basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

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

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

2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 24 pages./
Hierdie nasienriglyne bestaan uit 24 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	C ✓✓	(2)
1.2	A ✓✓	(2)
1.3	D ✓✓	(2)
1.4	D ✓✓	(2)
1.5	B ✓✓	(2)
1.6	B ✓✓	(2)
1.7	A ✓✓	(2)
1.8	C ✓✓	(2)
1.9	C ✓✓	(2)
1.10	C ✓✓	(2)

[20]

QUESTION 2/*VRAAG 2*

2.1

NOTE/*LET WEL*
-1 mark for each key word/phrase omitted in the correct context.
-1 punt vir elke sleutel woord/frase in die korrekte konteks weggelaat.
The word "resultant/net force" has to be mentioned at least once
Die woord "resultante/netto krag" moet ten minste een keer genoem word

When a (non-zero) resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓

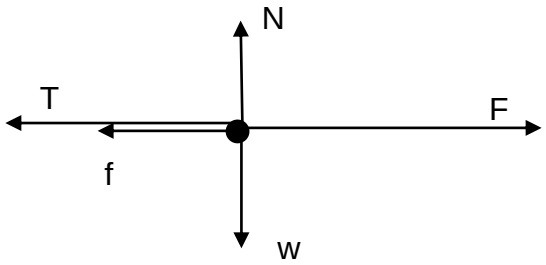
Wanneer 'n (nie-nul) resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*

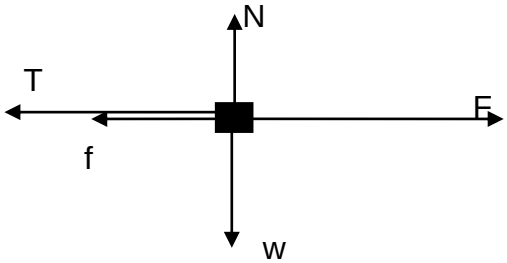
The (non-zero) resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. ✓✓

Die (nie-nul) resultante/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwerp in die rigting van die resultante/netto krag. (2)

2.2



ACCEPT/*AANVAAR*



Accept the following symbols./*Aanvaar die volgende simbole*:	
N ✓	F_N / Normal / *Normaal* / Normal force / *Normaalkrag* / 78,4 N
f ✓	F_f / f_k / f_r / / F_w / frictional force/*wrywingskrag*/kinetic frictional force / *kinetiese wrywingskrag*
w ✓	F_g/ mg / weight / $F_{Earth\ on\ block}$/ 78,4 N / gravitational force / g*ewig* / $F_{aarde\ op\ blok}$ / *gravitasiekrag/ gravity / gravitasie*
T ✓	Tension / *Spanning* / F_T / F_s
$F_{applied/toegepas}$ ✓	F / F_A / F_{app} / F_{toeg} / 29,6 N / Applied force / *Toegepaste krag*

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 force(s) do not make contact with body/dot /*Indien krag(te) nie met die voorwerp / kolletjie kontak maak nie:* Max./*Maks:* $4/5$
- If arrows missing/*Indien pyltjies uitgelaat is*: Max./*Maks:* $4/5$

(5)

2.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
8 kg block/*blok:* $F_{net} = ma$ $F_{net} = 0$ $F - (f + T) = ma$ } ✓Any one/*Enige een* $29,6 - 10 - T = 0$ ✓ $T = 19,6$ N ✓	2 kg block/*blok:* $F_{net} = ma$ $F_{net} = 0$ $T - w = 0$ } ✓Any one/*Enige een* $T = w = mg = (2)(9,8)$ ✓ $T = 19,6$ N ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta E_k$ ✓
$W_w + W_N + W_F + W_f + W_T = 0$
$0 + 0 + F\Delta x\cos\theta + f\Delta x\cos\theta + T\Delta x\cos\theta = 0$
$(29,6)\cos0° + (10)\cos180° + T\cos180° = 0$ ✓
$29,6 - 10 - T = 0$
$T = 19,6$ N ✓

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$W_F + W_f + W_T = 0 + 0$
$F\Delta x\cos\theta + f\Delta x\cos\theta + T\Delta x\cos\theta = 0$
$(29,6)\cos0° + (10)\cos180° + T\cos180° = 0$ ✓
$29,6 - 10 - T = 0$
$T = 19,6$ N ✓

