basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

NOVEMBER 2022

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 32 pages.
Hierdie nasienriglyne bestaan uit 32 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 D ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 C ✓✓ (2)

1.10 D ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

2.1

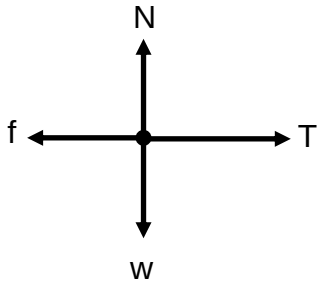
Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

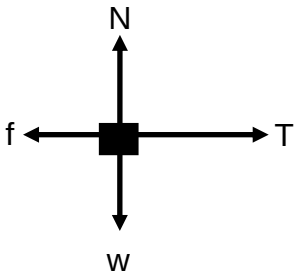
When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Die versnelling is direk eweredig aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The resultant/net force acting on an object is equal to the rate of change of momentum of the object. **(2 or 0)**
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. ***(2 of 0)*** (2)

2.2

Accept force diagram/
Aanvaar kragte-diagram:





Accepted labels/*Aanvaarde benoemings*	
w	F_g /F_w /$F_{earth\ on\ P}$ /weight /mg /12,25 N /gravitational force *F_g /F_w /$F_{aarde\ op\ P}$ /gewig /mg /12,25 N /gravitasiekrag*
T	F_T /F_{string} /*F_{tou}* /F_t /tension /*spanning* /*F_s*
f	F_f /f_k /(kinetic) friction /*(kinetiese) wrywing* /1,8 N /*F_w*
N	F_N /Normal /F_{normal} /*$F_{normaal}$* /*Normaal*

Notes/*Aantekeninge*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* Max/*Maks* $^3/_4$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $^3/_4$
- If force(s) do not make contact with the dot /*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks* $^3/_4$

(4)

2.3.1

For P/*Vir P* **RIGHT AS POSITIVE/** ***REGS AS POSITIEF***	**For P/*Vir P*** **LEFT AS POSITIVE/** ***LINKS AS POSITIEF***
$F_{net} = ma$ $T + f = ma$ $T - f = ma$ } ✓ Any one/ *Enige een* $T - 1,8$ ✓$= (1,25)(0,1)$ ✓ $T = 1,93$ N ✓ (1,925 N)	$F_{net} = ma$ $T + f = ma$ $-T + f = ma$ } ✓ Any one/ *Enige een* $-T + 1,8$ ✓$= (1,25)(-0,1)$ ✓ $T = 1,93$ N ✓ (1,925 N)

(4)

2.3.2

POSITIVE MARKING FROM QUESTION 2.3.1/
POSITIEWE NASIEN VANAF VRAAG 2.3.1.

RIGHT AS POSITIVE/*REGS AS POSITIEF:*

For Q/*Vir Q*

Accept/*Aanvaar*
Sin(90°- θ)

$F_{net} = ma$
$F\cos\theta - T - f = ma$
$F\cos\theta + T + f = ma$
$7,5\cos\theta - 1,93 - 2,2$ ✓$= (2)(0,1)$ ✓
$\theta = 54,74°$✓ (Range:54,55° - 54,78°)

LEFT AS POSITIVE/*LINKS AS POSITIEF:*

For Q/*Vir Q*

Accept/*Aanvaar*
Sin(90°- θ)

$F_{net} = ma$
$-F\cos\theta + T + f = ma$
$F\cos\theta + T + f = ma$
$-7,5\cos\theta + 1,93 + 2,2$ ✓$= (2)(-0,1)$ ✓
$\theta = 54,74°$ ✓ (Range:54,55° - 54,78°)

(3)

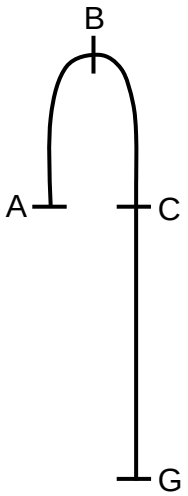
[13]

QUESTION 3/*VRAAG 3*

3.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓
Beweging slegs onder die invloed van gravitasie/gewig/swaartekrag.
(2 or/of 0)

OR/*OF*
Motion in which the only force acting is gravity/weight/gravitational force.
Beweging waar die enigste krag wat inwerk, gravitasie/gewig/swaartekrag is.
(2 or/of 0) (2)

3.2.1



Marking criteria/*Nasienkriteria*

- Formula with Δt/*Formule met Δt* ✓
- Correct substitution into formula/*Korrekte vervanging in formule* ✓
- Final answer/*Finale antwoord*: 1,22 s ✓ (1,22 s to/*tot* 1,23 s)

OPTION 1/*OPSIE 1*

A-B:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$0 = 12 + (-9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$0 = -12 + (9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

OPTION 2/*OPSIE 2*

B-C:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$-12 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$12 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓

OPTION 3/*OPSIE 3*

A-C:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$-12 = 12 + (-9,8)\Delta t$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$12 = -12 + (9,8)\Delta t$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

OPTION 4/*OPSIE 4*

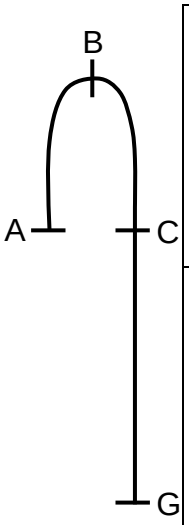
A-C:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = (12)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0 = (-12)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓



OPTION 5/*OPSIE 5*
A-B OR/*OF* B-C:

$(E_{mech})_{Top/Bo} = (E_{mech})_{25\ m}$
$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{25\ m}$
$(mgh + ½mv^2)_{Top/Bo} = (mgh + ½mv^2)_{25\ m}$
$(9,8)h + 0 = 0 + (½)(12)^2$
$\Delta h = 7,35$ m

OPTION 6/*OPSIE 6*
A-B OR/*OF* B-C

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = \Delta K + mg(h_f - h_i)$
$0 = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$
$0 = ½(0^2 - 12^2) + (9,8)\Delta h$
$\Delta h = 7,35$ m

OPTION 7/*OPSIE 7*
A-B OR/*OF* B-C

$W_{net} = \Delta E_k$
$w\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$
$(9,8)\Delta y\cos 180° = 0 - ½(12)^2$
$\Delta y = 7,35$ m

OPTION 8/*OPSIE 8*
A-B:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = 12^2 + 2(-9,8)\Delta y$
$\Delta y = 7,35$ m

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = (-12)^2 + 2(9,8)\Delta y$
$\Delta y = -7,35$ m

OPTION 9/*OPSIE 9*
B-C:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$
$(-12)^2 = 0^2 + 2(-9,8)\Delta y$
$\Delta y = -7,35$ m

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

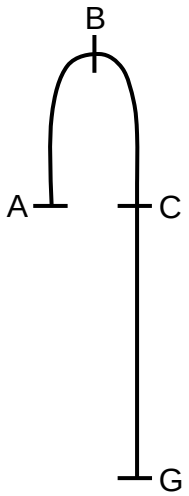
$v_f^2 = v_i^2 + 2a\Delta y$
$(12)^2 = 0^2 + 2(9,8)\Delta y$
$\Delta y = 7,35$ m

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$7,35 = \left(\frac{12 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,23$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-7,35 = \left(\frac{-12 + 0}{2}\right)\Delta t$ ✓
$\Delta t = 1,23$ s ✓



