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SENIOR CERTIFICATE EXAMINATIONS/
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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 <u>remain in</u> its state of <u>rest</u> or <u>motion at constant velocity</u> unless a (non-zero) <u>resultant/net force/unbalanced force</u> acts on it. ✓✓

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

OR/*OF*

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

'n Liggaam sal <u>in</u> sy toestand <u>rus</u> of <u>uniforme beweging</u> in 'n reguit lyn volhard, tensy 'n (nie-nul) <u>resulterende/netto krag</u> daarop inwerk.   (2)

2.2

<div align="center">ACCEPT/<i>AANVAAR</i></div>
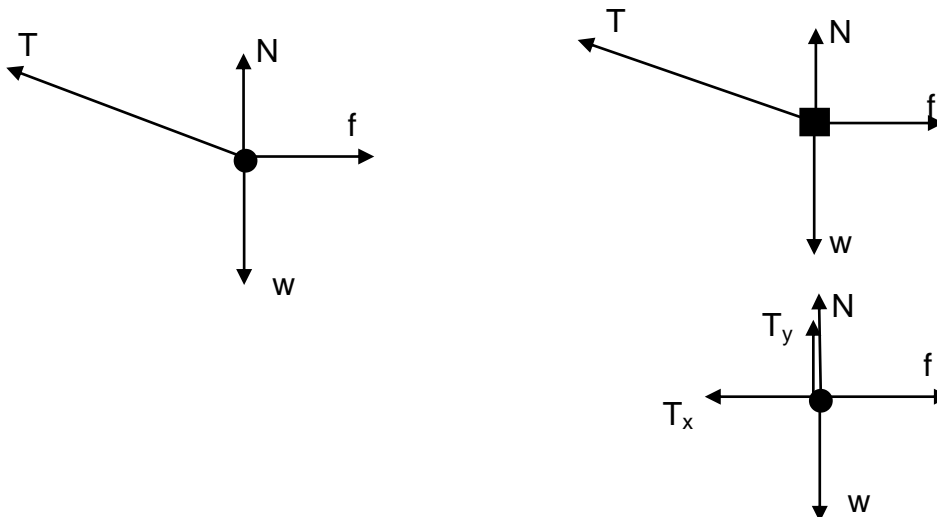
	Accepted symbols/*Aanvaarde simbole*
N ✓	F_N/Normal/Normal force/*Normaal/Normaalkrag*/$F_{buoyant}$
f ✓	F_f/f_k/frictional force/*wrywingskrag*/kinetic frictional force/*kinetiese wrywingskrag/300 N*
w ✓	F_g/mg/Weight/*Gewig*/$F_{Earth\ on\ man}$/ *$F_{Aarde\ op\ man}$*/F_w/Gravitational force/ *Gravitasiekrag/* 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

OPTION 1/*OPSIE 1*	**OR/*OF***
$F_{net} = ma$ $T\cos 50° - F_f = ma$ ⎫ ✓Any one/*Enige een*	$F_{net} = 0$ ✓✓ $T\cos 50° = F_f$ ✓✓

$\underline{T\cos 50° - 300}$ ✓ $= 0$ ✓ **OR/*OF*** $\underline{T\cos 50° = 300}$ ✓✓
$T = 466,72 \text{ N}$ ✓ (468,75 N)

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$ ✓

$\underline{T\Delta x \cos 0° + f\Delta x \cos 180°} = 0$ ✓

	OR/*OF*
$\underline{T\cos 50° - 300}$ ✓ $= 0$ $T = 466,72 \text{ N}$ ✓ (468,75 N)	$W_{net} = 0$ ✓✓ $\underline{T\Delta x \cos 50° = -f\Delta x \cos 180°}$ ✓✓

NOTE/*AANTEKENING*
Can use $\sin 40°$ instead of $\cos 50°$.
Kan ook sin40° i.p.v. cos50° gebruik.

(4)

2.4   Increases/*Neem toe* ✓

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

(2)

2.5

Marking criteria Options 1 & 2/*Nasienkriteria Opsies 1 & 2*
- Substitution to calculate a/*Vervanging om a te bereken* ✓
- Formula to calculate $F_{up/water}$/*Formule om $F_{op/water}$ te bereken* ✓
- Substitution to calculate $F_{up/water}$/*Vervanging om $F_{op/water}$ te bereken* ✓✓
- Final answer/*Finale antwoord*: 679,20 N ✓

OPTION 1/*OPSIE 1*

DOWNWARDS AS POSITIVE/ ***AFWAARTS AS POSITIEF:***	**UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
$\dfrac{0 = (16)^2 + 2a\,(0,8)}{a = -160 \text{ m·s}^{-2}}$ ✓	$\dfrac{0 = (-16)^2 + 2a(-0,8)}{a = 160 \text{ m·s}^{-2}}$ ✓
$F_{net} = ma$ $F_g - F_{up/op} = ma$ ⎫ ✓Any one/*Enige een*	$F_{net} = ma$ $-F_g + F_{up/op} = ma$ ⎫ ✓Any one/*Enige een*
$\underline{(4)(9,8)} - F_{up/op}$ ✓ $= (4)(-160)$ ✓ $F_{up/op} = -679,20 \text{ N}$ $F_{up/op} = 679,20 \text{ N}$ ✓	$\underline{-(4)(9,8)} + F_{up/op}$ ✓ $= (4)(160)$ ✓ $F_{up/op} = 679,20 \text{ N}$ ✓