(3)

2.4.1

8 kg block/*blok*
$F_{net} = ma$
$F - (f + T) = ma$ } ✓Any one/*Enige een*
$50 - 10 - T$ ✓$= 8a$ ✓
$40 - T = 8a$

2 kg block/*blok*
$F_{net} = ma$
$T - mg = ma$
$T - 2(9,8)$ ✓$= 2a$

$40 - 19,6 = 10a$
$20,4 = 10a$
$a = 2,04$ m·s^{-2} ✓

Marking criteria/*Nasienkriteria*
- Appropriate formula / *Geskikte formule* ✓
- Substitution for forces on 8 kg / *Vervanging van kragte op die 8 kg* ✓
- 2a **OR/*OF*** 8a ✓
- Substitution of forces on 2 kg / *Vervanging van kragte op die 2 kg* ✓
- Final answer/*Finale antwoord* 2,04 m·s^{-2} ✓

(5)

2.4.2 **POSITIVE MARKING FROM QUESTION 2.4.1**
POSITIEWE NASIEN VANAF VRAAG 2.4.1

Substitute/*Vervang* a
$T - 2(9,8) = 2a$
$T - 19,6 = 2(2,04)$ ✓
$T = 23,68$ N ✓
OR/*OF*
$40 - T = 8a$
$T = 40 - 8(2,04)$ ✓
$T = 23,68$ N ✓

Marking criteria/*Nasienkriteria*
- Substitution of a/*Vervanging van a* ✓
- Final answer/*Finale antwoord:* 23,68 N ✓

Notes/*Aantekeninge*
If substitution into incorrect equation for T / *Indien vervanging in verkeerde vergelyking vir T:* Max/*Maks* $\frac{1}{2}$

(2)
[17]

QUESTION 3/*VRAAG 3*

3.1 Weight / gravitational force / *Gewig / Gravitasiekrag* ✓

Accept/Aanvaar:
Gravity /*Gravitasie* (1)

3.2 9,8 $m \cdot s^{-2}$ ✓ downwards / *afwaarts* ✓ (2)

3.3 3 (m) ✓ (1)

3.4.1

OPTION 1/*OPSIE 1*

Gradient/*Gradiënt* = $\frac{y_2 - y_1}{x_2 - x_1}$

$-9,8$ ✓ $= \left(\frac{0 - v_i}{1,02 - 0}\right)$ ✓

$v_i = 10\ m \cdot s^{-1}$ ✓ (9,996)

OPTION 2/*OPSIE 2*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(1,02)$ ✓	$0 = v_i + (9,8)(1,02)$ ✓
$v_i = 10\ m \cdot s^{-1}$ ✓ (9,996)	$v_i = -10$
	$v_i = 10\ m \cdot s^{-1}$ ✓ (9,996)
OPTION 3/*OPSIE 3*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$-v = v + (-9,8)(2,04)$ ✓	$v = -v + (9,8)(2,04)$ ✓
$v = 10\ m \cdot s^{-1}$ ✓ (9,996)	$v = -10$
	$v = 10\ m \cdot s^{-1}$ ✓ (9,996)
OPTION 4/ *OPSIE 4*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$0 = v_i(2,04) + \frac{1}{2}(-9,8)(2,04)^2$ ✓	$0 = v_i(2,04) + \frac{1}{2}(9,8)(2,04)^2$ ✓
$v_i = 10\ m \cdot s^{-1}$ ✓ (9,996)	$v_i = -10$
	$v_i = 10\ m \cdot s^{-1}$ ✓ (9,996)

OPTION 5/*OPSIE 5* **UPWARDS POSITIVE/ *OPWAARTS POSITIEF*:**	**DOWNWARDS POSITIVE/ *AFWAARTS POSITIEF:***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $= \underbrace{\left(\frac{v_i + 0}{2}\right)}(1{,}02)$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(-9{,}8)\left(\frac{v_i + 0}{2}\right)(1{,}02)$ ✓ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $= \underbrace{\left(\frac{v_i + 0}{2}\right)}(1{,}02)$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9{,}8)\left(\frac{v_i + 0}{2}\right)(1{,}02)$ ✓ $v_i = -10\ m\cdot s^{-1}$ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)

From maximum height to projection point/
Vanaf maksimum hoogte tot punt van projeksie:

OPTION 6/OPSIE 6 **UPWARDS POSITIVE/ *OPWAARTS POSITIEF***	**DOWNWARDS AS POSITIVE/ *AFWAARTS POSITIEF***
$v_f = v_i + a\Delta t$ ✓ $v_f = \underline{0 + (-9{,}8)(1{,}02)}$ $v_f = 10\ m\cdot s^{-1}$ $v_i = 10\ m\cdot s^{-1}$ ✓	$v_f = v_i + a\Delta t$ ✓ $v_f = \underline{0 + (9{,}8)(1{,}02)}$ ✓ $v_f = 10\ m\cdot s^{-1}$ $v_i = 10\ m\cdot s^{-1}$ ✓

OPTION 7/*OPSIE 7*	**OPTION 8/*OPSIE 8***
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$ ✓ $mgh + 0 = 0 + \frac{1}{2}mv^2$ $\underline{(9{,}8)(5{,}09796) = \frac{1}{2}v^2}$ ✓ $(2)(9{,}8)(5{,}09796) = v^2$ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)	$W_{net} = \Delta E_k$ ✓ $F_{net}\Delta y\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ $ma\Delta y\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ $\underline{(0{,}06)(9{,}8)(5{,}09796) = \frac{1}{2}(0{,}06)(v_f^2 - 0^2)}$ ✓ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)

OPTION 9/*OPSIE 9*
$W_{nc} = \Delta E_p + \Delta E_k$ ✓ $0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ $\underline{0 = (0{,}06)(9{,}8)(h_f - 0) + \frac{1}{2}(0{,}06)(0^2 - v_i^2)}$ ✓ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)

OPTION 10/*OPSIE 10*
$F_{net}\Delta t = m\Delta v$ ✓ $\underline{(0{,}06)(-9{,}8)(1{,}02) = (0{,}06)(0 - v_i)}$ ✓ $v_i = 10\ m\cdot s^{-1}$ ✓ (9,996)

(3)

3.4.2 **POSITIVE MARKING FROM QUESTION 3.4.1 /**
POSITIEWE NASIEN VANAF VRAAG 3.4.1

Marking criteria OPTIONS 1-5/*Nasienkriteria OPSIES 1-5*

- Appropriate formula / *Geskikte formule*✓
- Substitution / *Vervanging* ✓
- Adding answer to 3/*Tel 3 by antwoord* ✓
- Final answer/ *Finale antwoord* 8,1 m ✓ (8,098 – 8,102)

OPTION 1/ *OPSIE 1*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = (10)^2 + 2(-9,8)\Delta y$ ✓	$0^2 = (-10)^2 + 2(9,8)\Delta y$ ✓
Δy = -5,1 m (-5,102) ↓	Δy = 5,1 m (5,102) ↓
h = 5,1 + 3 ✓ = 8,1 m✓ (8,102)	h = 5,1 + 3 ✓ = 8,1 m✓(8,102)
OPTION 2/ *OPSIE 2*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ = (10)(1,02) + ½ (-9,8)(1,02)^2 ✓	$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ = (-10)(1,02) + ½ (9,8)(1,02)^2 ✓
Δy = 5,1 m (5,102) ↓	Δy = -5,1 m (-5,102) ↓
h = 5,1 + 3 ✓ = 8,1 m ✓(8,102)	h = 5,1 + 3 ✓ = 8,1 m ✓(8,102)
OPTION 3/*OPSIE 3*	
UPWARDS POSITIVE/ ***OPWAARTS POSITIEF*:**	**DOWNWARDS POSITIVE/** ***AFWAARTS POSITIEF:***
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ = $\left(\frac{0-10}{2}\right)(1,02)$ ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ = $\left(\frac{0+10}{2}\right)(1,02)$ ✓
Δy = -5,1 m ↓	Δy = 5,1 m ↓
h = 5,1 + 3 ✓ = 8,1 m ✓	h = 5,1 + 3 ✓ = 8,1 m ✓
OPTION 4/ *OPSIE 4*	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ = 0 + ½ (-9,8)(1,02)^2 ✓	$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓ = 0 + ½ (9,8)(1,02)^2 ✓
Δy = -5,1 m (-5,098) ↓	Δy = 5,1 m (5,098) ↓
h = 5,1 + 3 ✓ = 8,1 m ✓ (8,098)	h = 5,1 + 3 ✓ = 8,1 m ✓ (8,098)