OPTION 10/*OPSIE 10*

A-B:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

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

$\Delta y = \left(\frac{12 + 0}{2}\right)\Delta t$

$\Delta y = 6\Delta t$

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

$0 = (12)^2 + 2(-9,8)(6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

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

$\Delta y = \left(\frac{-12 + 0}{2}\right)\Delta t$

$\Delta y = -6\Delta t$

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

$0 = (-12)^2 + 2(9,8)(-6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

OPTION 11/*OPSIE 11*

B-C:

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

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

$\Delta y = \left(\frac{0 - 12}{2}\right)\Delta t$

$\Delta y = -6\Delta t$

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

$-12 = (0)^2 + 2(-9,8)(-6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

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

$\Delta y = \left(\frac{12 + 0}{2}\right)\Delta t$

$\Delta y = 6\Delta t$

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

$12^2 = 0^2 + 2(9,8)(6\Delta t)$ ✓

$\Delta t = 1,22$ s ✓

OPTION 12/*OPSIE 12*

A-B:

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*

$-(9,8)\Delta t = 0 - 12$ ✓

$\Delta t = 1,22$ 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*

$(9,8)\Delta t = 12 - 0$ ✓

$\Delta t = 1,22$ s ✓

(3)

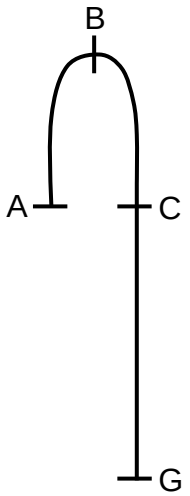
3.2.2

Marking criteria/*Nasienkriteria*

- Formula with v_f./*Formule met* v_f. ✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Correct final answer/*Korrekte finale antwoord*:
  25,18 m·s^{-1} ✓ (25,03 m·s^{-1} to/*tot* 25,59 m·s^{-1})
- Correct direction (only if numerical value is given)./*Korrekte rigting (slegs indien numeriese waarde gegee is).*✓

OPTION 1/*OPSIE 1*

A-G:	**A-G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
***OPWAARTS AS POSITIEF*:**	***AFWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(12)^2 + 2(-9,8)(-25)}$ ✓	$v_f^2 = \underline{(-12)^2 + 2(9,8)(25)}$ ✓
v_f = 25,18 m·s^{-1}✓ downwards ✓	v_f = 25,18 m·s^{-1}✓ downwards ✓
afwaarts	*afwaarts*

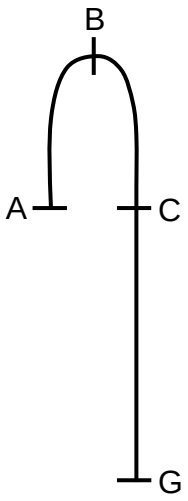


OPTION 2/*OPSIE 2*

C-G:	**C-G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	**AFWAARTS AS POSITIEF**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(-12)^2 + 2(-9,8)(-25)}$ ✓	$v_f^2 = \underline{(12)^2 + 2(9,8)(25)}$ ✓
v_f = 25,18 m·s^{-1}✓ downwards ✓	v_f = 25,18 m·s^{-1}✓ downwards ✓
afwaarts	*afwaarts*

OPTION 3/*OPSIE 3*

B-G	**B-G**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	**AFWAARTS AS POSITIEF**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (0)^2 + \underline{2(-9,8)(-32,35)}$ ✓	$v_f^2 = (0)^2 + \underline{2(9,8)(32,35)}$ ✓
v_f = 25,18 m·s^{-1}✓ downwards ✓	v_f = 25,18 m·s^{-1}✓ downwards ✓
afwaarts	*afwaarts*



OPTION 4/*OPSIE 4*

A-G:

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*

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

$-25 = 12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$

$\Delta t = 3,79$ s

A-G

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

$-25 = \left(\frac{12 + v_f}{2}\right)3,79$

$v_f = -25,18\ m\cdot s^{-1}$

$\therefore v_f = 25,18\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

B-G

$v_f = v_i + a\Delta t$ ✓

$v_f = 0 + \underline{(-9,8)(3,79 - 1,22)}$ ✓

$v_f = -25,19\ m\cdot s^{-1}$

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

C-G

$v_f = v_i + a\Delta t$ ✓

$v_f = \underline{-12 + (-9,8)(1,35)}$ ✓

$v_f = -25,19\ m\cdot s^{-1}$

$v_f = 25,19\ m\cdot s^{-1}$✓ downwards ✓
afwaarts

A-G:
DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

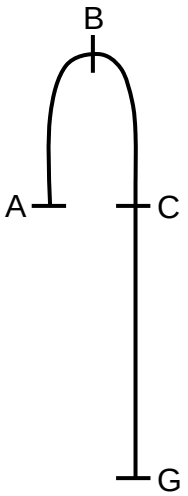
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$25 = -12\Delta t + \frac{1}{2}(9,8)\Delta t^2$
$\Delta t = 3,79$ s

A-G
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$25 = \left(\frac{-12 + v_f}{2}\right)3,79$ ✓
$\therefore v_f = 25,18$ m·s^{-1}✓ downwards ✓
afwaarts

B-G
$v_f = v_i + a\Delta t$ ✓
$= 0 + (9,8)(3,79 - 1,22)$ ✓
$v_f = 25,19$ m·s^{-1}✓ downwards ✓
afwaarts

C-G
$v_f = v_i + a\Delta t$ ✓
$v_f = 12 + (9,8)(3,79 - 2(1,22))$ ✓
$v_f = 25,19$ m·s^{-1}✓ downwards ✓
afwaarts

OPTION 5/*OPSIE 5*



C-G:
UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-25 = -12\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
$\Delta t = 1,34$ s

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-25 = \left(\frac{-12 + v_f}{2}\right)1,34$ ✓
$v_f = -25,18$ m·s^{-1}
$\therefore v_f = 25,18$ m·s^{-1}✓ downwards ✓
afwaarts

C-G:
DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$25 = 12\Delta t + \frac{1}{2}(9,8)\Delta t^2$
$\Delta t = 1,34$ s

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$25 = \left(\frac{12 + v_f}{2}\right)1,34$ ✓
$v_f = 25,18$ m·s^{-1}✓ downwards ✓
afwaarts

OPTION 6/*OPSIE 6*

$(E_{mech/meg})_i = (E_{mech/meg})_f$
$(E_P + E_K)_i = (E_P + E_K)_f$
$(mgh + ½mv^2)_i = (mgh + ½mv^2)_f$
✓Any one/
Enige een

$m(9,8)(25) + ½m(12^2) = 0 + ½mv_f^2$ ✓
$v_f = 25,18$ m·s^{-1}✓ downwards/*afwaarts* ✓

OPTION 7/*OPSIE 7*

$W_{nc} = \Delta E_k + \Delta E_p$
$= (E_{kf} - E_{ki}) + (E_{pf} - E_{pi})$
$= (½mv_f^2 - ½mv_i^2) + (mgh_f - mgh_i)$ ✓Any one/ *Enige een*
$0 = [½mv_f^2 - ½m(12)^2] + [0 - m(9,8)(25)]$ ✓
$v_f = 25,18\ m\cdot s^{-1}$✓ downwards/*afwaarts* ✓

OPTION 8/*OPSIE 8*

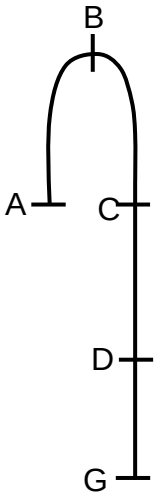
$W_{net} = \Delta E_k$
$= (E_{kf} - E_{ki})$
$= (½mv_f^2 - ½mv_i^2)$ ✓Any one/ *Enige een*
$m(9,8)(25) = ½mv_f^2 - ½m(12)^2$ ✓
$v_f = 25,18\ m\cdot s^{-1}$✓ downwards/*afwaarts* ✓ (4)

3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2.2.