OPTION 2/*OPSIE 2*

DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*	**UPWARDS AS POSITIVE/** *OPWAARTS AS POSITIEF*
$\Delta x = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$	$\Delta x = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$
$0{,}8 = \left(\dfrac{16 + 0}{2}\right)\Delta t$	$-0{,}8 = \left(\dfrac{-16 + 0}{2}\right)\Delta t$
$\Delta t = 0{,}1$ s	$\Delta t = 0{,}1$ s
$v_f = v_i + a\Delta t$ $\underline{0 = 16 + a(0,1)}$ ✓ $a = -160$ m·s^{-2}	$v_f = v_i + a\Delta t$ $\underline{0 = -16 + a(0,1)}$ ✓ $a = 160$ m·s^{-2}
OR/*OF*	**OR/*OF*** $\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\underline{-0{,}8 = (-16)(0,1) + \frac{1}{2}(a)(0,1)^2}$ ✓ $a = 160$ m·s^{-2}
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $\underline{0{,}8 = (16)(0,1) + \frac{1}{2}(a)(0,1)^2}$ ✓ $a = -160$ m·s^{-2}	
$F_{net} = ma$ $F_g - F_{up/op} = ma$ ⎫ ✓Any one/*Enige een* $\underline{(4)(9,8) - F_{up/op}}$ ✓ $= (4)(-160)$ ✓ $F_{up/op} = -679{,}20$ N $F_{up/op} = 679{,}20$ N ✓	$F_{net} = ma$ $-F_g + F_{up/op} = ma$ ⎫ ✓Any one/*Enige een* $\underline{-(4)(9,8) + F_{up/op}}$ ✓ $= (4)(160)$ ✓ $F_{up/op} = 679{,}20$ N ✓

USING ENERGY PRINCIPLES/GEBRUIK VAN ENERGIE BEGINSELS
Marking criteria OPTIONS 3 to 5/Nasienkriteria OPSIES 3 to 5
- Formula / *Formule* ✓
- Substitution / *Vervanging* ✓✓✓
- Final answer/*Finale antwoord*: 679,20 N ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎫ ✓Any one/*Enige een*
$\underline{(4)(9,8)(0,8)\cos0°}$✓ $+ \underline{F_{up/op}(0,8)\cos180°}$ ✓ $= \frac{1}{2}(4)(0 - 16^2)$ ✓
$F_{up/op} = 679{,}20$ N ✓

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta K + \Delta U$
$F_{up/op}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ⎫ ✓Any one/*Enige een*
$\underline{F_{up/op}(0,8)\cos180°}$ ✓ $= \underline{\frac{1}{2}(4)(0 - 16^2)}$ ✓ $+ \underline{(4)(9,8)(0 - 0,8)}$ ✓
$F_{up/op} = 679{,}20$ N ✓

OPTION 5/*OPSIE 5*

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

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

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

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

$F_{net}\Delta t = (p_{tube/band})_f - (p_{tube/band})_i$ ✓Any one/*Enige een*

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

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

$F_{up/op} = 679{,}20 \text{ N}$ ✓

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

(2)

3.2.1

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

(3)

Marking criteria OPTIONS 5 to 7/*Nasienkriteria OPSIES 5 tot 7*
- Any formula relating Δy and Δt/ **OR/*OF*** $F_{net}\Delta t = m\Delta v$✓
- Substitution to calculate Δt/*Vervanging om Δt te bereken* ✓
- Final answer/*finale antwoord*: 1,53 s ✓

OPTION 5/*OPSIE 5*
$$(E_{mech})_{Top/Bo} = (E_{mech})_{30\,m}$$
$$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{30\,m}$$
$$(mgh + \tfrac{1}{2}mv^2)_{Top/Bo} = (mgh + \tfrac{1}{2}mv^2)_{30\,m}$$
$$(9,8)h + 0 = 0 + (\tfrac{1}{2})(15)^2$$
$$\Delta h = 11,48 \text{ m}$$

OPTION 6/*OPSIE 6*
$$W_{nc} = \Delta K + \Delta U$$
$$W_{nc} = \Delta K + mg(h_f - h_i)$$
$$0 = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 + mgh_f - mgh_i$$
$$0 = \tfrac{1}{2}(0 - 15^2) + (9,8)\Delta h$$
$$\Delta h = 11,48 \text{ m}$$

OPTION 7/*OPSIE 7*
$$W_{net} = \Delta E_k$$
$$w\Delta y\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$(9,8)\Delta y\cos 180^o = 0 - \tfrac{1}{2}(15)^2$$
$$\Delta y = 11,48 \text{ m}$$

OPTION A/*OPSIE A*
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2 ✓$$
$$11,48 = (15)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2 ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2 ✓$$
$$11,48 = (-15)\Delta t + \tfrac{1}{2}(9,8)\Delta t^2 ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

OPTION B/*OPSIE B*
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t ✓$$
$$11,48 = \left(\frac{15 + 0}{2}\right)\Delta t ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

OPTION 8/*OPSIE 8*
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t ✓$$
$$\Delta y = \left(\frac{15 + 0}{2}\right)\Delta t$$
$$\Delta y = 7,5 \Delta t$$

$$v_f^2 = v_i^2 + 2a\Delta y$$
$$0 = (15)^2 + 2(-9,8)(7,5\Delta t) ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$$
$$\Delta y = \left(\frac{-15 + 0}{2}\right)\Delta t$$
$$\Delta y = -7,5\Delta t$$
$$v_f^2 = v_i^2 + 2a\Delta y ✓$$
$$0 = (-15)^2 + 2(9,8)(-7,5\Delta t) ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

OPTION 9/*OPSIE 9*
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
$$F_{net}\Delta t = m\Delta v$$
$$F_{net}\Delta t = m(v_f - v_i)$$
✓ Any one/ *Enige een*
$$-(9,8)\Delta t = 0 - 15 ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
$$F_{net}\Delta t = m\Delta v$$
$$F_{net}\Delta t = m(v_f - v_i)$$
✓ Any one/ *Enige een*
$$(9,8)\Delta t = 15 - 0 ✓$$
$$\Delta t = 1,53 \text{ s} ✓$$

(3)

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1/
POSITIEWE NASIEN VANAF VRAAG 3.2.1

Marking criteria/*Nasienkriteria*
- 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 swopped
v_f en v_i kan omgeruil word