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$
$w\Delta y\cos 180° = ½m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$(0,06)(9,8)(\Delta y)\cos 180° = ½(0,06)(0 - 10^2)$ ✓
$\Delta y = 5,1$ m
↓
$h = 5,1 + 3$ ✓
$= 8,1$ m ✓

OPTION 6/ *OPSIE 6*

$(E_{mech})_{3\ m(ref/verw)} = (E_{mech})_{Top/Bo}$
$(E_P + E_K)_{3\ m(ref/verw)} = (E_P + E_K)_{Top/Bo}$
$(mgh + ½ mv^2)_{3\ m\ (ref/verw)} = (mgh + ½ mv^2)_{Top/Bo}$ } ✓Any one/*Enige een*
$(0) + ½(0,06)(10)^2 = (0,06)(9,8)(h) + 0$ ✓
$h = 5,1$ m
$h = 5,1$ m
↓
$h = 5,1 + 3$ ✓
$= 8,1$ m ✓

Marking criteria OPTIONS 7 to 9/*Nasienkriteria OPSIES 7 tot 9*

- Appropriate formula / *Geskikte formule*✓
- Substitution / *Vervanging* ✓✓
- Final answer/ *Finale antwoord*: 8,1 m ✓

OPTION 7/ *OPSIE 7*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$-3 = -10\ \Delta t + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 2,31$ s (2,306)

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½(-9,8)(2,31 - 1,02)^2$ ✓
$\Delta y = -8,15$ m (8,1)
$h = 8,15$ m (8,1) ✓

DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$+3 = -10\ \Delta t + ½(9,8)\Delta t^2$ ✓
$\Delta t = 2,31$ s (2,306)

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$= 0 + ½(9,8)(2,31 - 1,02)^2$ ✓
$\Delta y = 8,15$ m (8,1)
$h = 8,15$ m (8,1) ✓

OPTION 8/ *OPSIE 8*

$(E_{mech})_{3\ m\ (ref/verw)} = (E_{mech})_{Top/Bo}$
$(E_P + E_K)_{3\ m(ref/verw)} = (E_P + E_K)_{Top/Bo}$
$(mgh + ½ mv^2)_{3\ m(ref/verw)} = (mgh + ½ mv^2)_{Top/Bo}$ } ✓Any one/*Enige een*
$(0,06)(9,8)(3) + ½(0,06)(10)^2$ ✓ $= (0,06)(9,8)(h) + 0$ ✓
$h = 8,1$ m ✓

OPTION 9/*OPSIE 9*

$W_{nc} = \Delta E_p + \Delta E_k$
$0 = mg(h_f - h_i) + ½m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*
$0 = (0,06)(9,8)(h_f - 3)$ ✓ $+ ½(0,06)(0 - 10^2)$ ✓
$h = 8,1$ m ✓

Marking criteria Options 10 to 11/*Nasienkriteria Opsies 10 tot 11*

- Formula / *Formule*✓
- Substitution to calculate v_f/ *Vervanging om v_f te bereken*✓
- Substitution to calculate Δy/ *Vervanging om Δy te bereken*✓
- Final answer / *Finale antwoord*: 8,1 m ✓

OPTION 10/*OPSIE 10*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
MAXIMUM HEIGHT TO GROUND/
MAKSIMUM HOOGTE TOT GROND

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= \underline{(10)^2 + 2(-9,8)(-3)}$ ✓
$v_f = -12,60$
$v_f = 12,6\ m\cdot s^{-1}$ (12,62)

$v_f^2 = v_i^2 + 2a\Delta y$
$\underline{(-12,60)^2 = (0)^2 + 2(-9,8)\Delta y}$ ✓
$\Delta y = -8,1$ m
$\Delta y = 8,1$ m ✓(8,102 - 8,103)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
MAXIMUM HEIGHT TO GROUND/
MAKSIMUM HOOGTE TOT GROND

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= \underline{(-10)^2 + 2(9,8)(3)}$ ✓
$v_f = 12,60\ m\cdot s^{-1}$(12,62)

$v_f^2 = v_i^2 + 2a\Delta y$
$\underline{(12,60)^2 = (0)^2 + 2(9,8)\ \Delta y}$ ✓
$\Delta y = 8,1$ m ✓(8,102 - 8,103)

OPTION 11/*OPSIE 11*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF
FROM BALCONY TO GROUND/
VANAF BALKON TOT GROND

