



# basic education

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

**SENIOR CERTIFICATE/SENIOR SERTIFIKAAT  
NATIONAL SENIOR CERTIFICATE/  
NASIONALE SENIOR SERTIFIKAAT**

**GRADE/GRAAD 12**

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

**NOVEMBER 2020**

**MARKING GUIDELINES/NASIENRIGLYNE**

**MARKS/PUNTE: 150**

**These marking guidelines consist of 19 pages./  
*Hierdie nasienriglyne bestaan uit 19 bladsye.***

**QUESTION 1/VRAAG 1**

- |      |      |             |
|------|------|-------------|
| 1.1  | B ✓✓ | (2)         |
| 1.2  | D ✓✓ | (2)         |
| 1.3  | C ✓✓ | (2)         |
| 1.4  | C ✓✓ | (2)         |
| 1.5  | C ✓✓ | (2)         |
| 1.6  | A ✓✓ | (2)         |
| 1.7  | A ✓✓ | (2)         |
| 1.8  | D ✓✓ | (2)         |
| 1.9  | A ✓✓ | (2)         |
| 1.10 | B ✓✓ | (2)         |
|      |      | <b>[20]</b> |

## QUESTION 2/VRAAG 2

2.1

### Marking criteria/Nasienriglyne

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

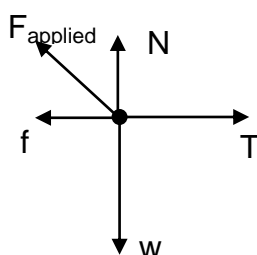
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:  
- 1 punt per woord/frase

The perpendicular force exerted by a surface on an object in contact with the surface. ✓✓

Die loodregte krag deur 'n oppervlak uitgeoefen op 'n voorwerp wat daarmee in kontak is.

(2)

2.2



	Accepted symbols/Aanvaarde simbole
N ✓	$F_N$ /Normal/Normal force/173,5N /Normaal/Normaalkrag
f ✓	$F_f$ / $f_k$ /frictional force/wrywingskrag/kinetic frictional force/kinetiese wrywingskrag/5 N
w ✓	$F_g$ /mg/Weight/ $F_{\text{Earth on block}}$ /Fw/Gewig/Gravitational force/Gravitasiekrag/196 N
T ✓	Tension/Spanning/ $F_T$
$F_{\text{applied}}$ ✓ $F_{\text{toegepas}}$	F/Applied force/35 N/Toegepaste krag/ $F_A$

### 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 all forces are correctly drawn and labelled, but no arrows, deduct 1 mark. / Indien all kragte korrek geteken en benoem is, maar geen lyne nie, trek 1punt af.

(5)

2.3

For the/Vir die 20 kg:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ T - f - F_{Ax} &= ma \end{aligned} \right\} \checkmark$$

$$T - 5 - 35 \cos 40^\circ \checkmark = 0 \checkmark$$

$$T = 31,81 \text{ N}$$

For/vir m:

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ mg - T &= ma \end{aligned} \right\} \checkmark$$

$$m(9,8) - 31,81 \checkmark = 0$$

$$m = 3,25 \text{ kg} \checkmark$$

### Marking criteria/Nasienriglyne

- Formula for 20 kg or m kg/Formule vir 20 kg of m kg /  $F_{\text{net}} = ma$  ✓
- Substitution of zero into either formula ✓  
Vervanging van nul in een van die formules
- All substitutions into  $F_{\text{net}}$  for 20 kg as shown ✓  
Alle vervanging in  $F_{\text{net}}$  for 20 kg soos getoon
- Substitution of value of T in eqn for m  
/Substitusie van waarde vir T in vgl vir m ✓
- Final answer/finale antwoord: 3,25 kg ✓

(5)

2.4.1 Decreases/Neem af ✓

(1)

2.4.2 **POSITIVE MARKING FROM QUESTION 2.3**

**POSITIEWE NASIEN VANAF VRAAG 2.3**

**Moving to the right/Beweeg na regs**

Velocity decreases/snelheid neem af ✓

Accelerates/Net force to left /Versnelling/netto krag na links ✓✓

**OR/OF**

As the tension force decreases, the net force/acceleration acts in the opposite direction of motion /to the left. ✓✓

Soos die spanning afneem, is daar 'n netto krag/versnelling in die teenoorgestelde rigting / na links

**Moving to the left/Beweeg na links**

Velocity increases/snelheid neem toe ✓

Accelerates/Net force to left /Versnelling/netto krag na links ✓✓

(3)  
[16]

**QUESTION 3/VRAAG 3**

- 3.1 (Motion of an object) under the influence of gravity (weight) only. ✓✓ (2 or 0)  
(Beweging van 'n voorwerp) slegs onder die invloed van gravitasie (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.

(2)

- 3.2.1  $\Delta t = 0,67 - 0,64 = 0,03 \text{ s}$  ✓✓

(2)

3.2.2	<b><u>OPTION 1/OPSIE 1</u></b> $\Delta t = \frac{(1,90 - 0,67)}{2}$ ✓ $= 0,62 \text{ s}$ ✓ (0,615 s)	<b><u>OPTION 2/OPSIE 2</u></b> $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $(-1,85) = 0 + \frac{1}{2} (-9,8) \Delta t^2$ ✓ $\Delta t = 0,61 \text{ s}$ ✓ (0,6145 s)
	<b><u>OPTION 3/OPSIE 3</u></b> $\Delta t = \frac{(1,90 + 0,67)}{2} = 1,285 \text{ s}$ $\Delta t = 1,285 - 0,67$ ✓ $= 0,62 \text{ s}$ ✓ (0,615 s)	<b><u>OPTION 4/OPSIE 4</u></b> $v_f^2 = v_i^2 + 2a\Delta x$ $0 = v_i^2 + 2(-9,8)(1,85)$ $v_i = 6,02 \text{ m} \cdot \text{s}^{-1}$ $v_f = v_i + a\Delta t$ $0 = 6,02 + (-9,8)\Delta t$ ✓ $\Delta t = 0,61 \text{ s}$ ✓