OPTION 1/*OPSIE 1* **UPWARDS AS POSITIVE/** *OPWAARTS AS POSITIEF* $\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$ ✓ $= \underline{(15)(1,53) + \tfrac{1}{2}(-9,8)(1,53)^2}$ ✓ $= 11,48$ m Height/*hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓ **DOWNWARDS AS POSITIVE/** *AFWAARTS AS POSITIEF* $\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$ ✓ $= \underline{(-15)(1,53) + \tfrac{1}{2}(9,8)(1,53)^2}$ ✓ $= -11,48$ m Height/*Hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓	**OPTION 2/*OPSIE 2*** **UPWARDS AS POSITIVE/** *OPWAARTS AS POSITIEF* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = (15)^2 + (2)(-9,8)\Delta y}$ ✓ $\Delta y = 11,48$ m Height/*hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓ **DOWNWARDS AS POSITIVE/** *AFWAARTS AS POSITIEF* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = (-15)^2 + (2)(9,8)\Delta y}$ ✓ $\Delta y = -11,48$ m Height/*Hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓
OPTION 3/*OPSIE 3* **UPWARDS AS POSITIVE/** *OPWAARTS AS POSITIEF* $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\dfrac{15+0}{2}\right)(1,53)$ ✓ $= 11,48$ m Height/*Hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓ **DOWNWARDS AS POSITIVE/** *AFWAARTS AS POSITIEF* $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\dfrac{-15+0}{2}\right)(1,53)$ ✓ $= -11,48$ m Height/*Hoogte* = 11,48 <u>+ 30</u> ✓ $= 41,48$ m ✓	**OPTION 4/*OPSIE 4*** **UPWARDS AS POSITIVE/** *OPWAARTS AS POSITIEF* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-15)^2 + (2)(-9,8)(-30)}$ ✓ $v_f = -28,51$ m·s^{-1} $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{(-28,51)^2 = (0)^2 + (2)(-9,8)\Delta y}$ ✓ $\Delta y = 41,48$ m Height/*Hoogte* = 41,48 m ✓ **DOWNWARDS AS POSITIVE/** *AFWAARTS AS POSITIEF* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(15)^2 + (2)(9,8)(30)}$ ✓ $v_f = 28,51$ m·s^{-1} $v_f^2 = v_i^2 + 2a\Delta y$ $\underline{(28,51)^2 = (0)^2 + (2)(9,8)\Delta y}$ ✓ $\Delta y = 41,48$ m Height/*Hoogte* = 41,48 m ✓

OPTION 5/ *OPSIE 5*
$(E_{mech})_{Top/Bo} = (E_{mech})_{30\,m}$ ⎫
$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{30\,m}$ ⎬ ✓Any one/*Enige een*
$(mgh + ½\,mv^2)_{Top/Bo} = (mgh + ½\,mv^2)_{30\,m}$ ⎭
$\underline{(9,8)h + 0 = (9,8)(30✓) + (½)(15)^2}$ ✓
h = 41,48 m ✓

OPTION 6/*OPSIE 6*
$W_{net} = ΔE_k$ ⎫
$wΔx\cos180° = ½m(v_f^2 - v_i^2)$ ⎬ ✓Any one/*Enige een*
$\underline{(9,8)(Δx)\cos180° = ½(0 - 15^2)}$ ✓
Δx = 11,47 m ⟶
Height above the ground/*hoogte bokant grond*= $\underline{30 +}$✓ 11,47 = 41,48 m ✓

OPTION 7/*OPSIE 7*
$W_{nc} = ΔE_p + ΔE_k$ ⎫
$0 = mg(h_f - h_i) + ½m(v_f^2 - v_i^2)$ ⎬ ✓Any one/*Enige een*
$\underline{0 = (9,8)(h_f - 0) + ½(0 - 15^2)}$ ✓
h = 11,47 m ⟶
Height above the ground/*hoogte bokant grond*= $\underline{30 +}$✓ 11,47 = 41,48 m ✓

(4)

3.3

POSITIVE MARKING FROM QUESTION 3.2.2/ **_POSITIEWE NASIEN VANAF VRAAG 3.2.2_**
Marking criteria/*Nasienkriteria*
• 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* Δt + 0,5 or/*of* Δt – 0,5 ✓
• Equating y_B and y_C ✓
• Final answer/*Finale antwoord:* 1,71 s ✓

OPTION 1/*OPSIE 1*
UPWARDS AS POSITIVE/*OPWAARTS 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*:
$Δy_C = v_iΔt + ½aΔt^2$ ✓
$y_C - 30 = \underline{15Δt + ½(-9,8)Δt^2}$ ✓
$y_C = 15Δt - 4,9Δt^2 + 30$ ….. (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*:
$Δy_B = v_iΔt + ½aΔt^2$
$y_B - 0 = \underline{40(Δt - 0,5✓) + ½(-9,8)}(Δt - 0,5✓)^2$ ✓
$y_B = 44,9t – 21,225 – 4,9t^2$ …..(2)
At meeting point/*By ontmoetingspunt*:
$y_C = y_B$
$\underline{15Δt - 4,9Δt^2 + 30 = 44,9t – 21,225 – 4,9t^2}$ ✓
Δt = 1,71 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*:

$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$y_C - 30 = \underline{-15\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$y_C = -15\Delta t + 4,9\Delta t^2 + 30$ ….. (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*:

$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$y_B - 0 = \underline{-40(\Delta t - 0,5}$✓$\underline{) + \frac{1}{2}(9,8)(\Delta t - 0,5}$✓$)^2$ ✓
$y_B = -44,9t + 21,225 + 4,9t^2$ …..(2)

At meeting point/*By ontmoetingspunt*:
$y_C = y_B$ ∴ $\underline{-15\Delta t + 4,9\Delta t^2 + 30 = -44,9t + 21,225 + 4,9t^2}$ ✓
$\Delta t = 1,71$ s ✓