$v_f^2 = v_i^2 + 2a\Delta y$✓
$= \underline{(-10)^2 + 2(-9,8)(-3)}$ ✓
$v_f = -12,60$
$v_f = 12,6\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$-12,60 = 0 + (-9,8)\Delta t$
$\Delta t = 1,29$ s (1,286)

$\Delta y = v_i\Delta t + ½\ a\Delta t^2$
$= \underline{0 + ½\ (-9,8)(\ 1,29)^2}$ ✓
$\Delta y = -8,1$ m (-8,098)
$h_1 = 8,1$ m ✓ (8,098 – 8,102)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF
FROM BALCONY TO GROUND/
VANAF BALKON TOT GROND

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= \underline{(10)^2 + 2(9,8)(3)}$ ✓
$v_f = 12,6\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$
$12,60 = 0 + (9,8)\Delta t$
$\Delta t = 1,29$ s (1,286)

$\Delta y = v_i\Delta t + ½\ a\Delta t^2$
$= \underline{0 + ½\ (9,8)(1,29)^2}$ ✓
$\Delta y = 8,1$ m (8,098)
$h_1 = 8,1$ m ✓ (8,098 – 8,102)

OPTION 12/*OPSIE 12*

Displacement = Area between the graph and the t-axis
Verplasing = Area tussen die grafiek en die t-as
= Area of a triangle/*Area van 'n driehoek* ✓
= ½ bh
= ½ (1,02)(9,996) ✓
= 5,09796 m
Height h/*Hoogte h* = 3 + 5,09796 ✓
= 8,09796 m ✓(8,09796 – 8,102) (4)

3.5 **POSITIVE MARKING FROM QUESTIONS 3.4.1 and 3.4.2**
***POSITIEWE NASIEN VANAF VRAE 3.4.1 en* 3.4.2**

Marking criteria/*Nasienkriteria*
Calculation of / *Berekening* van 10,78 m·s^{-1} or/*of* 12,60 m·s^{-1} or/*of* 5,93 m:
- Any suitable formula/*Enige geskikte formule*✓
- Any correct substitution/*Enige korrekte vervanging*✓

W calculation/*berekening*:
- Formula/*Formule* ✓
- Difference in calculated velocities/height/*Verskil in berekende snelhede/hoogtes*✓
- Correct substitution/*Korrekte vervanging*✓
- Final answer/*Finale antwoord*: -1,28 J ✓

OPTION 1/*OPSIE 1*

When ball is on ground/*Wanneer bal op grond is*:
Work done by the floor = change in E_k ($\Delta E_p = 0$)
Arbeid verrig deur vloer = verandering in E_k ($\Delta E_p = 0$)

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(1,1)$ ✓
$v_i = 10,78$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta y$
$= (10)^2 + 2(-9,8)(-3)$
$v_f = -12,60$
$v_f = 12,6$ m·s^{-1} (12,62)

OR

$v_f^2 = v_i^2 + 2a\Delta y$
$= (0)^2 + 2(-9,8)(-8,1)$
$v_f = -12,60$
$v_f = 12,6$ m·s^{-1} (12,62)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(1,1)$ ✓
$v_i = -10,78$
$v_i = 10,78$ m·s^{-1}

$v_f^2 = v_i^2 + 2a\Delta y$
$= (-10)^2 + 2(9,8)(3)$
$v_f = 12,60$ m·s^{-1} (12,62)

$W_{net} = \Delta E_k$
$W_{nc} = \Delta E_p + \Delta E_k$
✓Any one/*Enige een*

$= 0 + ½(0,06)(10,78^2 – 12,60^2)$ ✓ ✓

$= -1,28$ J ✓ (-1,2785)

OPTION 2/*OPSIE 2*

Comparing differences in heights/*vergelyk verskil in hoogtes*:
Work done by the floor = change in E_k ($\Delta E_p = 0$)
Arbeid verrig deur vloer = verandering in E_k ($\Delta E_p = 0$)

UPWARDS AS POSITIVE
OPWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{0 + \frac{1}{2}(-9,8)(1,1)^2}$ ✓
$= -5,93$ m
$\Delta y = 5,93$ m (5,929)

DOWNWARDS AS POSITIVE
AFWAARTS AS POSITIEF
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{0 + \frac{1}{2}(9,8)(1,1)^2}$ ✓
$= -5,93$ m
$\Delta y = 5,93$ m