Marking criteria/*Nasienkriteria*
- Substitution into formula to calculate v at the top of the door ✓
  Vervanging in formule om v bokant die deur te bereken.
- Formula to calculate Δt from top to bottom of door.✓
  Formule om Δt te bereken van bokant tot onderkant van deur.
- Substitution to calculate Δt. ✓
  Vervanging om Δt *te bereken.*
- Final answer/*Finale antwoord*: 0,07 to/*tot* 0,08 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*



A-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (12)^2 + 2(-9,8)(-23,1)$ ✓
$v_f = 24,43\ m\cdot s^{-1}$

C-D:
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-12)^2 + (2)(-9,8)(-23,1)$ ✓
$v_f = 24,43\ m\cdot s^{-1}$

D-G:
$v_f^2 = v_i^2 + 2a\Delta y$
$(-25,18)^2 = (v_i)^2 + 2(-9,8)(-1,9)$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

B-D
$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = 0 + 2(-9,8)(-30,447)$ ✓
$= 24,43\ m\cdot s^{-1}$

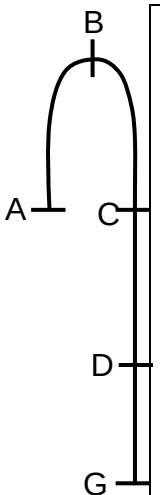
D-G:
$E_{(mech\ top/meg\ bo)} = E_{(mech\ bot/meg\ ond)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bot/ond}$
$(mgh + ½mv^2)_{top/bo} = (mgh + ½mv^2)_{bot/ond}$
$m(9,8)(1,9) + ½m(v_i)^2 = 0 + ½m(25,18)^2$ ✓
$v_i = 24,43\ m\cdot s^{-1}$

D-G:
$v_f = v_i + a\Delta t$ ✓
$-25,18 = -24,43 + (-9,8)\Delta t$ ✓
$\Delta t = 0,08\ s$ ✓

D-G:
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓
$-1,9 = -24,43\Delta t + ½(-9,8)\Delta t^2$✓
$\Delta t = 0,08\ s$ ✓

D-G:
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$✓
$-1,9 = \left(\frac{-24,43 - 25,18}{2}\right)\Delta t$ ✓
$\Delta t = 0,08\ s$ ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



A-D:

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

$v_f^2 = (-12)^2 + 2(9,8)(23,1)$ ✓

$v_i = 24,43\ m\cdot s^{-1}$

C-D:

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

$v_f^2 = (12)^2 + (2)(9,8)(23,1)$ ✓

$v_f = 24,43\ m\cdot s^{-1}$

D-G:

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

$(25,18)^2 = (v_i)^2 + 2(9,8)(1,9)$ ✓

$v_i = 24,43\ m\cdot s^{-1}$

B-D

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

$v_f^2 = 0 + 2(9,8)(30,447)$ ✓

$= 24,43\ m\cdot s^{-1}$

D-G:

$E_{(\text{mech top/}meg\ bo)} = E_{(\text{mech bot/}meg\ ond)}$

$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bot/ond}$

$(mgh + \frac{1}{2}mv^2)_{top/bo} = (mgh + \frac{1}{2}mv^2)_{bot/ond}$

$m(9,8)(1,9) + \frac{1}{2}m(v_i)^2 = 0 + \frac{1}{2}m(25,18)^2$ ✓

$v_i = 24,43\ m\cdot s^{-1}$

D-G:

$v_f = v_i + a\Delta t$ ✓

$25,18 = 24,43 + (9,8)\Delta t$ ✓

$\Delta t = 0,08\ s$ ✓

D-G:

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

$1,9 = 24,43\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓

$\Delta t = 0,08\ s$ ✓

D-G:

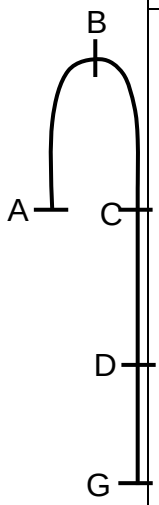
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$1,9 = \left(\frac{24,43 + 25,18}{2}\right)\Delta t$ ✓

$\Delta t = 0,08\ s$ ✓

Marking criteria OPTION 2 and 3/*Nasienkriteria OPSIE 2 en 3*

- Either one of the formula to calculate Δt./*Enige een van die formules om Δt te bereken.* ✓
- Substitute into formula to calculate time from A to G or C to G/*Vervanging in formule om tyd te bereken tussen A tot G of C tot G* ✓
- Substitute into formula to calculate time from A to D or C to D/ *Vervanging in formule om tyd te bereken tussen A tot D of C tot D* ✓
- Final answer/*Finale antwoord*: 0,07 s ✓ (0,07s to/*tot* 0,08s)



OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*

A-G:

$v_f = v_i + a\Delta t$

$-25,18 = 12 + (-9,8)\ \Delta t$ ✓

$\Delta t = 3,79$ s

✓Any one/ *Enige een*

A-D:

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

$-23,1 = (12)\Delta t + ½(-9,8)\Delta t^2$ ✓

$\Delta t = 3,72$ s

Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*

D-G:

3,79 – 3,72 = 0,07 s ✓

DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:*

A-G:

$v_f = v_i + a\Delta t$

$25,18 = -12 + (9,8)\ \Delta t$ ✓

$\Delta t = 3,79$ s

✓Any one/ *Enige een*

A-D:

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

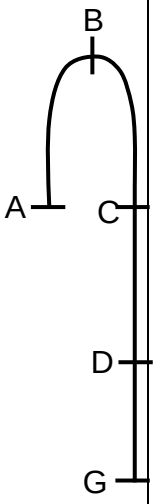
$23,1 = (-12)\Delta t + ½(9,8)\Delta t^2$ ✓

$\Delta t = 3,72$ s

Time from top to bottom/*Tyd van bokant tot onderkant van deur:*

D-G:

3,79 – 3,72 = 0,07 s ✓



OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*

C-G:

$v_f = v_i + a\Delta t$

$-25,18 = -12 + (-9,8)\ \Delta t$ ✓

$\Delta t = 1,34$ s

✓Any one/ *Enige een*

C-D:

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

$-23,1 = (-12)\Delta t + ½(-9,8)\Delta t^2$ ✓

$\Delta t = 1,27$ s

Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*

D-G:

1,34 – 1,27 = 0,07 s ✓

DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:*

C-G:

$v_f = v_i + a\Delta t$

$25,18 = 12 + (9,8)\ \Delta t$ ✓

$\Delta t = 1,34$ s

✓Any one/ *Enige een*

C-D:

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

$23,1 = (12)\Delta t + ½(9,8)\Delta t^2$ ✓

$\Delta t = 1,27$ s

Time from top to bottom of door/*Tyd van bokant tot onderkant van deur:*

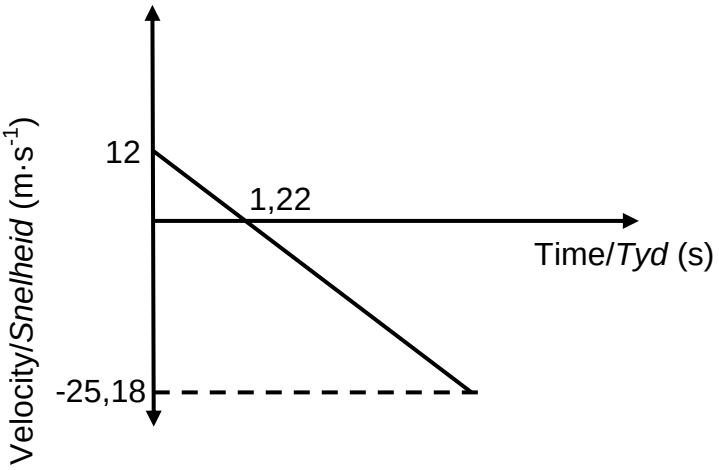
D-G:

1,34 – 1,27 = 0,07 s ✓

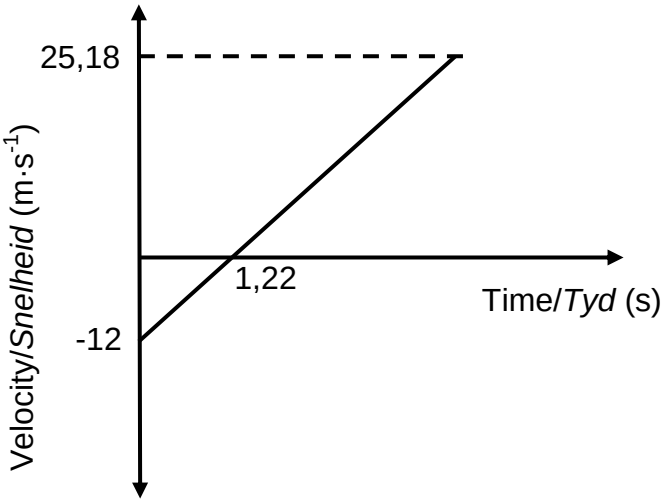
OPTION 4/*OPSIE 4*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF:*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:***
G-D:	**G-D:**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$1,9$ ✓$= \frac{25,18\Delta t + \frac{1}{2}(-9,8)\Delta t^2}{}$ ✓	$-1,9$ ✓$= \frac{-25,18\Delta t + \frac{1}{2}(9,8)\Delta t^2}{}$ ✓
$\Delta t = 0,08$ s ✓ (0,077 s)	$\Delta t = 0,08$ s ✓ (0,077 s)

(4)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.1 AND QUESTION 3.2.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN VRAAG 3.2.2.
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



Criteria for graph/*Kriteria vir grafiek*	
Straight line starting at v = 12 m·s^{-1} with negtive final velocity or straight line starting at v = -12 m·s^{-1} with positive final velocity. /*Reguitlyn wat begin by v = 12 m·s^{-1}met negatiewe finale snelheid of reguitlyn wat begin by v = -12 m·s^{-1}*met positiewe finale snelheid.	✓
Straight line cuts time axis at time calculated in Question 3.2.1/ *Reguitlyn sny tydas by die tyd bereken in Vraag 3.2.1.*	✓
Correct final velocity as calculated in Question 3.2.2 is indicated./*Korrekte finale snelheid soos uitgewerk in Vraag 3.2.2 is aangedui.*	✓

(3)
[16]

QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

In an isolated/closed system the total (linear) momentum is conserved/remains constant. ✓✓
In 'n geïsoleerde/geslote sisteem bly die totale (lineêre) momentum behoue/konstant. (2)

4.2.1

OPTION 1/*OPSIE 1*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\sum p_i = \sum p_f$
$m_x v_{ix} + m_y v_{iy} = m_x v_{fx} + m_y v_{fy}$ } ✓Any one/*Enige een*

$(1,2)(8)$ ✓ $+ (0,5)(0) = (1,2)(4) + (0,5)(v_{fy})$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIVE/*WES AS POSITIEF*

$\sum p_i = \sum p_f$
$m_x v_{ix} + m_y v_{iy} = m_x v_{fx} + m_y v_{fy}$ } ✓ Any one/*Enige een*

$(1,2)(-8)$ ✓ $+ (0,5)(0) = (1,2)(-4) + (0,5)(v_{fy})$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

OPTION 2 /*OPSIE 2*
EAST AS POSITIVE/*OOS AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*

$1,2(4 - 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓

WEST AS POSITIVE/*WES AS POSITIEF*

$\Delta p_x = -\Delta p_y$
$m(v_{xf} - v_{xi}) = -m(v_{yf} - v_{yi})$ } ✓ Any one/*Enige een*

$1,2(-4 + 8)$ ✓ $= -0,5(v_f - 0)$ ✓
$v_{fy} = -9,6\ m.s^{-1}$
$\therefore v_{fy} = 9,6\ m\cdot s^{-1}$ ✓ (4)

4.2.2

OPTION 1/*OPSIE 1*

EAST POSITIVE/*OOS POSITIEF:*
For X/*Vir X:*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*

$F_{net}(0,1) = 1,2(4 - 8)$ ✓
$F_{net} = -48$ N ✓
$\therefore F_{net} = 48$ N ✓

WEST POSITIVE/*WES POSITIEF:*
For X /*Vir X:*

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/*Enige een*

$F_{net}(0,1) = 1,2(-4 + 8)$ ✓
$\therefore F_{net} = 48$ N ✓

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM QUESTION 4.2.1.
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

EAST AS POSITIVE ***OOS AS POSITIEF*** **For Y/*Vir Y:***	**WEST AS POSITIVE** ***WES AS POSITIEF*** **For Y/*Vir Y:***
$F_{net}\Delta t = \Delta p$ ✓Any one/ *Enige een* $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $F_{net}(0,1) = 0,5(-9,6 - 0)$ ✓ $F_{net} = -48$ N $\therefore F_{net} = 48$ N ✓	$F_{net}\Delta t = \Delta p$ ✓Any one/ *Enige een* $F_{net}\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $F_{net}(0,1) = 0,5(9,6 - 0)$ ✓ $F_{net} = 48$ N ✓

OPTION 3/*OPSIE 3*

EAST AS POSITIVE for X ***OOS AS POSITIEF vir X***	**WEST AS POSITIVE for X** ***WES AS POSITIEF vir X***
$v_f = v_i + a\Delta t$ $-4 = -8 + a(0,1)$ $a = -40$ m·s^{-2} $F_{net} = ma$ ✓ $F_{net} = (1,2)(-40)$ ✓ $F_{net} = -48$ N $\therefore F_{net} = 48$ N ✓	$v_f = v_i + a\Delta t$ $4 = 8 + a(0,1)$ $a = 40$ m·s^{-2} $F_{net} = ma$ ✓ $F_{net} = (1,2)(40)$ ✓ $F_{net} = 48$ N✓

OPTION 4/*OPSIE 4*

EAST AS POSITIVE for X ***OOS AS POSITIEF vir X***	**WEST AS POSITIVE for X** ***WES AS POSITIEF vir X***
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $\Delta x = \left(\frac{8 + 4}{2}\right)(0,1)$ $\Delta x = 0,6$ m $F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓ $F_{net}(0,6)\cos 180^o = \frac{1}{2}(1,2)(4)^2 - \frac{1}{2}(1,2)(8)^2$ ✓ $F_{net} = 48$ N ✓	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $\Delta x = \left(\frac{-8 - 4}{2}\right)(0,1)$ $\Delta x = -0,6$ m $F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓ $F_{net}(0,6)\cos 0^o = \frac{1}{2}(1,2)(-4)^2 - \frac{1}{2}(1,2)(-8)^2$ ✓ $F_{net} = -48$ N ✓ $\therefore F_{net} = 48$ N ✓

OPTION 5/*OPSIE 5*

$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$
$$= \frac{\Delta v}{\Delta t}$$
$$= \frac{4 - 8}{0,1}$$
$$= -40 \text{ m·s}^{-2}$$

$F_{net} = ma$ ✓
$F_{net} = (1,2)(-40)$ ✓
$F_{net} = -48$ N
$F_{net} = 48$ N ✓

(3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2.1/**
POSITIEWE NASIEN VANAF VRAAG 4.2.1.