OPTION 2/*OPSIE 2*
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:
$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= \underline{15\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓
$= 15\Delta t - 4,9\Delta t^2$ ….. (1)

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

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y_C = 40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2$
$\Delta y_C = -4,9\Delta t^2 + 44,9\Delta t - 51,225$ …..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk*:
$\underline{15\Delta t = 44,9\Delta t - 51,225}$ ✓
$\Delta t = 1,71$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*:
$\Delta y_C = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= \underline{-15\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$= 4,9\Delta t^2 - 15\Delta t$ …..(1)

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

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y_C = (-40)(t - 0,5) + \frac{1}{2}(9,8)(\Delta t - 0,5)^2$
$\Delta y_C = 4,9\Delta t^2 - 44,9\Delta t + 51,225$…..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk*:
$\underline{-15\Delta t = -44,9\Delta t + 51,225}$ ✓
$\Delta t = 1,71$ s ✓

OPTION 3/*OPSIE 3*
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$\quad = \underline{15(\Delta t + 0{,}5}$✓$\underline{) + \frac{1}{2}(-9{,}8)(\Delta t + 0{,}5)^2}$ ✓
$\quad = -4{,}9t^2 + 10{,}1\Delta t + 6{,}275…..(1)$
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$\quad = \underline{40\Delta t + \frac{1}{2}(-9{,}8)\Delta t^2}$ ✓

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y = 40\Delta t + \frac{1}{2}(-9{,}8)t^2$
$\quad\quad \Delta y = -4{,}9\Delta t^2 + 40t - 30 …..(2)$

Equate (1) and (2)/*Stel (1) en (2) gelyk*:
$\underline{10{,}1\Delta t + 6{,}275 = 40\Delta t – 30}$ ✓
$\quad\quad\quad\quad \Delta t = 1{,}21 \text{ s}$
$\quad\quad\quad \Delta t_{TOT} = 1{,}21 + 0{,}5$
$\quad\quad\quad\quad\quad = 1{,}71 \text{ s}$ ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$\quad = \underline{-15(\Delta t + 0{,}5}$✓$\underline{) + \frac{1}{2}(9{,}8)(\Delta t + 0{,}5)^2}$ ✓
$\quad = 4{,}9\Delta t^2 - 10{,}1\Delta t + 6{,}275…..(1)$
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$\quad = \underline{-40\Delta t + \frac{1}{2}(9{,}8)\Delta t^2}$ ✓

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y = -40\Delta t + \frac{1}{2}(9{,}8)t^2$
$\Delta y = -4{,}9\Delta t^2 - 40\Delta t - 30…..(2)$

Equate (1) and (2)/*Stel (1) en (2) gelyk*:
$\underline{-10{,}1\Delta t + 6{,}275 = -40\Delta t – 30}$ ✓
$\quad\quad\quad\quad \Delta t = 1{,}21 \text{ s}$
$\Delta t_{TOT} = 1{,}21 + 0{,}5$
$\quad\quad = 1{,}71 \text{ s}$ ✓

OPTION 4/*OPSIE 4*	
Marking criteria:	***Nasienkriteria:***
• Formula: $\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	• *Formule: $\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$* ✓
• Substitute to calculate Δy_B ✓	• *Vervang om Δy_B te bereken* ✓
• Substitute to calculate Δy_C ✓	• *Vervang om Δy_c te bereken* ✓
• Substitute $\Delta t = 0,5$ ✓	• *Vervang $\Delta t = 0,5$* ✓
• Adding Δy_B and Δy_C ✓	• *Som van Δy_B en Δy_C* ✓
• Final answer: 1,71 s ✓	• *Finale antwoord: 1,71 s* ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

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

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

$\quad\quad = 15(0,5) + \frac{1}{2}(-9,8)(\underline{0,5}✓)^2$

$\Delta y_C = 6,28$ m

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

$v_f = v_i + a\Delta t$

$\quad = 15 + (-9,8)(0,5)$

$\quad = 10,10$ m·s^{-1}

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

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

$\quad\quad = \underline{10,1\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$\quad\quad = 10,1\Delta t - 4,9\Delta t^2$

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

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

$\quad\quad = \underline{40\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$\quad\quad = 40t - 4,9t^2$

At meeting point/*By ontmoetingspunt*:

$\underline{\Delta y_C + \Delta y_B = -[10,1\Delta t - 4,9\Delta t^2] + 40\Delta t - 4,9\Delta t^2}$ ✓

$\quad\quad\quad 36,28 = -10,10\Delta t + 40\Delta t$

$\quad\quad\quad\quad\quad \Delta t = 1,21$ s

$\quad\quad\quad\quad \Delta t_{tot} = 1,21 + 0,5 = 1,71$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*
Displacement of C after 0,5 s/*Verplasing van C na 0,5 s*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$\qquad = -15(0,5) + \frac{1}{2}(9,8)(\underline{0,5}✓)^2$
$\Delta y_C = -6,28$ m

Velocity of C after 0,5 s/ *Snelheid van C na 0,5 s*
$v_f = v_i + a\Delta t$
$\qquad = -15 + (9,8)(0,5)$
$\qquad = -10,10$ m·s^{-1}

Displacement of C at meeting point/*Verplasing van C by ontmoetingspunt*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$\qquad = \underline{-10,1\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$\qquad = -10,1\Delta t + 4,9\Delta t^2$