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$= mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$= \underline{(0,06)(9,8)(5,93 \text{ ✓} 8,10) + 0}$ ✓
$= -1,28$ J ✓

OPTION 3/*OPSIE 3*

Comparing differences in heights/*vergelyk verskil in hoogtes*:
Work done by floor/*arbeid verrig deur vloer* = Change/*Verandering* in E_p

UPWARDS AS POSITIVE
OPWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$
$0 = v_i + (-9,8)(1,1)$
$v_i = 10,78 \text{ m·s}^{-1}$

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \underline{\left(\frac{10,78 + 0}{2}\right)(1,1)}$ ✓
$\Delta y = 5,93$ m

OR/*OF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = \underline{(10,78)^2 + 2(-9,8)\,\Delta y}$ ✓
$\Delta y = 5,93$ m

DOWNWARDS AS POSITIVE
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$
$0 = v_i + (9,8)(1,1)$
$v_i = -10,78$
$v_i = 10,78 \text{ m·s}^{-1}$

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \underline{\left(\frac{-10,78 - 0}{2}\right)(1,1)}$ ✓
$\Delta y = -5,93$ m

OR/OF
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = \underline{(-10,78)^2 + 2(9,8)\,\Delta y}$ ✓
$\Delta y = -5,93$ m
$\Delta y = 5,93$ m

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$= mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$= \underline{(0,06)(9,8)(5,93 \text{ ✓} 8,10) + 0}$ ✓
$= -1,28$ J ✓

(6)
[17]

QUESTION 4/*VRAAG 4*

4.1

NOTE: -1 mark for each key word/phrase omitted in the correct context.
LET WEL: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

The total (linear) momentum of an isolated/closed system remains constant (is conserved). ✓✓
Die totale (liniêre) momentum in 'n geïsoleerde/ geslote sisteem bly konstant (behoue).

Accept/*Aanvaar*
The total (linear) momentum before a collision is equal to the total linear momentum after collision in an isolated/closed system.
Die totale (lineêre) momentum voor botsing is gelyk aan die totale lineêre momentum na botsing in 'n geïsoleerde/geslote sisteem. (2)

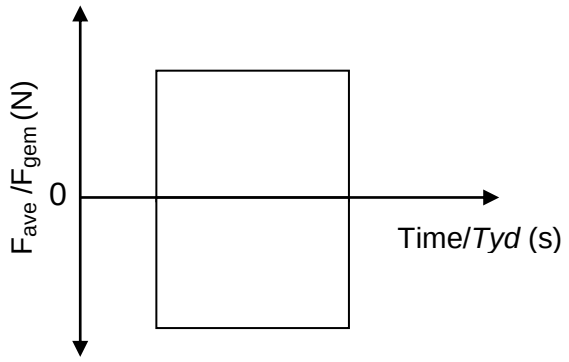
4.2

OPTION 1/*OPSIE 1*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\sum p_i = \sum p_f$ ✓Any one/ *Enige een* $(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ ✓Any one/ *Enige een*	$\sum p_i = \sum p_f$ ✓Any one/ *Enige een* $(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ ✓Any one/ *Enige een*
$(2m + 3m)v$ ✓$= (3m)(-\frac{1}{3}v) + 2mv_{Bf}$ ✓	$(2m + 3m)(-v)$✓$= (3m)(\frac{1}{3}v) + 2mv_{Bf}$ ✓
$v_{Bf} = 3v$ ✓upwards/*opwaarts* ✓	$v_{Bf} = -3v$ $v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓
OPTION 2/*OPSIE 2*	
UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF***
$\Delta p_{iA} = -\Delta p_{iB}$ ✓Any one/ *Enige een* $m_A(v_{Af} - v_{Aif}) = - m_A(v_{Bf} - v_{Bi})$ ✓Any one/ *Enige een*	$\Delta p_{iA} = -\Delta p_{iB}$ ✓Any one/ *Enige een* $m_A(v_{Af} - v_{Aif}) = - m_A(v_{Bf} - v_{Bi})$ ✓Any one/ *Enige een*
$3m(-\frac{1}{3}v - v)$ ✓$= - (2m)(v_{Bf} - v)$ ✓	$3m[\frac{1}{3}v - (-v)]$ ✓$= (2m)[v_{Bf} - (-v)]$ ✓
$v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓	$v_{Bf} = -3v$ $v_{Bf} = 3v$ ✓ upwards/*opwaarts*✓