OPTION 1/*OPSIE 1*

Inelastic/*onelasties* ✓

$E_k = ½mv^2$ ✓

$\sum E_{ki} = ½m_Xv_{Xi}^2 + ½m_Yv_{Yi}^2$
$= ½(1,2)(8)^2 + 0$ ✓
$= 38,4$ J

$\sum E_{kf} = ½m_Xv_{Xf}^2 + ½m_Yv_{Yf}^2$
$= ½(1,2)(4)^2 + ½(0,5)(9,6)^2$ ✓
$= 32,64$ J

$\sum E_{ki} \neq \sum E_{kf}$ ✓

OPTION 2/*OPSIE 2* (Change in E_{ktotal} total /*verandering in* $E_{ktotaal}$))

Inelastic/onelasties✓

$E_k = ½mv^2$ ✓

$\Delta E_k(X) = ½mv_f^2 - ½mv_i^2$
$= ½(1,2)(4)^2 – ½(1,2)(8)^2$ ✓
$= - 28,8$ J

$\Delta E_k(Y) = ½mv_f^2 - ½mv_i^2$
$= ½(0,5)(9,6)^2 – ½(0,5)(0)^2$ ✓
$= 23,04$ J

$\Delta E_k(X) \neq \Delta E_k(Y)$ ✓

Note/*Aantekening*:
If candidate starts with conservation of kinetic energy/*Indien kandidaat begin met behoud van kinetiese energie:* max/*maks* $\frac{4}{5}$

(5)
[14]

QUESTION 5/*VRAAG 5*

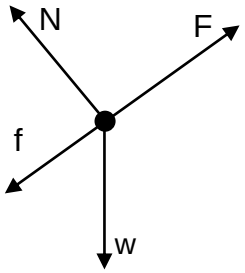
5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

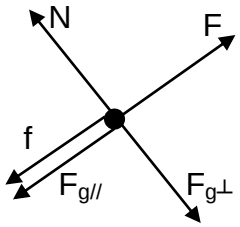
A force is non-conservative if the work done by the force on an object (which is moving between two points) depends on the path taken. ✓✓
'n Krag waarvoor die arbeid wat verrig word deur die krag op 'n voorwerp (wat tussen twee punte beweeg,) afhanklik is van die pad wat gevolg word.
OR/*OF*
A force is non-conservative if the work it does in moving an object around a closed path is non-zero.
'n Krag is nie-konserwatief wanneer die arbeid wat dit verrig om 'n voorwerp in 'n geslote pad te beweeg, nie nul is nie. (2)

Note/*Aantekening:*
-If work done is ommited/ Indien arbeid verrig uitgelaat word: $\frac{0}{2}$

5.2



OR/*OF*



Accepted labels/*Aanvaarde benoemings*	
w	F_w / F_g / mg /117,6 N / gravitational force / *gravitasiekrag* / weight / *gewig*
F	F_A /Applied force / T /*Toegepaste krag*/ F_T
f	F_f / f_k / (kinetic) Friction / *(kinetiese) wrywing* / F_w
N	F_N / Normal / *Normaal*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- If w is not shown but $F_{//}$ and $F_{g\perp}$ are shown, give 1 mark for both./*Indien w nie aangetoon is nie maar $F_{//}$ en* $Fg_{\perp}$ *is getoon, ken 1 punt toe vir beide.*
- Any other additional force(s)/*Enige ander addisionele krag(te):* *Max/Maks* $\frac{3}{4}$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $\frac{3}{4}$ •
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $\frac{3}{4}$

(4)

5.3

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta E_k + \Delta E_p$
$W_{nc} = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓ Any one/Enige een
$= \frac{1}{2}(12)(2,25^2 - 0)$ ✓ + $(12)(9,8)(4,5 - 0)$ ✓
$= 559,58$ J ✓

OPTION 2/*OPSIE 2*

$W_{Fg//} = F_{g//}\Delta x\cos$
$= (mg\sin\theta)\Delta x\cos\theta$
$= (12)(9,8)\left(\frac{4,5}{\Delta x}\right)\Delta x\cos180°$
$= -529,2$ J

$W_{Fg} = F_g\Delta x\cos(90° + \theta)$
$= mg\Delta x(-\sin\theta)$
$= (12)(9,8)\left(\frac{-4,5}{\Delta x}\right)\Delta x$
$= -529,2$ J

$W_{net} = \Delta Ek$
$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}(12)(2,25)^2 - 0^2$ ✓
$= 30,375$ J

$W_{net} = W_{nc} + W_c$ ✓
$30,375 = W_{nc} + (-529,2)$ ✓
$W_{nc} = 559,575$ J ✓ (559,58 J)

OPTION 3/*OPSIE 3*

$\sin\theta = \frac{4,5}{\Delta x}$

$\Delta x = \frac{4,5}{\sin\theta}$

$W_{net} = \Delta E_k$
$W_F + W_f + W_w = \Delta E_k$
$W_{nc} + (mg\sin\theta)\Delta x(\cos\beta) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓Any one/ *Enige een*

$W_{nc} + (12)(9,8)\left(\frac{4,5}{\sin\theta}\right)\sin\theta\cos180°$ ✓ $= \frac{1}{2}(12)(2,25)^2 - 0^2$ ✓

$W_{nc} = 559,58$ J ✓

(4)

5.4 **POSITIVE MARKING FROM QUESTION 5.3.**
POSITIEWE NASIEN VANAF VRAAG 5.3.

Marking criteria for OPTION 1 /*Nasienkriteria vir OPSIE 1*

- Formula for W_{nc} /*Formule vir* W_{nc} ✓
- Correct substitution of 559,58 J in W_{nc} along inclined plane ✓
  Korrekte vervanging van 559,58 J in W_{nc} *langs die skuinsvlak*
- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane✓
  Korrekte kragvergelyking en vervanging van 0 vir F_{net} ***OF*** $F = f_2$ *op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓
  Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ *vir* f_2*).*
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 1/*OPSIE 1*

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{nc} = W_F + W_f$
$W_{nc} = F\Delta x\cos 0° + f_1\Delta x\cos 180°$ } ✓ Any one/*Enige een*
$559,58 = F\Delta x\cos 0° + f_1\Delta x\cos 180°$
$559,58$ ✓ $= (F - f_1)\Delta x$ .....(1)

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓ $= 0$
$F - f_1 = 42$.....(2)

Substitute/*Vervang* (2) into/*in* (1):
$559,58 = 42\Delta x$
$\Delta x = 13,32$ m ✓

Marking criteria for OPTION 2 and 3 /*Nasienkriteria vir OPSIE 2 en 3*

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane✓
  Korrekte kragvergelyking en vervanging van 0 vir F_{net} ***OF*** $F = f_2$ *op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓
  Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ *vir* f_2*).*
- Formula for W_{nc} **OR** W_{net} /*Formule vir* W_{nc} ***OF*** W_{net}✓
- Correct substitution into equation for W_{nc} **OR** W_{net} on the horizontal plane✓
  Korrekte vervanging in W_{nc} ***OF*** W_{net} *vergelyking langs die skuinsvlak*
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 2/*OPSIE 2*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓ **OR/*OF*** $F = f_2$
$F - (f_1 + 42)$ ✓ $= 0$
$F = f_1 + 42$

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{nc} = \Delta E_K + \Delta E_P$
$(F - f_1)\Delta x\cos\theta = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$ } ✓ Any one/*Enige een*
$(f_1 + 42 - f_1)\Delta x\cos 0° = [\frac{1}{2}(12)(2,25)^2 - 0^2] + [(12)(9,8)(4,5) - 0]$ ✓
$\Delta x = 13,32$ m ✓ (13,32 m)