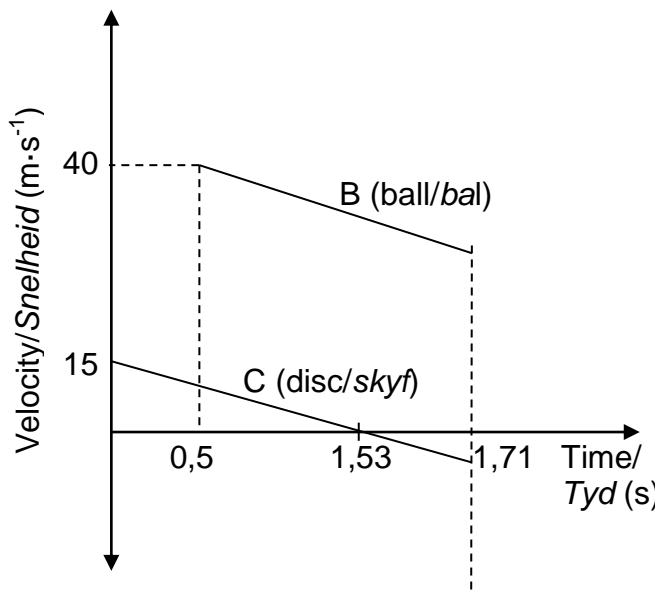Displacement of B at meeting point/*Verplasing van B by ontmoetingspunt*
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$\qquad = \underline{-40\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$\qquad = -40t + 4,9t^2$
At meeting point/*By ontmoetingspunt*:
$\underline{\Delta y_C + \Delta y_B = -[-10,1\Delta t + 4,9\Delta t^2] - 40\Delta t + 4,9\Delta t^2}$✓
$\qquad -36,28 = 10,10\Delta t - 40\Delta t$
$\qquad\qquad \Delta t = 1,21$ s
$\qquad\qquad \Delta t_{tot} = 1,21 + 0,5 = 1,71$ s ✓

(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*✓
- *Parallelle 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*
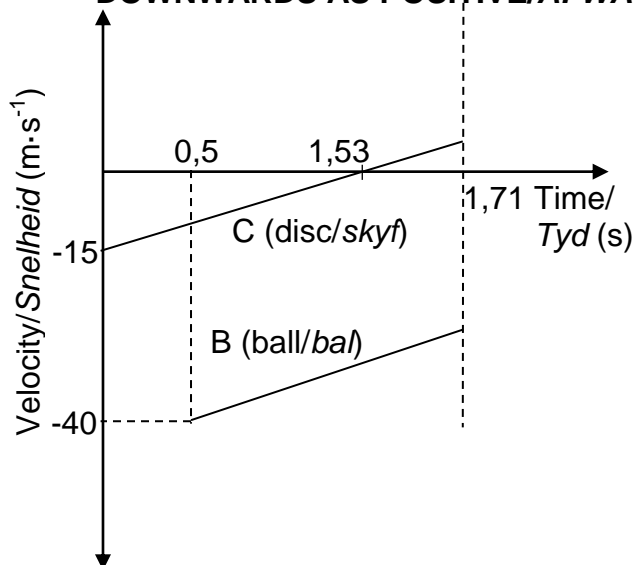
Marking criteria:
- Initial velocities -40 and -15 and straight lines ✓
- B starting at 0,5 s ✓
- Parallel lines with positive gradient ✓
- Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
- Time at which B hits C (answer from 3.3) 1,71 s ✓

Nasienkriteria:
- *Aanvanklike snelhede -40 en -15 en reguitlyne* ✓
- *B begin by 0,5 s*✓
- *Parallelle 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 <u>resultant/net external force is zero</u>./*'n Sisteem waarop die <u>resultante/netto eksterne krag nul is</u>.* ✓✓ (2 or/*of* 0)   (2)

4.2   1. <u>According to Newton 3rd Law</u> ✓ the <u>rocket exerts a force on the toy cart to the left/</u>opposite to direction of motion. ✓
             OR
         2. <u>The toy cart exerts a force on the rocket to the right</u> ✓and <u>the rocket exerts a force on the toy cart to the left/</u>opposite to direction of motion. ✓
             OR
         3. <u>The rocket experiences a change in momentum to the right</u> ✓, <u>the toy cart experiences a change in momentum to the left.</u> ✓
             OR
         4. <u>$\Delta p_{toy\ cart} = -\Delta p_{rocket}$</u> ✓✓
             OR
         5. <u>Total momentum is conserved / remains constant.</u> ✓
             <u>The momentum of the rocket increases. Therefore, the momentum of the toy cart must decrease.</u> ✓
             OR
         6. <u>The rocket experiences an impulse to the right</u> ✓ therefore, the <u>toy cart experiences an impulse to the left.</u> ✓
             OR
         7. Impulse_{rocket} = -Impulse_{toy cart} ✓✓

         1. <u>Volgens Newton se derde wet</u> ✓ <u>oefen die vuurpyl 'n krag op die speelgoedwaentjie na links uit/</u> teen die bewegingsrigting. ✓
             OF
         2. *<u>Die speelgoedwaentjie oefen 'n krag op die vuurpyl na regs</u> ✓ en <u>die vuurpyl oefen 'n krag op die speelgoedwaentjie na links/</u>teen die bewegingsrigting ✓ .*
             OF
         3. *<u>Die vuurpyl ondervind 'n verandering in momentum na regs</u> ✓, <u>die speelgoedwaentjie ondervind 'n verandering in momentum na links.</u> ✓*
             OF
         4. *$\Delta p_{speelgoedwaentjie} = -\Delta p_{vuurpyl}$*
             OF
         5. *Totale momentum bly behoue. ✓*
             <u>Die momentum van die vuurpyl neem toe.</u> Dus moet d<u>ie momentum van die speelgoedwaentjie af neem</u>. ✓
             OF
         6. *<u>Die vuurpyl ondervind 'n impuls na regs</u> ✓ dus ondervind die <u>speelgoedwaentjie 'n impuls na links.</u> ✓*
             OF
         7. *Impuls_{vuurpyl} = -Impuls_{speelgoedwaentjie} ✓✓*   (2)