(2)

## 3.2.3

**POSITIVE MARKING FROM QUESTION 3.2.2****POSITIEWE NASIEN VANAF VRAAG 3.2.2****Marking Criteria/Nasienriglyne**

- Any appropriate formula/*Enige geskikte formule* ✓
- Correct substitution/*Korrekte vervanging* ✓
- Final answer/*Finale antwoord*: 5,94 to 6,08 m·s<sup>-1</sup> ✓

**OPTION 1/OPSIE 1**Upwards positive/*Opwaarts positief*

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

$$0 = v_i + (-9,8)(0,62) \quad \checkmark$$

$$v_i = 6,08 \text{ m}\cdot\text{s}^{-1} \text{ (6,076 m}\cdot\text{s}^{-1}) \quad \checkmark$$

Downwards positive/*Afwaarts positief*

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

$$0 = v_i + (9,8)(0,62) \quad \checkmark$$

$$v_i = -6,08$$

$$\therefore 6,08 \text{ m}\cdot\text{s}^{-1} \text{ (6,076 m}\cdot\text{s}^{-1}) \quad \checkmark$$

**OPTION 3/OPSIE 3****Motion from top to bottom /****Beweging vanaf bo na onder**Downwards positive/*Afwaarts positief*

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

$$v_f^2 = 0 + 2(9,8)(1,85) \quad \checkmark$$

$$v_f = 6,02 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

$$\text{initial velocity/beginsnelheid} = 6,02 \text{ m}\cdot\text{s}^{-1}$$

Upwards positive/*Opwaarts positief*

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

$$v_f^2 = 0 + 2(-9,8)(-1,85) \quad \checkmark$$

$$v_f = 6,02 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

$$\text{initial velocity/beginsnelheid} = 6,02 \text{ m}\cdot\text{s}^{-1}$$

**Motion from bottom to top****Beweging vanaf onder na bo**Downwards positive/*Afwaarts positief*

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

$$0^2 = v_i^2 + 2(9,8)(-1,85) \quad \checkmark$$

$$v_i = 6,02 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

Upwards positive/*Opwaarts positief*

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

$$0 = v_i^2 + 2(-9,8)(1,85) \quad \checkmark$$

$$v_i = 6,02 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

**OPTION 7/OPSIE 7**

$$(E_p + E_k)_{\text{floor/vloer}} = (E_p + E_k)_{\text{top/bo}} \quad \checkmark$$

$$(mgh + \frac{1}{2}mv^2)_{\text{floor/vloer}} = (mgh + \frac{1}{2}mv^2)_{\text{top/bo}}$$

$$0 + \frac{1}{2}v^2 = (9,8)(1,85) + 0 \quad \checkmark$$

$$v = 6,02 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

**OPTION 2/OPSIE 2**Upwards positive/*Opwaarts positief*

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

$$1,85 = v_i(0,62) + \frac{1}{2}(-9,8)(0,62)^2 \quad \checkmark$$

$$v_i = 6,02 \text{ m}\cdot\text{s}^{-1} \text{ (6,022 m}\cdot\text{s}^{-1}) \quad \checkmark$$

Downwards positive/*Afwaarts positief*

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

$$1,85 = v_i(0,62) + \frac{1}{2}(9,8)(0,62)^2 \quad \checkmark$$

$$v_i = -6,02$$

$$\therefore v_i = 6,02 \text{ m}\cdot\text{s}^{-1} \text{ (6,022 m}\cdot\text{s}^{-1}) \quad \checkmark$$

**OPTION 4/OPSIE 4**Upwards positive/*Opwaarts positief*

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

$$0 = v_i(1,23) + \frac{1}{2}(-9,8)(1,23)^2 \quad \checkmark$$

$$v_i = 6,03 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

Downwards positive/*Afwaarts positief*

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

$$0 = v_i(1,23) + \frac{1}{2}(9,8)(1,23)^2 \quad \checkmark$$

$$v_i = -6,03 \text{ m}\cdot\text{s}^{-1}$$

$$\text{speed/speed} = 6,03 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

**OPTION 5/OPSIE 5**

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

$$1,85 = \left( \frac{0 + v_i}{2} \right) (0,62) \quad \checkmark$$

$$v_i = 5,97 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

**OPTION 6/OPSIE 6**

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

$$F_{\text{net}}\Delta t = m(v_f - v_i) \quad \checkmark$$

$$m(9,8)(0,62) = m(0 - v_i) \quad \checkmark$$

$$v_i = 6,08 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

(3)