OPTION 3/*OPSIE 3*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓

OR/*OF* $F = f_2$

$F - (f_1 + 42)$ ✓$= 0$
$F = f_1 + 42$

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$W_{net} = \Delta E_K$
$(F - f_1 - F_{g//})\Delta x\cos\theta = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2]$
✓ Any one/ *Enige een*

$[(42) - (12)(9,8)\left(\frac{4,5}{\Delta x}\right)]\ \Delta x\cos 0^o = \frac{1}{2}(12)(2,25)^2$ ✓$- 0^2$

$\Delta x = 13,323214$ m ✓ (13,32 m)

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta E_K + \Delta E_P$
$W_{nc} = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$
✓ Any one/ *Enige een*

$(f_1 + 42 - f_1)$✓$\Delta x\cos 0°$ ✓$= 559,575$ ✓
$(42)\Delta x\cos 0° = 559,575$
$\Delta x = 13,323214$ m ✓ (13,32 m)

Marking criteria for OPTION 5/*Nasienkriteria vir OPSIE 5*

- Correct force equation and substitution of 0 for F_{net} **OR** $F = f_2$ on horizontal plane✓/ *Korrekte kragvergelyking en vervanging van 0 vir F_{net}* ***OF*** *$F = f_2$ op die horisontale vlak.*
- Relating the two frictional forces (substitution of $f_1 + 42$ for f_2).✓
  Bring die twee wrywingskragte in verband (vervanging van $f_1 + 42$ vir f_2).
- Correct substitution to calculate a./*Korrekte vervanging om a te bereken.* ✓.
- Substitution to calculate F_{net}./*Vervanging om F_{net} te bereken.* ✓
- Correct answer/*Korrekte antwoord*: 13,32 m.✓

OPTION 5/*OPSIE 5*

ALONG THE HORIZONTAL/BC/*LANGS DIE HORISONTAAL*

$F - f_2 = ma$
$F - f_2 = 0$ ✓

OR/*OF* $F = f_2$

$F - (f_1 + 42)$ ✓$= 0$
$F = f_1 + 42$ .....(1)

ALONG THE INCLINE/AB/*TEEN DIE SKUINSVLAK*

$v_f^2 = v_i^2 + 2a\Delta x$
$2,25^2 = 0 + 2a\Delta x$ ✓
$a = \frac{2,53}{\Delta x}$

$F_{net} = ma$
$F - F_{g//} - f_1 = ma$
$F - mg\sin\theta - f_1 = 12a$ .....
$F - (12)(9,8)\sin\theta - f_1 = 12\left(\frac{2,53}{\Delta x}\right)$ ✓….(2)

Substitute/*Vervang* (2) into/*in* (1):
$42 - (12)(9,8)\left(\frac{4,5}{\Delta x}\right) = 30,38$
$\Delta x = 13,32$ m ✓

(5)
[15]

QUESTION/*VRAAG 6*

6.1 Doppler Effect/*Doppler-effek* ✓ (1)

6.2 Measurement of foetal heartbeat./*Meting van die hartklop van 'n fetus.*✓

OR/*OF*
Measurement of blood flow./*Meting van bloedvloei.* ✓

OR/*OF*
Doppler flow meter/*Doppler vloeimeter* ✓
(1)

6.3 $f_L \propto f_s$ ✓

OR/*OF*
Directly (proportional)/*Direk (eweredig)* (1)

6.4

Marking criteria/*Nasienkriteria*

- Doppler formula/*Doppler formule* ✓
- Correct substitution for v and v_S./*Korrekte vervanging van v en v_S.* ✓
- Substitution for $\frac{f_L}{f_S} = 1,06$ **OR** $f_L = 1,06\ f_s$ **OR** any set of values for f_L and f_S so that $f_L = 1,06\ f_S$ / *Vervanging van $\frac{f_L}{f_S} = 1,06$ **OF** $f_L = 1,06\ f_s$ **OF** enige stel waardes vir f_L en f_S sodat $f_L = 1,06\ f_S$* ✓✓
- Final answer/*Finale antwoord:* 20,4 $m \cdot s^{-1}$ ✓

OPTION 1/*OPSIE 1*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$\frac{f_L}{f_s} = \frac{v \pm v_L}{v \pm v_s}$

✓✓ $1,06 = \left(\frac{340 + v_L}{340}\right)$ ✓

$v_L = 20,4\ m \cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

Gradient $= \frac{0-f_L}{0-f_S}$

✓✓ $1,06 = \frac{0-f_L}{0-f_S}$

$f_L = 1,06\ f_S$

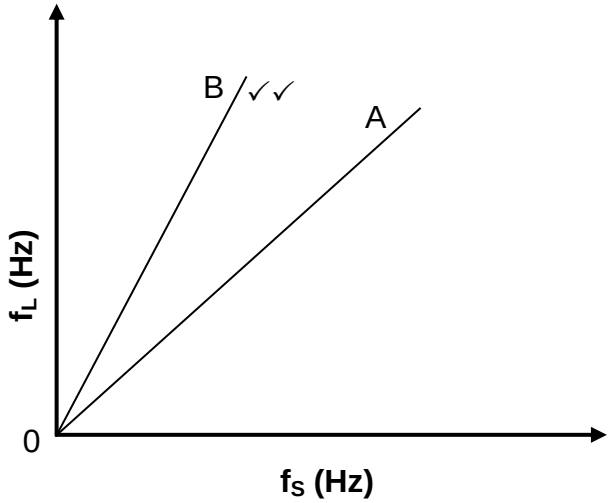
$f_L = \frac{v \pm v_L}{v \pm v_s} f_S$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_S$

$1,06\ f_S = \left(\frac{340 + v_L}{340}\right) f_S$ ✓

$v_L = 20,4\ m \cdot s^{-1}$ ✓

(5)

6.5



Marking criteria/*Nasienkriteria*	
Graph is a straight line starting at the origin./ Grafiek is 'n reguitlyn wat by die oorsprong begin.	✓
Gradient of B is greater than gradient of A./ *Gradiënt van B is groter as gradiënt van A.*	✓

(2)
[10]

QUESTION 7/VRAAG 7

7.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The magnitude of the electrostatic force exerted by one point charge on another is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓
Die grootte van die elektrostatiese krag wat een puntlading op 'n ander uitoefen, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

7.2 Negative/*negatief* ✓ (1)

7.3

Accepted labels/*Aanvaarde byskrifte*	
F_E	$F_{electrostatic}$/ F/ $F_{M\ ON\ N}$/ electrostatic force/ F_M *$F_{elektrostaties}$/ F/ $F_{M\ OP\ N}$/ elektrostatiese krag/ F_M*
w	F_g / w/ mg/ gravitational force / F_w/ weight/ gravity F_g / w/ mg/ *gravitasiekrag*/ F_w/ *gewig/ swaartekrag*

Notes/*Aantekeninge*:

- Do not penalise for length of arrows./*Moenie vir lengte van die pyltjie penaliseer nie.*
- Any other additional force(s)/*Enige addisionele krag(te)*: Max/M*aks* $^1/_2$
- If arrows are omitted but correctly labelled/*Indien pyltjies weggelaat is, maar korrek benoem*: Max/*Maks* $^1/_2$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^1/_2$

(2)