4.3

OPTION 1/*OPSIE 1*
RIGHT AS POSITIVE/*REGS AS POSITIEF*

$$\sum p_i = \sum p_f$$
$$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$$
$$mv_i = m_1 v_{1f} + m_2 v_{2f}$$
✓Any one/*Enige een*

$$\underline{(20 + m_2)2,5} \checkmark = \underline{20(0,6)} \checkmark + \underline{m_2(30)} \checkmark$$
$$m_2 = 1,38 \text{ kg} \checkmark$$

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$$\sum p_i = \sum p_f$$
$$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$$
$$mv_i = m_1 v_{1f} + m_2 v_{2f}$$
✓Any one/*Enige een*

$$\underline{(20 + m_2)(-2,5)} \checkmark = \underline{20(-0,6)} \checkmark + \underline{m_2(-30)} \checkmark$$
$$m_2 = 1,38 \text{ kg} \checkmark$$

OPTION 2/*OPSIE 2*
RIGHT AS POSITIVE/*REGS AS POSITIEF*

$$\Delta p_{\text{toy cart}/speelgoedwaentjie} = -\Delta p_{\text{rocket}/vuurpyl}$$
$$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$$
✓Any one/*Enige een*

$$(20) \checkmark \underline{(0,6 - 2,5)} \checkmark = \underline{-(m)(30 - 2,5)} \checkmark$$
$$m_2 = 1,38 \text{ kg} \checkmark$$

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$$\Delta p_{\text{toy cart}/speelgoedwaentjie} = -\Delta p_{\text{rocket}/vuurpyl}$$
$$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$$
✓Any one/*Enige een*

$$(20) \checkmark \underline{[-0,6 - (-2,5)]} \checkmark = \underline{-(m)[(-30 - (-2,5)]} \checkmark$$
$$m_2 = 1,38 \text{ kg} \checkmark$$

(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 <u>net/total work</u> done on an object is <u>equal to the change in</u> the object's <u>kinetic energy.</u> ✓✓
Die <u>netto/totale arbeid</u> op 'n voorwerp is <u>gelyk aan die verandering</u> in die voorwerp se <u>kinetiese energie.</u>

OR/*OF*

The <u>work done</u> on an object <u>by a net force</u> is <u>equal to the change</u> in the object's <u>kinetic energy</u>.
Die <u>arbeid verrig</u> op 'n voorwerp <u>deur 'n netto krag</u> is <u>gelyk aan die verandering</u> in die voorwerp se <u>kinetiese energie.</u>   (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* $\theta = 180°/\cos\theta = -1$ (1)

5.3

OPTION 1/*OPSIE 1*
$W_{net} = \Delta K$ $W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige een* $mgsin\theta\Delta x cos\theta + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $\underline{(30\ 000)(9,8)sin28°\Delta x cos180°}$✓ $+ \underline{(31\ 000)\Delta x cos180°}$✓ $= \frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓ $\Delta x = 96,64$ m ✓
OPTION 2/*OPSIE 2*
$W_{nc} = \Delta K + \Delta U$ $W_f = \Delta K + mg(h_f - h_i)$ ✓Any one/*Enige een* $f\Delta x cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ $\underline{31\ 000\Delta x\ cos180°}$✓ $= \underline{\frac{1}{2}(30\ 000)(0^2 - 33^2)}$ ✓ $+ \underline{30\ 000(9,8)(\Delta x\ sin28° - 0)}$ ✓ $\Delta x = 96,64$ m ✓
OPTION 3/*OPSIE 3*
$W_{net} = \Delta K$ $W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $-\Delta E_p + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige* $-mg(h_f - h_i) + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $\underline{-(30\ 000)(9,8)(\Delta x sin28° - 0)}$✓ $+ \underline{(31\ 000)\Delta x cos180°}$✓ $= \frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓ $\Delta x = 96,64$ m ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎱ ✓Any one/*Enige*
$mg\Delta x \cos\theta + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎰

$\underline{(30\ 000)(9,8)\Delta x \cos 118°}$✓ $+ \underline{(31\ 000)\Delta x \cos 180°}$✓ $= \frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓

$\Delta x = 96,64$ m ✓

OPTION 5/*OPSIE 5*

$F_{net} = ma$
$F_{net} = F_{w//} + f$
$\quad = \underline{(30\ 000)(9,8)\sin 28° + 31\ 000}$✓
$\quad = 169\ 024,64$ N

$W_{net} = \Delta E_k$ ⎱ ✓Any one/*Enige een*
$F_{net}\Delta x \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎰

$\underline{169\ 024,64\Delta x \cos 180°}$✓ $= \frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓

$\Delta x = 96\ 64$ m ✓

(5)

5.4   Ascending/*Opgaande* ✓

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

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 woord/frase.

The (apparent) <u>change in frequency (or pitch)</u> (of the sound) detected by a listener because <u>the source and the listener have different velocities relative to the medium of propagation.</u> ✓✓

Die (skynbare) <u>verandering in die frekwensie (of toonhoogte)</u> (van die klank) waargeneem deur 'n luisteraar omdat die <u>bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.</u>

OR/*OF*

An (apparent) <u>change in</u> observed/detected <u>frequency/pitch</u> as a result of the <u>relative motion</u> between <u>a source and an observer</u>/listener.