## 3.2.4

<b>OPTION/OPSIE 1, 2, 3, 4: Marking criteria/Nasienriglyne</b>	
<b>Calculate initial velocity:</b> <b>Bereken aanvanklike snelheid:</b> <ul style="list-style-type: none"> <li>Appropriate formula/Gesikhte formule ✓</li> <li>Substitution/Vervanging ✓</li> </ul>	<b>Calculate/Bereken <math>\Delta t</math>:</b> <ul style="list-style-type: none"> <li>Appropriate formula/Gesikhte formule ✓</li> <li>Substitution/Vervanging ✓</li> <li><math>1,97 \text{ s} + \Delta t</math> ✓</li> <li>Fin answer/Fin antwoord: <math>2,95 - 2,97 \text{ s}</math> ✓</li> </ul>
<b>Calculate initial velocity:</b> <b>Bereken beginsnelheid</b>	<b>Calculate time <math>\Delta t</math></b> <b>Bereken tyd <math>\Delta t</math></b>
<b>OPTION 1/OPSIE 1</b> Downwards positive/Afwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(9,8)(-1,2)$ ✓ $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$  Upwards positive/Opwaarts positief $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = v_i^2 + 2(-9,8)(1,2)$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$	Upwards positive Opwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ <b>OR/OF</b> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s} \text{ (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ $= 2,96 \text{ s}$ ✓  Downwards positive Afwaarts positief $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,2 = (-4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,4898 \text{ s} / 0,5 \text{ s}$ $t = 1,97 + 2(0,4898)$ ✓ $= 2,95 \text{ s} / 2,97 \text{ s}$ ✓ <b>OR/OF</b> $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (4,85)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 0,9898 \text{ s} \text{ (or } \Delta t = 0)$ $t = 1,97 + 0,9898$ ✓ $= 2,96 \text{ s}$ ✓ <b>OR/OF</b> $v_f = v_i + a\Delta t$ ✓ $-4,85 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,9898 \text{ s}$ $\Delta t = 1,97 + 0,9898$ ✓ $= 2,96 \text{ s}$ ✓ <b>OR/OF</b> Upwards positive Opwaarts positief $v_f = v_i + a\Delta t$ ✓ $0 = 4,85 + (-9,8)\Delta t$ ✓ $\Delta t = 0,4949 \text{ s}$ $\Delta t = 1,97 + (2)(0,4949)$ ✓ $= 2,96 \text{ s}$ ✓ <b>OR/OF</b> $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $1,2 = \left(\frac{0 + 4,85}{2}\right)\Delta t$ ✓ $\Delta t = 0,4948 \text{ s}$ $\Delta t_{\text{total}} = 2(0,4948) = 0,99 \text{ s}$ $\Delta t = 1,97 + 0,99$ ✓ $= 2,96 \text{ s}$ ✓
<b>OPTION 2/OPSIE 2</b> $(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bot/ond}}$ } ✓ Any one/ $(E_p + E_k)_{\text{top}} = (E_p + E_k)_{\text{Bot/Ond}}$ } Enige een $(mgh + \frac{1}{2}mv^2)_{\text{top}} = (mgh + \frac{1}{2}mv^2)_{\text{Bot/Ond}}$ $(9,8)(1,2) + 0 = 0 + \frac{1}{2}v^2$ ✓ $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
<b>OPTION 3/OPSIE 3</b> $W_{\text{nc}} = \Delta E_p + \Delta E_k$ $0 = (0 - mgh) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $0 = -(9,8)(1,2) + \frac{1}{2}v_i^2$ } Enige een $v_i = 4,85 \text{ m}\cdot\text{s}^{-1}$ upwards /opwaarts	
<b>OPTION 4/OPSIE 4</b> $W_{\text{net}} = \Delta E_k$ $w\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any one/ $(9,8)(1,2)\cos 180^\circ = \frac{1}{2}v_i^2$ } Enige een $v_i = -4,85 \text{ m}\cdot\text{s}^{-1}$	

<p><b>OPTION 5/OPSIE 5</b> Downwards positive/Afwaarts positief  <math>\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark</math>  <math>1,2 \checkmark = 0 + \frac{1}{2}(9,8) \Delta t^2 \checkmark</math>  <math>\Delta t = 0,49 \text{ s}</math>  <math>t = 1,97 + \checkmark 2(0,49) \checkmark</math>  <math>= 2,96 \text{ s} \checkmark</math>  Upwards positive/Opwaarts positief  <math>\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark</math>  <math>-1,2 \checkmark = 0 + \frac{1}{2}(-9,8) \Delta t^2 \checkmark</math>  <math>\Delta t = 0,49 \text{ s}</math>  <math>t = 1,97 + \checkmark 2(0,49) \checkmark</math>  <math>= 2,96 \text{ s} \checkmark</math></p>	<p><b>OPTION 5: Marking criteria/OPSIE 5: Nasienriglyne</b></p> <ul style="list-style-type: none"> <li>• Formula <math>\checkmark</math>/Formule</li> <li>• Substitution/Vervanging  <math>\Delta y = 1,2 \checkmark</math></li> <li>• Substitution/Vervanging  <math>0 + \frac{1}{2}(9,8) \Delta t^2</math></li> <li>• <math>1,97 \text{ s} + \checkmark</math></li> <li>• <math>2 \Delta t \checkmark</math></li> <li>• Final answer/Finale antwoord: <math>2,95 - 2,97 \text{ s} \checkmark</math></li> </ul>
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(6)  
[15]

#### QUESTION 4/VRAAG 4

- 4.1 (Linear) momentum (of an object) is the product of mass and velocity.  $\checkmark \checkmark$   
(Liniêre) momentum (van 'n voorwerp) is die produk van massa en snelheid.  
(2 or/of 0)

(2)

4.2.1

<p><b>OPTION 1/OPSIE 1</b> East as positive/Oos as positief  <math>\sum p_i = \sum p_f</math>  <math>m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark</math> Any one/Enige een  <math>(0,16)(10) + (0,2)(-15) \checkmark = (0,16)(-5) + (0,2)v_{Qf} \checkmark</math>  <math>v_{Qf} = -3 \text{ m} \cdot \text{s}^{-1}</math>  <math>v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark</math> west/wes <math>\checkmark</math></p>
<p><b>OPTION 2/OPSIE 2</b> West as positive/Wes as positief  <math>\sum p_i = \sum p_f</math>  <math>m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf} \checkmark</math> Any one/Enige een  <math>(0,16)(-10) + (0,2)(15) \checkmark = (0,16)(5) + (0,2)v_{Qf} \checkmark</math>  <math>v_{Qf} = 3 \text{ m} \cdot \text{s}^{-1} \checkmark</math> west/wes <math>\checkmark</math></p>
<p><b>OPTION 3/OPSIE 3</b>  <math>\Delta p_p = -\Delta p_Q \checkmark</math>  <math>(0,16)(-5 - 10) \checkmark = -(0,2)(v - (-15)) \checkmark</math>  <math>v = -3 \text{ m} \cdot \text{s}^{-1}</math>  <math>= 3 \text{ m} \cdot \text{s}^{-1} \checkmark</math> west/wes <math>\checkmark</math></p>