7.4

Marking criteria/*Nasienkriteria*

- Correct substitution to calculate weight of M./*Korrekte vervanging om gewig van M te bereken.* ✓
- Coulomb's formula/*Coulomb se formule* ✓
- Substitute/*Vervang* $F_{net} = 0$/ $mg = \frac{kQ_MQ_N}{r^2}$ (equating forces)/
  $0,02 = \frac{kQ_MQ_N}{r^2}$ (equating forces)✓
- Correct substitution into $\frac{kQ_MQ_N}{r^2}$/*Korrekte vervanging in* $\frac{kQ_MQ_N}{r^2}$ ✓
- Correct final answer (accept negative value)/*Korrekte finale antwoord (aanvaar negatiewe waarde):*
  $2,33 \times 10^{-6}$ C to/*tot* $2,32 \times 10^{-6}$ C✓

$F_g = mg$
$= (2,04 \times 10^{-3})(9,8)$ ✓
$= 0,02$ N

$F = \frac{kQ_MQ_N}{r^2}$ ✓

$F_{net} = mg - \frac{kQ_MQ_N}{r^2}$

$0 = 0,02 - \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

IF/*INDIEN*:

$F = \frac{kQ_MQ_N}{r^2}$ ✓

$2,04 \times 10^{-3})(9,8)$ ✓✓ $= \frac{(9 \times 10^9)(Q_M)(8,6 \times 10^{-8})}{(0,3)^2}$ ✓

$Q_M = 2,33 \times 10^{-6}$ C ✓

(5)

7.5.1 Equal/*Gelyk* ✓

OR/*OF*
Same/*Dieselfde* (1)

7.5.2 Opposite **OR** upwards/*Teenoorgesteld **OF** opwaarts*✓ (1)

7.6 **POSITIVE MARKING FROM QUESTION 7.4.**
POSITIEWE NASIEN VANAF VRAAG 7.4.

Marking criteria/*Nasienkriteria*
- Formula for E./*Formule vir E.* ✓
- Correct substitution for M **OR** N./*Korrekte vervanging vir M **OF** N.* ✓
- Subtraction of $E_M - E_N$ **OR** $E_N - E_M$ /*Aftrekking van $E_M - E_N$ **OF** $E_N - E_M$.* ✓
- Correct final answer/*Korrekte finale antwoord:*
  $5{,}31 \times 10^4$ N.C^{-1} to/*tot* $5{,}37 \times 10^4$ N·C^{-1}✓
- Correct direction/*Korrekte rigting*: upwards/*opwaarts* ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*

$$E = \frac{kQ}{r^2} \checkmark$$

$$E_{net} = \left(\frac{(9 \times 10^9)(2{,}33 \times 10^{-6})}{(0{,}4)^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(8{,}6 \times 10^{-8})}{(0{,}1)^2}\right) \checkmark$$

E_{net} = 131 062,5 - 77 400
= 53 662,5 N·C^{-1} ✓ ($5{,}36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

$$E_{net} = \frac{kQ}{r^2} \checkmark$$

$$E_{net} = \left(\frac{(9 \times 10^9)(8{,}6 \times 10^{-8})}{(0{,}1)^2}\right) \checkmark - \left(\frac{(9 \times 10^9)(2{,}33 \times 10^{-6})}{(0{,}4)^2}\right) \checkmark$$

E_{net} = 77 400 – 131 062,5
= - $5{,}37 \times 10^4$ N·C^{-1}
∴ E_{net} = 53 662,5 N·C^{-1} ✓ ($5{,}36 \times 10^4$ N.C^{-1}) upwards/towards M
opwaarts/na M ✓ (5)

[17]

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided temperature and all other physical conditions are constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided temperature and all other physical conditions are constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly). (2)

NOTE/*LET WEL*
Do not award the mark for addition of 4 if any other value is added to R_p/ *Moenie die punt vir bytel van 4 toeken indien enige ander waarde by R_p bygetel word nie.*

8.2.1

OPTION 1/*OPSIE 1*

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$$

$$\frac{1}{R_p} = \frac{1}{1} + \frac{1}{5} \checkmark$$

$R_p = 0,83\ \Omega$

$R_T = 0,83 + 4$ ✓
$= 4,83\ \Omega$ ✓

OPTION2/*OPSIE2*

$$R_p = \frac{R_1 R_2}{R_1 + R_2} \checkmark$$

$$R_p = \frac{(1)(5)}{1 + 5} \checkmark$$

$R_p = 0,83\ \Omega$

$R_T = 0,83 + 4$ ✓
$= 4,83\ \Omega$ ✓

(4)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/*OPSIE 1*

$R = \frac{V}{I}$ ✓

$4{,}83 = \frac{V}{3{,}5}$ ✓

$V = 16{,}91$ V ✓ (16,92 V)

OPTION 2/*OPSIE 2*

$R_p = \frac{V_2}{I}$ ✓

$0{,}83 = \frac{V}{3{,}5}$

$V_2 = 2{,}91$ V

$R_{4\Omega} = \frac{V_{4\Omega}}{I}$ ✓ Any one/*Enige een*

$4 = \frac{V_{4\Omega}}{3{,}5}$

$V_{4\Omega} = 14$ V

$V_1 = V_2 + V_{4\Omega}$
$V_1 = 2{,}91 + 14$
$= 16{,}91$ V ✓ (16,92 V) (3)

8.2.3 Smaller than/*Kleiner as* ✓ (1)

8.3.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

Maximum work done by the battery per unit charge. ✓✓
Maksimum arbeid verrig deur die battery per eenheidslading.

OR/*OF*
Maximum energy supplied by the battery per unit charge.
Maksimum energie verskaf deur die battery per eenheidslading.

OR/*OF*
The total amount of electric energy supplied by the battery per coulomb/per unit charge.
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheidslading. (2)

8.3.2 No/*Nee* ✓ (1)

8.3.3 The battery has internal resistance.✓
Die battery het interne weerstand.

OR/*OF*
Some energy per coulomb of charge/volts is used to overcome internal resistance.
'n Gedeelte van die energie per coulomb lading/volts word gebruik om interne weerstand te oorkom.

OR/*OF*
There is a potential drop/lost volts inside the battery.
Daar is 'n potensiaalval/verlore volts binne-in die battery.

OR/*OF*
$\varepsilon = V_{ext} + V_{int}$

OR/*OF*
$\varepsilon > V_{ext}$ (1)

8.4.1 Decreases/*Verlaag* ✓ (1)

8.4.2 Increases/*Verhoog* ✓ (1)

8.5 When the voltmeter is connected:
- No/very little current through the 1 Ω branch **OR** Branch with 1 Ω resistor is disabled/bypassed **OR** A voltmeter has a very high resistance **OR** The resistance of the parallel branch increases. ✓
- (Total) resistance of the circuit increases. ✓
- Current in circuit decreases. ✓
- $V_{internal}$/ Internal volts/ V_{lost} decreases. ✓

Therefore, external volts increase for a constant emf.