'n (Skynbare) <u>verandering in</u> waargenome <u>frekwensie/toonhoogte</u> as gevolg van <u>die relatiewe beweging</u> tussen <u>die bron en 'n waarnemer/ luisteraar.</u>   (2)

6.2 $v = f\lambda$ ✓
$340 = (880)\lambda$ ✓
$\lambda = 0,39$ m $(0,386)$ ✓   (3)

6.3

OPTION 1/*OPSIE 1*
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $\qquad f_L = \dfrac{v + v_L}{v} f_S$
$f_L = \left(\dfrac{340 + 10}{340}\right)^{\checkmark} 880^{\checkmark}$
$f_L = 905,88$ Hz ✓

POSITIVE MARKING FROM QUESTION 6.2/
POSITIEWE NASIEN VANAF VRAAG 6.2
OPTION 2/*OPSIE 2*
$v = f\lambda$ ✓
$340 + 10$ ✓ $= f_L(0,39)$ ✓
$f_L = 897,44$ Hz ✓

(4)

6.4
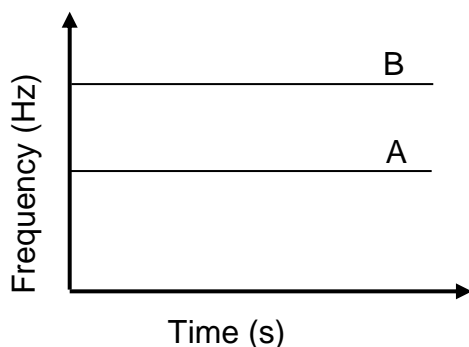
Marking criteria/*Nasienkriteria*
B parallel with A and above A. ✓✓
B parallel aan A en bokant A. **2 or/*of* 0**

(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) <u>is directly proportional to the product of the (magnitudes) of the charges</u> ✓ and <u>inversely proportional to the square of the distance (r) between them.</u> ✓
Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is <u>direk eweredig aan die produk van die ladings</u> en <u>omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.</u>

(2)

7.1.2
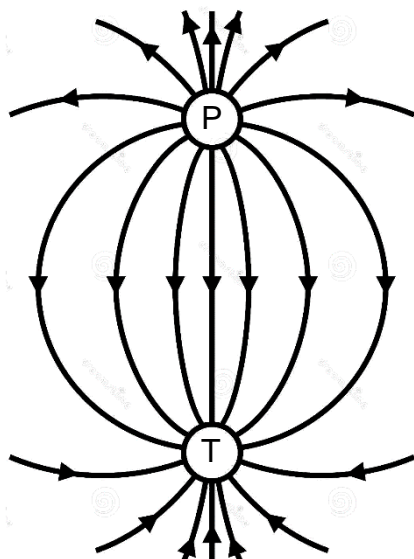
Criteria for graph/*Kriteria vir grafiek:*	
Correct shape *Korrekte vorm*	✓
Correct direction from P to T. *Korrekte rigting van P na T.*	✓
Lines must not cross and must touch spheres. *Lyne mag nie kruis nie en moet die sfere raak.*	✓
NOTE/*AANTEKENING*: If the net electric field pattern is drawn for 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 x10^{13} ✓

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

$$= \left(\frac{kQ_1Q_2}{r^2}\right)^{2✓} + \left(\frac{kQ_1Q_2}{r^2}\right)^2$$

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

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

$$Q_S = ne$$

$$\underline{4,887 \times 10^{-6}} = n(1,6 \times 10^{-19}) ✓$$

$$n = 3,05 \times 10^{13} ✓ \text{ electrons/}elektrone$$ (6)

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

OR/*OF*

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

7.2.2

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

(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 $\dfrac{1}{r^2}$, E is greater for sphere B. ✓✓

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

(3)
[20]

QUESTION 8/*VRAAG 8*

8.1 A conductor (resistor) which <u>obeys Ohm's law</u>./*'n Geleier wat <u>Ohm se wet gehoorsaam</u>.* ✓✓ **(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
$\dfrac{V}{I}$ = constant / k / c*onstant at constant temperature.* ✓✓ **(2 or/*of* 0)**
$\dfrac{V}{I}$ = konstant / k / *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 $R = \dfrac{V}{I}$ ✓
$4 = \dfrac{3,2}{I}$ ✓
$I = 0,8$ A ✓

(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_**
$\varepsilon = I(R+r)$ ✓　✓ $= 0,8\ (4+8) + 0,5)$ ✓ $= 10\ V$ ✓ **OR/_OF_** $\varepsilon = I(R+r)$ ✓ $= 0,8 (4+8)) + 0,8 \times 0,5$ ✓ $= 10\ V$ ✓	$V_8 = IR$ $\quad = (0,8)(8)$ $\quad = 6,4\ V$ $V_{ext} = \underline{3,2 + 6,4}$ $\quad = 9,6\ V$ $V_{int} = Ir$ $\quad = (0,8)(0,5)$ ✓ $\quad = 0,4\ V$ $\varepsilon = I(R + r)$ $\quad = V_{ext} + V_{int}$ ⎫ ✓Any one/_Enige een_ $\quad = \underline{9,6 + 0,4}$ ✓ $\quad = 10\ V$ ✓

(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_**
$V_{int} = Ir$ $\underline{1,2 = I(0,5)}$ ✓ $\quad I = 2,4\ A$ $R_{ext} = \dfrac{V}{I}$ $\quad = \dfrac{8,8\ ✓}{2,4\ ✓}$ $\quad = 3,67\ \Omega \quad (3,667)$ $R_P = \dfrac{12R}{12 + R}$ $3,67 = \dfrac{12R}{12 + R}$ ✓ $\quad R = 5,29\ \Omega\ (5,28)$ ✓ **OR/_OF_** $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ $\dfrac{1}{3,67} = \dfrac{1}{R} + \dfrac{1}{12}$ ✓ $R = 5,29\ \Omega\ (5,28)$ ✓	$V_{int} = 10 - 8,8$ $\quad = 1,2\ V$ $V_{int} = Ir$ $\underline{1,2 = I(0,5)}$ ✓ $\quad I = 2,4\ A$ $I_{series\ branch} = \dfrac{V}{R}$ $\quad = \dfrac{8,8\ ✓}{8+4}$ $\quad = 0,73\ A\ (0,733)$ $I_R = \underline{2,4 - 0,73}$ ✓ $\quad = 1,67\ A\ (1,667)$ $R = \dfrac{V}{I_R}$ $\quad = \dfrac{8,8}{1,67}$ ✓ $\quad = 5,27\ \Omega\ (5,28)$ ✓

(5)