(5)

4.2.2

<p>For ball/Vir bal P:  West as negative/Wes as negatief  Impulse = <math>\Delta p</math>  <math>F_{\text{net}}\Delta t = \Delta p</math>  <math>\Delta p = m(v_{\text{Pf}} - v_{\text{Pi}})</math>  <math>= 0,16(-5 - 10) \checkmark</math>  <math>= -2,4</math>  <math>\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})</math></p> <p><b>OR/OF</b>  West as positive /Wes as positief  Impulse = <math>\Delta p</math>  <math>F_{\text{net}}\Delta t = \Delta p</math>  <math>= m(v_{\text{Pf}} - v_{\text{Pi}})</math>  <math>= 0,16(5 - (-10)) \checkmark</math>  <math>= 2,4 \text{ N}\cdot\text{s} \checkmark</math></p>	<p><b>POSITIVE MARKING FROM QUESTION 4.2.1 /POSITIEWE NASIEN VANAF VRAAG 4.2.1</b></p> <p>For ball/Vir bal Q:  West as negative/Wes as negatief  Impulse = <math>\Delta p</math>  <math>F_{\text{net}}\Delta t = \Delta p</math>  <math>= m(v_{\text{Qf}} - v_{\text{Qi}})</math>  <math>= 0,2[-3 - (-15)] \checkmark</math>  <math>= 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})</math></p> <p><b>OR/OF</b>  West as positive /Wes as positief  Impulse = <math>\Delta p</math>  <math>F_{\text{net}}\Delta t = \Delta p</math>  <math>= m(v_{\text{Qf}} - v_{\text{Qi}})</math>  <math>= 0,16(3 - (15)) \checkmark</math>  <math>= -2,4 \text{ N}\cdot\text{s}</math>  <math>\therefore 2,4 \text{ N}\cdot\text{s} \checkmark \quad (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})</math></p>
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(3)  
[10]**QUESTION 5/VRAAG 5**

5.1

**Marking criteria/Nasienriglyne**

If any of the underlined key words/phrases in the correct context are omitted:  
- 1 mark per word/phrase. However, **IF**: The word “work” is omitted 0 marks  
*Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:*  
- 1 punt per woord/frase. Maar, **INDIEN**: Die woord “arbeid” uitgelaat is, 0 punte

A force is non-conservative if the work it does on an object (which is moving between two points) depends on the path taken.  $\checkmark\checkmark$

*'n Krag is nie-konserwatief indien die arbeid wat dit verrig (op 'n voorwerp wat tussen twee punte beweeg) afhanklik is van die pad.*

**OR/OF**

A force is non-conservative if the work it does on an object depends on the path taken.  $\checkmark\checkmark$

*'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhanklik is van die pad.*

**OR/OF**

A force is non-conservative if the work it does in moving an object around a closed path is non-zero.  $\checkmark\checkmark$

*'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg, nie-nul is nie.*

(2)

5.2

$$\begin{aligned}
 K &= \frac{1}{2}mv^2 / E_k = \frac{1}{2}mv^2 \\
 \Delta K &= K_f - K_i \\
 \Delta K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 &= \frac{1}{2}m(v_f^2 - v_i^2) \\
 &= \frac{1}{2}(200)(2^2 - 4^2) \checkmark \\
 \Delta K &= -1\,200 \text{ J} \checkmark
 \end{aligned}
 \quad \left. \vphantom{\begin{aligned} K &= \frac{1}{2}mv^2 \\ \Delta K &= K_f - K_i \\ \Delta K &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ &= \frac{1}{2}m(v_f^2 - v_i^2) \\ &= \frac{1}{2}(200)(2^2 - 4^2) \checkmark \\ \Delta K &= -1\,200 \text{ J} \checkmark \end{aligned}} \right\} \checkmark \text{ Any one / Enige een}$$

(3)



5.3

**POSITIVE MARKING FROM QUESTION 5.2.****POSITIEWE NASIEN VANAF VRAAG 5.2.****Marking criteria/Nasienriglyne**

- Appropriate formula/Geskikte formule ✓
- Substitution into appropriate formula together with/Vervanging in geskikte formule saam met  $-3,40 \times 10^3$  ✓✓
- Final answer/Finale antwoord: 8,88 m ✓

**OPTION 1/OPSIE 1**

$$\begin{aligned}
 W_{nc} &= \Delta K + \Delta U \\
 W_{nc} &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \vphantom{\begin{aligned} W_{nc} &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \\ &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \end{aligned}} \right\} \checkmark \text{ Any one/Enige een} \\
 &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\
 -3,40 \times 10^3 \checkmark &= \frac{-1\,200 + 200(9,8)(h_f - 10)}{\quad} \checkmark \\
 h &= 8,88 \text{ m } \checkmark \quad (8,87765 \text{ m})
 \end{aligned}$$

**OPTION 2/OPSIE 2**

$$\begin{aligned}
 E_{(\text{mech/meg})A} + W_f &= E_{(\text{mech})B} \\
 (E_p + E_k)_A + W_f &= (E_p + E_k)_B \quad \left. \vphantom{\begin{aligned} E_{(\text{mech/meg})A} + W_f &= E_{(\text{mech})B} \\ (E_p + E_k)_A + W_f &= (E_p + E_k)_B \end{aligned}} \right\} \checkmark \text{ Any one/Enige een} \\
 (mgh + \frac{1}{2}mv^2)_A + W_f &= (mgh + \frac{1}{2}mv^2)_B \\
 200(9,8)(10) + \frac{1}{2}(200)(4^2) - 3,40 \times 10^3 \checkmark &= 200(9,8)(h) + \frac{1}{2}(200)(2)^2 \checkmark \\
 h &= 8,88 \text{ m } \checkmark \quad (8,87755)
 \end{aligned}$$