Wanneer die voltmeter geskakel word:
- *Geen/baie min stroom deur die 1 Ω-tak **OF** Tak met 1 Ω-weerstand is uitgeskakel **OF** Voltmeter het baie hoë weerstand **OF** Die weerstand van die parallelle tak neem toe.*
- *(Totale) weerstand van die stroombaan neem toe.*
- *Stroom in stroombaan neem af.*
- *V_{intern}/ Interne volts/ $V_{verlore}$ neem af.*

Dus neem die eksterne volts toe vir konstante emf. (4)
[20]

QUESTION 9/*VRAAG 9*

9.1.1 Split ring/commutator/*Splitring/kommutator* ✓ (1)

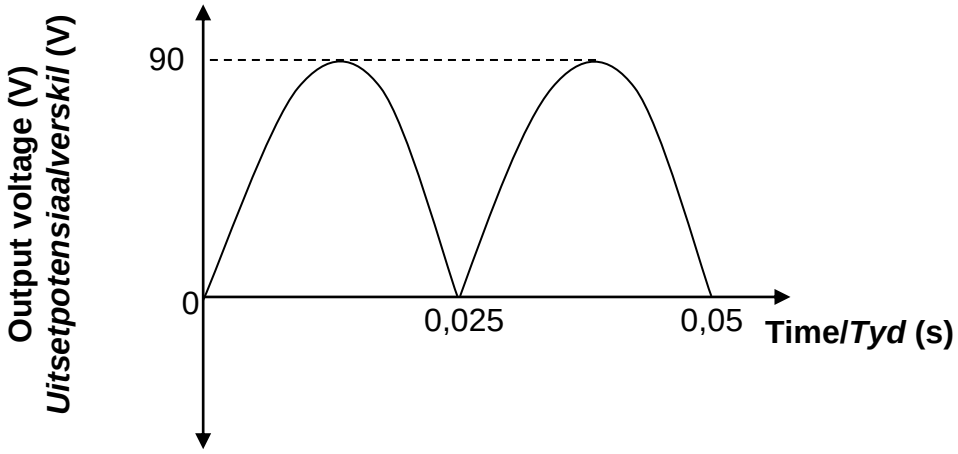
9.1.2 **Y** to/*na* **X** **OR/*OF*** 0 /no current/*geen stroom nie*✓ (1)

9.1.3 $T = \frac{1}{f}$

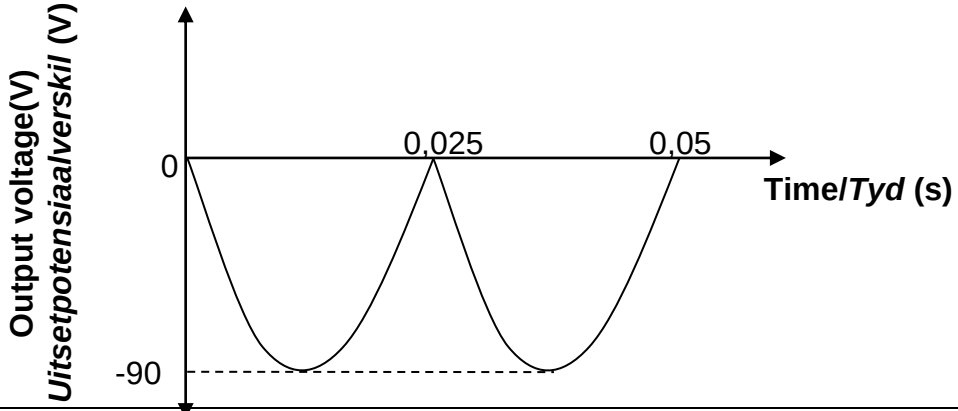
$T = \frac{1}{20}$

$T = 0,05$ s ✓ (1)

9.1.4 **POSITIVE MARKING FROM QUESTION 9.1.3.**
POSITIEWE NASIEN VANAF VRAAG 9.1.3.



OR/*OF*



Criteria for graph/*Kriteria vir grafiek*	
Correct shape with one full cycle./*Korrekte vorm met 1 volledige siklus.*	✓
Curve starts at zero to first peak./*Kurwe begin by nulpunt tot eerste piek.*	✓
Any one of the correct time values at the correct position./*Enige een van die korrekte tyd waardes op die korrekte posisie.*	✓
Maximum voltage of 90 V OR -90 V/ *Maksimum potensiaalverskil van 90 V OF -90 V*	✓
NOTE/*LET WEL*: - 1 mark for half cycle/incomplete cycle or more than one cycle *-1 punt vir halwe siklus/onvoltooide siklus of meer as een siklus*	

(4)

9.2

Marking criteria/*Nasienkriteria*

- Formula to calculate W_{ave} (do not penalise if subscripts are ommited)./ *Formule om W_{gem} te bereken (moenie penaliseer indien onderskrifte uitgelaat is nie).* ✓
- Substitution of 220 and 32 in correct equation. ✓ *Vervanging van 220 en 32 in die korrekte vergelyking.*
- Substitution of 120 for Δt/*Vervanging van 120 in Δt.* ✓
- Correct answer in range: 181 500 J to 181 764 J ✓ *Korrekte antwoord in gebied: 181 500 J tot 181 764 J* ✓

OPTION 1/*OPSIE 1*

$W_{ave} = \frac{V_{rms}^2 \Delta t}{R}$ ✓

$= \frac{220^2 (120)}{32}$ ✓

$= 181\ 500$ J ✓

OPTION 2/*OPSIE 2*

$R = \frac{V_{rms}}{I_{rms}}$ ✓

$32 = \frac{220}{I_{rms}}$

$I_{rms} = 6,88$ A (6,875 A)

$W_{ave} = V_{rms} I_{rms} \Delta t$ ✓
$= (220)(6,88)(120)$ ✓
$= 181\ 632$ J ✓

OR/*OF*

$W_{ave} = I_{rms}^2 R \Delta t$ ✓
$= (6,88)^2(32)(120)$ ✓
$= 181\ 764,10$ J ✓

OPTION 3/*OPSIE 3*

$R = \frac{V_{rms}}{I_{rms}}$ ✓

$32 = \frac{220}{I_{rms}}$ ✓

$I_{rms} = 6,88$ A (6,875 A)

$P_{ave} = V_{rms} I_{rms}$
$= (220)(6,88)$
$= 1\ 513,6$ W
$(1,51 \times 10^3$ W)

$P_{ave} = I_{rms}^2 R$
$= (6,88)^2(32)$
$= 1\ 514,7$ W (1 512,5 W)
$(1,51 \times 10^3$ W)

OPTION 4/OPSIE 4

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

$P_{ave} = \frac{220^2}{32}$ ✓

$P_{ave} = 1\ 512,5$ W
$(1,51 \times 10^3$ W)

$P = \frac{W}{\Delta t}$ ✓

$1\ 513,6 = \frac{W}{120}$ ✓

$W = 181\ 632$ J ✓ $(1,82 \times 10^5$ J)

(4)

[11]

QUESTION 10/*VRAAG 10*

10.1 Light has a particle nature/is quantized ✓
Lig het 'n deeltjie geaardheid/is gekwantiseerd (1)

10.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓
Die minimum energie (van invallende fotone) wat elektrone kan vrystel vanuit 'n metaal/oppervlak. (2)

10.3

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$
$hf = hf_0 + \frac{1}{2}mv^2_{max}$
$E = W_0 + \frac{1}{2}mv^2_{max}$
✓ Any one/ *Enige een*

$(6,63 \times 10^{-34})(5,96 \times 10^{14})$ ✓ $= 3,42 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 5,30 \times 10^{-20}$ J ✓ $(5,32 \times 10^{-20}$ J) (4)

10.4 $q = I\Delta t$
$= (0,012)(10)$ ✓
$= 0,12$ C

$n = \frac{Q}{e}$

$n = \frac{0,12}{1,6 \times 10^{-19}}$ ✓✓

$n = 7,5 \times 10^{17}$ (electrons/*elektrone*)

number of photons/*aantal fotone* = $n = 7,5 \times 10^{17}$ ✓ (4)

10.5 Increases/*Verhoog* ✓

More photons strike the surface of the metal per unit time/ at a higher rate ✓ hence more (photo) electrons ejected per unit time ✓(resulting in increased current).
Meer fotone tref die oppervlak van die metaal per eenheidstyd/ teen 'n hoër tempo, gevolglik word meer (foto)elektrone per eenheidstyd vrygestel (wat tot 'n verhoogde stroom lei). (3)
[14]

TOTAL/*TOTAAL*: 150