8.3.2   There is a short circuit /*Daar is 'n kortsluiting.*
- The <u>resistance</u> of the connected wire is very <u>low</u>. / The total <u>resistance</u> <u>decreases</u>. ✓
  Die <u>weerstand</u> van die verbindingsdrade is baie <u>klein</u>. /Die totale <u>weerstand</u> <u>neem af</u>.
- $I \propto \dfrac{1}{R}$, <u>current</u> delivered by the battery is very <u>high.</u> ✓

  $I \propto \dfrac{1}{R}$, <u>stroom</u> gelewer deur die battery is baie <u>groot</u>.
- 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:*

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

                                                                                                    (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*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P_{ave} = \dfrac{V_{rms}^2}{R}$ ✓	$P_{ave} = V_{rms}I_{rms}$	$P_{ave} = V_{rms}I_{rms}$
$100 = \dfrac{220^2}{R}$ ✓	$100 = 220I_{rms}$	$100 = 220I_{rms}$
$R = 484\ \Omega$ ✓	$I_{rms} = 0,45\ A\ (0,455)$	$I_{rms} = 0,45\ A\ (0,455)$
	$I_{rms} = \dfrac{V_{rms}}{R}$ ✓	$P_{ave} = I_{rms}^2 R$ ✓
	$0,45 = \dfrac{220}{R}$ ✓	$100 = (0,45)^2 R$ ✓
	$R = 488,89\ \Omega$ ✓	$R = 493,83\ \Omega$ ✓

(3)

9.2.2

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

Marking criteria:	Nasienriglyne:
• Uses power of Y in circuit (80 W) to calculate I $_{rms}$ of the circuit. ✓	• *Gebruik drywing van Y in stroombaan (80 W) om I$_{wgk}$ te bereken. ✓*
• Determines V $_{rms}$ across R$_Z$ in the circuit. ✓	• *Bepaal V$_{wgk}$ oor R$_Z$ in die stroombaan. ✓*
• Uses I $_{rms}$ and V$_{rms}$ across R$_Z$ in the circuit to calculate resistance R$_Z$. ✓	• *Gebruik I$_{wgk}$ en V$_{wgk}$ oor R$_Z$ in die stroombaan om weerstand R$_Z$ te bereken. ✓*
• Use of any <u>one</u> relevant power equation. ✓	• *Gebruik van <u>enige</u> drywing-formule.*
• Uses R$_Z$ and 220 V to calculate X. ✓	• *Gebruik R$_Z$ en 220 V om X te bereken. ✓*
• Final answer for X. ✓	• *Finale antwoord vir X. ✓*
Accept range:	***Aanvaar gebied:***
846,07 W to 856,03 W	*846,07 W tot 856,03 W*

For resistor Y/*Vir resistor Y*

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

$\underline{80 = I_{rms}^2 \,(484)}$ ✓

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

OR/*OF*

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

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

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

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

$\quad = \dfrac{196{,}77}{484}$ ✓

$\quad = 0{,}407$ A

For/*Vir Z*

$V_{rms} = 220 - 196{,}77$ ✓

$\quad = 23{,}23$ V

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

$[0{,}407 = \dfrac{23{,}23}{R}]$ ✓

$R = 57{,}08\ \Omega$

Range/*Gebied*:
56,66 Ω to/tot 57,13 Ω

X for Z/*X vir Z*:

$X = P_{ave} = \dfrac{V_{rms}^2}{R}$ ✓

$\quad = \dfrac{220^2}{57{,}08}$ ✓

$\quad = 847{,}93$ W ✓

OR/*OF*

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

$\quad = \dfrac{220}{57{,}08}$

$\quad = 3{,}85$ A

$X = P_{ave} = I_{rms}^2 R$ ✓

$\quad = \underline{(3{,}85)^2 (57{,}08)}$ ✓

$\quad = 846{,}07$ W ✓

OR/*OF*

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

$\quad = \dfrac{220}{57{,}08}$

$\quad = 3{,}85$ A

$X = P_{ave} = V_{rms}I_{rms}$ ✓

$\quad = (220)(3{,}85)$ ✓

$\quad = 847$ W ✓

(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 word/frase.*

The process whereby <u>electrons are ejected from a</u> (metal) <u>surface</u> when <u>light of suitable frequency is incident on that surface.</u> ✓✓
Die proses waartydens <u>elektrone vrygestel word vanaf 'n</u> (metaal) <u>oppervlak</u> wanneer <u>lig</u> van geskikte frekwensie <u>invallend is op die oppervlak.</u>   (2)

10.1.2   For one photon/*Vir een foton*:

$E = hf$ ✓

$\qquad = (6{,}63 \times 10^{-34})(1{,}2 \times 10^{15})$ ✓

$\qquad = 7{,}96 \times 10^{-19}\text{J}$

| **NOTE/*LET WEL***
| $W_o = hf_o$ $^0/_2$

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

$$= \frac{\text{Total energy of photons}}{\text{Energy of one photon}} \Big/ \frac{\text{Totale energie van fotone}}{\text{Energie van een foton}}$$

$$= \frac{1{,}75 \times 10^{-9}}{7{,}96 \times 10^{-19}} \;✓$$

$$= 2{,}2 \times 10^9 \;✓ \; (2{,}198 \times 10^9) \qquad\qquad (4)$$

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

$$\left. \begin{array}{l} E = W_0 + K_{max} \\ hf = hf_o + \frac{1}{2}mv_{max}^2 \end{array} \right\} ✓\text{Any one/}Enige\ een$$

$$7{,}96 \times 10^{-19} ✓ = (6{,}63 \times 10^{-34})(9{,}09 \times 10^{14}) ✓ + \frac{1}{2}(9{,}11 \times 10^{-31})v_{max}^2 ✓$$

$$v_{max} = 6{,}51 \times 10^5 \text{ m·s}^{-1} ✓$$

                                                                   (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**