**OPTION 3/OPSIE 3**

$$\begin{aligned}
 W_{net} &= \Delta K \\
 W_f + W_w &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\
 W_f - \Delta E_p &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \left. \vphantom{\begin{aligned} W_{net} &= \Delta K \\ W_f + W_w &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \\ W_f - \Delta E_p &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \end{aligned}} \right\} \checkmark \text{ Any one/Enige een} \\
 W_f - mg(h_f - h_i) &= \frac{1}{2}m(v_f^2 - v_i^2) \\
 -3,40 \times 10^3 - 200(9,8)(h-10) \checkmark &= -1\,200 \checkmark \\
 h &= 8,88 \text{ m } \checkmark \quad (8,87755 \text{ m})
 \end{aligned}$$

(4)

5.4

**OPTION 1 AND 2/OPSIE 1 EN 2: Marking criteria /Nasienriglyne**

- Appropriate formula/Geskikte formule ✓✓
- Work done by friction/Arbeid verrig deur wrywing ✓✓
- Substitution of/Vervanging van  $(200)(9,8)(13,12)$  ✓
- Appropriate formula/Geskikte formule
- Substitution into power formula/Vervanging in drywingformule
- Final answer /Finale antwoord: 1 814,35 W

**OPTION 1/OPSIE 1**

$$\begin{aligned}
 W_{nc} &= \Delta K + \Delta U \\
 W_{engine} + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \quad \left. \vphantom{\begin{aligned} W_{nc} &= \Delta K + \Delta U \\ W_{engine} + W_f &= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i \end{aligned}} \right\} \checkmark \checkmark \text{ Any one/Enige een} \\
 &= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i) \\
 W_{engine} + (50)(15)(2)\cos 180^\circ \checkmark \checkmark &= 0 + 200(9,8)\checkmark(22 - 8,88) \\
 W_{engine} &= 27\,215,20 \text{ J} \\
 P_{engine} &= \frac{W_{engine}}{\Delta t} \\
 &= \frac{27\,215,20}{15} \\
 &= 1\,814,35 \text{ W}
 \end{aligned}$$

**OPTION 2/OPSIE 2**

$$\left. \begin{aligned} W_{\text{net}} &= \Delta K \\ W_N + W_{\text{engine}} + W_w + W_f &= 0 \\ W_N + W_{\text{engine}} - \Delta E_p + W_f &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$0 + W_{\text{engine}} - (200)(9,8)\checkmark(13,12) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

**OR/OF**

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

$$W_N + W_{\text{engine}} + W_{w\parallel} + W_f = 0$$

$$W_N + W_{\text{engine}} + mgsin\theta\Delta x\cos 180^\circ + W_f = 0$$

$$0 + W_{\text{engine}} - (200)(9,8)\checkmark\left(\frac{13,12}{\Delta x}\right)\Delta x(-1) + (50)(2)(15)\cos 180^\circ \checkmark\checkmark = 0$$

$$W_{\text{engine}} = 27\,215,20 \text{ J}$$

$$P_{\text{engine}} = \frac{W_{\text{engine}}}{\Delta t}$$

$$= \frac{27\,215,20}{15}$$

$$= 1\,814,35 \text{ W}$$

**OPTION/OPSIE 3: Marking criteria/Nasienriglyne Opsie 3**

- Appropriate formula/Geskikte formule  $\checkmark\checkmark$
- Substitution of/Vervanging van - 50  $\checkmark\checkmark$
- Substitution of/Vervanging van  $(-200)(9,8)(0,4373)$  or/of  $(-200)(9,8)(0,44)\checkmark$
- Appropriate formula/Geskikte formule
- Substitution into/Vervanging in  $P_{\text{ave}} = Fv_{\text{ave}}$
- Final answer/Finale antwoord: 1 814,35 W - 1 824,8 W

**OPTION 3/OPSIE 3**

$$\left. \begin{aligned} F_{\text{net}} &= ma \\ F_{\text{engine}} + F_{\text{friction}} + F_{g\parallel} &= 0 \end{aligned} \right\} \checkmark\checkmark \text{ Any one/Enige een}$$

$$F_{\text{engine}} + (-50)\checkmark\checkmark + (-200)(9,8)\checkmark(0,4373) = 0$$

$$F_{\text{engine}} = 906,52 \text{ N } (906,52 - 912,4)$$

$$P_{\text{ave}} = Fv_{\text{ave}}$$

$$P_{\text{ave}} = (908,52)(2)$$

$$= 1\,813,04 \text{ W } (1\,824,8 \text{ W})$$

**OR/OF**

$$W = F_{\text{engine}}\Delta x\cos\theta$$

$$= (906,52)(30)\cos 0^\circ$$

$$= 27\,195,6 \text{ J } (27\,372 \text{ W})$$

$$P = \frac{W}{\Delta t} = \frac{27\,195,6}{15} = 1\,813,04 \text{ W } \checkmark \quad (1\,824,8 \text{ W})$$

$$\sin\theta = \frac{h}{\Delta x}$$

$$= \frac{13,12}{2(15)}$$

$$= 0,4373$$

(5)  
[14]

## QUESTION 6/VRAAG 6

6.1

### Marking criteria/Nasienriglyne

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 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 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

Towards/Nader ✓

(1)

6.3

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

$$3148 = \frac{340 + 0}{340 - v_s} f_s \quad \text{OR/OF} \quad 2073 = \frac{340 - 0}{340 + v_s} f_s$$

$$\frac{3148(340 - v_s)}{340 + 0} = \frac{2073(340 + v_s)}{340 - 0}$$

$$v_s = 70 \text{ m} \cdot \text{s}^{-1} \quad (69,95 - 70,16 \text{ m} \cdot \text{s}^{-1})$$

