_{rms} across R_Z in the circuit to calculate resistance R_Z . ✓
- Use of any one relevant power equation. ✓
- Uses R_Z and 220 V to calculate X. ✓
- Final answer for X. ✓

Accept range:

846,07 W to 856,03 W

Nasienriglyne:

- Gebruik drywing van Y in stroombaan (80 W) om I_{wgk} te bereken. ✓
- Bepaal V_{wgk} oor R_Z in die stroombaan. ✓
- Gebruik I_{wgk} en V_{wgk} oor R_Z in die stroombaan om weerstand R_Z te bereken. ✓
- Gebruik van enige drywing-formule. ✓
- Gebruik R_Z en 220 V om X te bereken. ✓
- Finale antwoord vir X. ✓

Aanvaar gebied:

846,07 W tot 856,03 W

For resistor Y/Vir resistor Y

$$P_{ave} = I_{rms}^2 R$$

$$80 = I_{rms}^2 (484) \checkmark$$

$$I_{rms} = 0,407 \text{ A}$$

OR/OF

$$P_{ave} = \frac{V_{rms}^2}{R}$$

$$80 = \frac{V_{rms}^2}{484}$$

$$V_{rms} = 196,77 \text{ V}$$

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

$$= \frac{196,77}{484} \checkmark$$

$$= 0,407 \text{ A}$$

For/Vir Z

$$V_{rms} = 220 - 196,77 \checkmark$$

$$= 23,23 \text{ V}$$

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

$$[0,407 = \frac{23,23}{R}] \checkmark$$

$$R = 57,08 \Omega$$

Range/Gebied:

56,66 Ω to/tot 57,13 Ω

X for Z/X vir Z:

$$X = P_{ave} = \frac{V_{rms}^2}{R} \checkmark$$

$$= \frac{220^2}{57,08} \checkmark$$

$$= 847,93 \text{ W} \checkmark$$

OR/OF

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

$$= \frac{220}{57,08}$$

$$= 3,85 \text{ A}$$

$$X = P_{ave} = I_{rms}^2 R \checkmark$$

$$= (3,85)^2 (57,08) \checkmark$$

$$= 846,07 \text{ W} \checkmark$$

OR/OF

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

$$= \frac{220}{57,08}$$

$$= 3,85 \text{ A}$$

$$X = P_{ave} = V_{rms} I_{rms} \checkmark$$

$$= (220)(3,85) \checkmark$$

$$= 847 \text{ W} \checkmark$$

(6)
 [12]

QUESTION 10/VRAAG 10

10.1.1

Marking criteria/Nasienkriteria:

If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
*Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -
1 punt per woord/frase.*

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

Die proses waartydens elektrone vrygestel word vanaf 'n (metaal) oppervlak wanneer lig van geskikte frekwensie invallend is op die oppervlak.

(2)

10.1.2 For one photon/*Vir een foton:*

$$E = hf \checkmark \\ = (6,63 \times 10^{-34})(1,2 \times 10^{15}) \checkmark \\ = 7,96 \times 10^{-19} \text{ J}$$

NOTE/LET WEL

$$W_0 = hf_0 \checkmark$$

No of e^- = No of photons/*Hoeveelheid fotone*

$$= \frac{\text{Total energy of photons}}{\text{Energy of one photon}} / \frac{\text{Totale energie van fotone}}{\text{Energie van een foton}} \\ = \frac{1,75 \times 10^{-9}}{7,96 \times 10^{-19}} \checkmark \\ = 2,2 \times 10^9 \checkmark (2,198 \times 10^9)$$

(4)

10.1.3 **POSITIVE MARKING FOR E ONLY FROM QUESTION 10.1.2/**
POSITIEWE NASIEN VIR SLEGS E VANAF VRAAG 10.1.2

$$E = W_0 + K_{\max} \left. \vphantom{E = W_0 + K_{\max}} \right\} \checkmark \text{ Any one/Enige een}$$
$$hf = hf_0 + \frac{1}{2}mv_{\max}^2$$

$$7,96 \times 10^{-19} \checkmark = (6,63 \times 10^{-34})(9,09 \times 10^{14}) \checkmark + \frac{1}{2}(9,11 \times 10^{-31})v_{\max}^2 \checkmark \\ v_{\max} = 6,51 \times 10^5 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(5)

10.2 An atom (electron) in higher (excited) energy state/level returns to a lower energy state/level. ✓

Energy is released as light (photons/frequencies of light are released). ✓
'n Atoom (elektron) in 'n hoër (opgewekte) energie toestand/vlak keer terug na 'n laer energievlak (grondvlak).

Energie word vrygestel as lig (fotone/frekwensies van lig word vrygestel).

(2)

[13]

TOTAL/TOTAAL: 150