(6)

6.4

### **POSITIVE MARKING FROM QUESTION 6.3 POSITIEWE NASIEN VANAF VRAAG 6.3**

#### **OPTION 1/OPSIE 1**

$$\Delta t = \frac{\Delta x}{v}$$

$$\Delta t = \frac{350}{70} \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

#### **OPTION 2/OPSIE 2**

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

$$350 = 70 \Delta t + 0 \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

#### **OPTION 3/OPSIE 3**

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

$$350 = \left( \frac{70 + 70}{2} \right) \Delta t \quad \checkmark$$

$$\Delta t = 5 \text{ s} \quad \checkmark$$

(2)

[11]

**QUESTION 7/VRAAG 7**

7.1

$$n = \frac{Q}{e} \checkmark$$
$$= \frac{(-)4 \times 10^{-6}}{(-)1,6 \times 10^{-19}} \checkmark$$
$$= 2,5 \times 10^{13} \checkmark \quad (3)$$

7.2 **Electrostatic force on B due to A:/Elektrostatiese krag op B a.g.v. A:**

$$F_{AB} = \frac{kQ_1Q_2}{r^2} \checkmark$$
$$= \left[ \frac{9 \times 10^9 (4 \times 10^{-6})(3 \times 10^{-6})}{0,2^2} \right] \checkmark$$
$$= 2,7 \text{ N} \checkmark \quad (3)$$

Ignore negative signs  
Ignoreer negatiewe tekens

7.3 **Marking criteria/Nasienriglyne**

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

Electric field is a region (in space) where (in which) an (electric) charge experiences a (electric) force. ✓✓  
*Elektriese veld is 'n gebied (in die ruimte) waarin 'n (elektriese) lading 'n (elektriese) krag ondervind.* (2)

7.4

**Marking criteria/Nasienriglyne**

- Appropriate formula/Geskikte formule ✓
- Correct substitution for A and B/Korrekte vervanging van A en B ✓✓
- Subtraction of electric fields/Aftrek van elektrieseveld ✓
- Final answer/Finale antwoord:  $2,3 \times 10^6 \text{ N} \cdot \text{C}^{-1}$  ✓

**OPTION 1/OPSIE 1**

Electric field at M due to / Elektriese veld by M as gevolg van:  $-4 \times 10^{-6} \text{ C}$

$$E_{AM} = k \frac{Q}{r^2} \checkmark$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})}{(0,3)^2} \checkmark$$

$$= 4,0 \times 10^5 \text{ N} \cdot \text{C}^{-1} \text{ (to left /links)}$$

Electric field at M due to / Elektriese veld by M as gevolg van:  $+3 \times 10^{-6} \text{ C}$ ,

$$E_{BM} = k \frac{Q}{r^2}$$

$$= 9 \times 10^9 \frac{(3 \times 10^{-6})}{(0,1)^2} \checkmark$$

$$= 2,7 \times 10^6 \text{ N} \cdot \text{C}^{-1} \text{ (to right /regs)}$$

Net electric field at M /Netto elektrieseveld by M

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= 4,0 \times 10^5 - 2,7 \times 10^6 \checkmark$$

$$= 2,3 \times 10^6 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ (right/regs)}$$

**OR/OF**

Net electric field at M /Netto elektrieseveld by M

$$E_{\text{net}} = E_{BM} + E_{AM}$$

$$= -4,0 \times 10^5 + 2,7 \times 10^6 \checkmark$$

$$= -2,3 \times 10^6 \text{ N} \cdot \text{C}^{-1}$$

$$= 2,3 \times 10^6 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ (right)}$$

**OPTION 2/OPSIE 2**

$$F_{AM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,3)^2} \checkmark = 4 \times 10^5 Q \text{ N}$$

$$F_{BM} = \frac{kQ_1Q_2}{r^2} = \frac{(9 \times 10^9)(3 \times 10^{-6})Q}{(0,1)^2} \checkmark = 2,7 \times 10^6 Q \text{ N}$$

$$F_{\text{net}} = 2,7 \times 10^6 Q + (-4 \times 10^5 Q) \checkmark = 2,3 \times 10^6 Q$$

$$E = \frac{F}{q} \checkmark = \frac{2,3 \times 10^6 Q}{Q} = 2,3 \times 10^6 \text{ N} \cdot \text{C}^{-1} \checkmark \text{ (right/regs)}$$

(5)

7.5 Positive/Positief ✓

(1)

7.6

**POSITIVE MARKING FROM 7.2/POSITIEWE NASIEN VANAF 7.2**

**Marking criteria/Nasienriglyne**

- Correct substitution into Pythagoras's equation/Korrekte vervanging in Pythagoras se vergelyking ✓
- Correct substitution into Coulomb's Law/Korrekte vervanging in Coulomb se wet ✓
- Correct answer/Korrekte antwoord ✓

$$(F_{\text{net}})^2 = (F_{\text{AD}})^2 + (F_{\text{AB}})^2$$

$$(7,69)^2 = (F_{\text{AD}})^2 + (2,7)^2 \checkmark$$

$$F_{\text{AD}} = 7,2 \text{ N}$$

$$F_{\text{AD}} = \frac{kQ_1Q_2}{r^2}$$

$$7,2 = \frac{(9 \times 10^9)(4 \times 10^{-6})Q}{(0,15)^2} \checkmark$$

$$Q_{\text{D}} = 4,5 \times 10^{-6} \text{ C} \checkmark$$

**OR/OF**

$$F_{\text{AD}} = k \frac{Q_1Q_2}{r^2}$$

$$= 9 \times 10^9 \frac{(4 \times 10^{-6})Q}{0,15^2} \checkmark$$

$$= 1,6 \times 10^6 Q$$

$$F_{\text{net}} = \sqrt{F_{\text{AB}}^2 + F_{\text{AD}}^2} \quad \text{OR/OF} \quad F_{\text{net}}^2 = F_{\text{AB}}^2 + F_{\text{AD}}^2$$

$$7,69 = \sqrt{2,7^2 + (1,6 \times 10^6 Q)^2} \checkmark$$

$$Q = 4,50 \times 10^{-6} \text{ C} \checkmark$$

(3)  
[17]

## QUESTION 8/VRAAG 8

8.1

### **Marking criteria/Nasienriglyne**

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*

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓

*(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidslading wat daardeur beweeg.*

Work done by the battery to move a unit coulomb of charge across the circuit. Arbeid verrig deur die battery om 'n eenheidslading oor die stroombaan te beweeg. (2)

8.2

Energy (per coulomb of charge) is converted to heat in the battery due to the internal resistance. ✓✓

*Energie (per coulomb lading) word na hitte omskep binne-in die battery a.g.v. interne weerstand.* (2)

8.3.1

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

$$I = \frac{1,5}{0,5} \checkmark$$

$$= 3 \text{ A} \checkmark$$

(3)

8.3.2

<b>OPTION 1/OPSIE 1</b>	<b>OPTION 2/OPSIE 2</b>
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$	$R_p = \frac{R_1 R_2}{R_1 + R_2} \checkmark$
$\frac{1}{R_p} = \frac{1}{25} + \frac{1}{15} \checkmark$	$R_p = \frac{(25)(15)}{25+15} \checkmark$
$R_p = 9,375 \Omega$	$R_p = 9,375 \Omega$
$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$ (13,375 $\Omega$ )	$R_{\text{ext}} = 9,375 + 4 \checkmark = 13,38 \Omega \checkmark$ (13,375 $\Omega$ )

(4)

8.3.3

**POSITIVE MARKING FROM QUESTIONS 8.3.1 AND 8.3.2.**  
**POSITIEWE NASIEN VANAF VRAAG 8.3.1 EN 8.3.2.**

**OPTION 1/OPSIE 1**

$$\begin{aligned}\mathcal{E} &= I(R + r) \checkmark \\ &= 3(13,38 + 0,5) \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

**OPTION 2/OPSIE 2**

$$\begin{aligned}\mathcal{E} &= V_{\text{ext/eks}} + V_{\text{int}} \checkmark \\ &= (3)(13,38) + 1,5 \checkmark \\ &= 41,64 \text{ V} \checkmark \quad (\text{Range/Gebied: } 41,625 - 41,64)\end{aligned}$$

(3)

8.4 Yes. ✓/Ja

For the same voltage/potential difference, ✓

a larger current will flow through a smaller resistor ( $I = \frac{V}{R}$ ) ✓

*Vir dieselfde spanning/ potensiaalverskil*

*sal 'n groter stroom deur die kleiner weerstand vloei ( $I = \frac{V}{R}$ ).*

**OR/OF**

$$I \propto \frac{1}{R} \checkmark, V = \text{constant} / \text{konstant} \checkmark$$

*I is inversely proportional to R and V is constant.*

*I is omgekeerd eweredig aan R en V is konstant.*

**OR/OF**

$$\begin{aligned}V_{||} &= IR \\ &= (3)(9,38) \\ &= 28,14 \text{ V}\end{aligned}$$

$$I_{R2} = \frac{V}{R} = \frac{28,14}{25} = 1,13 \text{ A} \checkmark$$

$$I_{R3} = \frac{V}{R} = \frac{28,14}{15} = 1,88 \text{ A} \checkmark$$

**OR/OF**

*V is the same / V is dieselfde ✓*

$$\left. \begin{aligned}I_{15\Omega} &= \frac{25}{40} I \\ I_{25\Omega} &= \frac{15}{40} I\end{aligned} \right\} \checkmark$$

(3)

8.5 Remains the same/Bly dieselfde ✓

(1)

**[18]**



## QUESTION 9/VRAAG 9

9.1.1 (DC) motor/(GS-)motor ✓ (1)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1**

**POSITIEWE NASIEN VANAF VRAAG 9.1.1**

Electrical to mechanical /kinetic (energy) ✓✓ (2 or 0)

Elektriese na meganiese/kinetiese (energie) (2 of 0) (2)

9.1.3 Split ring/commutator/Splitring/kommutator ✓ (1)

9.1.4 Anticlockwise/antikloksgewys ✓✓ (2)

9.2.1 (The rms voltage/value of AC is) the AC voltage/potential difference which dissipates the same amount of energy/heat/power as an equivalent DC voltage/potential difference. ✓✓ (2 or 0)

(Die wgk-waarde van WS is) die WS-potensiaalverskil/spanning wat dieselfde hoeveelheid energie/hitte/drywing verbruik as 'n ekwivalente GS-spanning/potensiaalverskil. (2 of 0)

### **ACCEPT/AANVAAR**

The rms voltage/value of AC is the DC potential difference which dissipates the same amount of energy/heat/power as AC.

Die wgk-waarde van WS is die GS-potensiaalverskil wat dieselfde hoeveelheid energie/hitte/drywing verbruik as die WS. (2)

9.2.2 **Marking criteria/Nasienriglyne**

- Appropriate formula for  $P_{ave}$ /Gesikte formule vir  $P_{ave}$  ✓
- Substitution to calculate/Vervanging vir berekening van R ✓
- Final answer/Finale antwoord:  $242 \Omega$  ✓

<b><u>OPTION 1/OPSIE 1</u></b>	<b><u>OPTION 2/OPSIE 2</u></b>	<b><u>OPTION 3/OPSIE 3</u></b>
$P_{ave} = \frac{V_{rms}^2}{R} \checkmark$ $200 = \frac{220^2}{R} \checkmark$ $R = 242 \Omega \checkmark$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $R = \frac{V_{rms}}{I_{rms}} \text{ or/of } R = \frac{V}{I}$ $R = \frac{220}{0,909} \checkmark$ $R = 242 \Omega \checkmark (241,76 \Omega)$	$P_{ave} = V_{rms} I_{rms} \checkmark$ $200 = I_{rms} (220)$ $I_{rms} = 0,909 \text{ A (0,91)}$ $P_{ave} = I_{rms}^2 R$ $200 = (0,909)^2 R \checkmark$ $R = 242 \Omega \checkmark$ $(241,52 \Omega)$

(3)

9.2.3

**Marking criteria for options 1,2 and 3 /Nasienriglyne vir opsies 1,2 en 3**

- Appropriate formula to calculate P or  $I_{\text{rms}}$  /Geskikte formule om P of  $I_{\text{rms}}$  te bereken ✓
- Substitution/Vervanging ✓
- Formula for P or W containing  $\Delta t$  /Formule vir P of W wat  $\Delta t$  bevat ✓
- Substitution/Vervanging ✓
- Final answer/Finale antwoord: 55 785,12 J ✓

**POSITIVE MARKING FROM QUESTION 9.2.2.****POSITIEWE NASIEN VANAF VRAAG 9.2.2.****OPTION 1/OPSIE 1****Marking criteria / Nasienriglyne**

- Appropriate formula for W containing V /Geskikte formule vir W wat V bevat ✓✓
- Substitution/Vervanging ✓✓
- Final answer/Finale antwoord: 55 785,12 J ✓

$$W = \frac{V^2 \Delta t}{R} \checkmark \checkmark$$

$$= \frac{(150^2)(10 \times 60)}{242} \checkmark$$

$$= 55\,785,12 \text{ J} \checkmark$$

**OPTION 2/OPSIE 2**

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

$$= \frac{150^2}{242} \checkmark$$

$$P_{\text{av}} = 92,975 \text{ W}$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

**OPTION 3/OPSIE 3**

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

$$242 = \frac{150}{I_{\text{rms}}} \checkmark$$

$$I_{\text{rms}} = 0,620 \text{ A}$$

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

$$= (0,62)(150) \checkmark$$

$$= 92,97 \text{ W} (93 \text{ W})$$

$$P = \frac{W}{\Delta t} \checkmark$$

$$92,975 = \frac{W}{(10)(60)} \checkmark$$

$$W = 55\,785,12 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

**OPTION 4/OPSIE 4**

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

$$242 = \frac{150}{I_{\text{rms}}} \checkmark$$

$$I_{\text{rms}} = 0,620 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,62)^2 (242)(10)(60) \checkmark$$

$$= 55\,814,88 \text{ J} \checkmark$$

$$(55\,785,12 - 55\,896 \text{ J})$$

**OR/OF**

$$W = VI \Delta t$$

$$= (150)(0,62)(600)$$

$$= 55\,800 \text{ J}$$

**OPTION 5/OPSIE 5**

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R} \checkmark = \frac{150^2}{242} \checkmark = 92,975 \text{ W}$$

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

$$92,975 = I_{\text{rms}}^2 (242)$$

$$I_{\text{rms}} = 0,6198 \text{ A}$$

$$W = I^2 R \Delta t \checkmark$$

$$= (0,6198)^2 (242)(10)(60) \checkmark$$

$$= 55\,778,88 \text{ J} \checkmark$$

(5)  
[16]

### QUESTION 10/VRAAG 10

10.1 Photoelectric effect/Fotoëlektriese effek ✓ (1)

10.2 Work function (of potassium)/Werksfunksie/Arbeidsfunksie (van kalium) ✓ (1)

10.3 Potassium/Kalium ✓  
It has the lowest work function / threshold frequency / highest threshold wavelength. ✓  
*Dit het die laagste arbeidsfunksie / drumpelfrekwensie / hoogste drumpel golflengte.* (2)

10.4 **Marking criteria/Nasienriglyne**  
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 work function of a metal is the minimum energy that an electron (in the metal) needs to be emitted/ejected from the metal / surface. ✓  
*Die werksfunksie/arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron vanaf 'n oppervlak / metaal vry te stel.* (2)

10.5.1  $W_o = hf_o$  ✓  
 $= (6,63 \times 10^{-34})(1,75 \times 10^{15})$  ✓  
 $= 1,160 \times 10^{-18} \text{ J}$  ✓

**OR/OF**

$$\left. \begin{array}{l} E = W_o + E_{k(\max)} \\ hf = W_o + E_{k(\max)} \end{array} \right\} \text{✓ Any one / Enigeen}$$

$$(6,63 \times 10^{-34})(1,75 \times 10^{15}) = W_o + 0 \text{ ✓}$$

$$W_o = 1,160 \times 10^{-18} \text{ J} \text{ ✓} \quad (3)$$

10.5.2 **POSITIVE MARKING FROM QUESTION 10.5.1.**  
**POSITIEWE NASIEN VANAF VRAAG 10.5.1.**

$$\left. \begin{array}{l} E = W_o + E_{k(\max)} \\ hf = hf_o + \frac{1}{2}mv_{\max}^2 \end{array} \right\} \text{✓ Any one/Enige een}$$

$$(6,63 \times 10^{-34})f \text{ ✓} = \frac{1,160 \times 10^{-18}}{2} + \frac{1}{2} (9,11 \times 10^{-31}) (5,60 \times 10^5)^2 \text{ ✓}$$

$$\therefore f = 1,97 \times 10^{15} \text{ Hz} \text{ ✓} \quad (4)$$

**[13]**

**TOTAL/TOTAAL: 150**