(5)

4.3 Impulse/*Impuls* ✓ (1)

4.4



Marking criteria/*Nasienkriteria*
Exact mirror image
Presiese spieëlbeeld ✓✓

IF/*INDIEN*
Mirror image at different times /
Spieëlbeeld by verskillende tye
Max/*maks* $\frac{1}{2}$

Note/*Let wel*:
If graph is drawn as given in question paper – no mirror image/*Indien grafiek geteken word soos in vraestel – geen spieëlbeeld:* Max/*Maks*: $\frac{1}{2}$

(2)
[10]

QUESTION 5/*VRAAG 5*

5.1 The rate at which work is done/energy is expended. ✓✓ **(2 or 0)**
Die tempo waarteen arbeid/werk verrig word/energie verkwis word. ***(2 of 0)***

Accept/*Aanvaar*
Work done per unit time / energy expended per unit time.
Arbeid verrig per eenheidstyd / energie verkwis per eenheidstyd. (2)

5.2

OPTION 1/*OPSIE 1*

$P = \frac{W}{\Delta t}$
$= \frac{\Delta mgh}{\Delta t}$ ✓Any one/*Enige een*
$= \frac{(1\,250)(9,8)(5,8)}{60}$ ✓
= 1 184,17 W ✓ (1 184,167)

OPTION 2/*OPSIE 2*

$P = \frac{W}{\Delta t}$
$= \frac{F\Delta x\cos\theta}{\Delta t}$ or/*of* $\frac{F\Delta y\cos\theta}{\Delta t}$ ✓Any one/*Enige een*
$= \frac{mg\Delta x\cos 0^\circ}{\Delta t}$
$= \frac{(1250)(9,8)(5,8)\cos 0^\circ}{60}$ ✓
= 1 184,17 W ✓ (1 184,167)

OPTION 3/*OPSIE 3*

$P = \frac{W}{\Delta t}$
$= \frac{F\Delta x\cos\theta}{\Delta t}$ or/*of* $\frac{F\Delta y\cos\theta}{\Delta t}$ ✓Any one/*Enige een*
$= \frac{mg\Delta x\cos 180^\circ}{\Delta t}$ ✓
$= \frac{(1250)(9,8)(5,8)\cos 180^\circ}{60}$
= - 1 184,17 W (-1 184,167)
Power dissipated by the crane/*Drywing verkwis deur hyskraan* =1 184,17 W✓

OPTION 4/*OPSIE 4*

$P_{ave} = Fv_{ave}$ ✓
$= 1\,250(9,8)\frac{5,8}{60}$ ✓
= 1 184,17 W ✓

(3)

5.3

Note: -1 mark for each key word/phrase omitted in the correct context.
Let Wel: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*
IF: The word 'work' is omitted - 0 marks.
***INDIEN*:** *Die woord 'arbeid' uitgelaat is - 0 punte.*

A *conservative force* is a force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓
'n Konserwatiewe krag is 'n krag waarvoor die arbeid wat verrig is (om 'n voorwerp tussen twee punte te beweeg) onafhanklik is van die pad wat gevat word.

OR/OF

A conservative force is a force for which the work done in moving an object in a closed path is zero.
'n Konserwatiewe krag is 'n krag waarvoor die arbeid verrig om 'n voorwerp in 'n geslote pad te beweeg, nul is. (2)

5.4 Non-conservative/ *Nie-konserwatief* ✓ (1)

5.5 (Gravitational) potential to kinetic (energy)
(Gravitasie)potensiële na kinetiese (energie) ✓ (1)

5.6

Marking criteria/ *Nasienkriteria*

- Any one of the following formulae/ *Enigeen van die volgende formules*:
  $W_{net} = \Delta Ek$ / $W_{nc} = \Delta E_k + \Delta E_p$ ✓
- Substitution to calculate the ΔE_k or initial velocity. ✓
  Vervanging om ΔE_k of begin snelheid te bereken.
- Correct substitution of ΔE_k in: / *Korrekte vervangings van ΔE_k in:*
  $W_{net} = \Delta Ek$ / $W_{nc} = \Delta E_k + \Delta E_p$ ✓
- Correct substitution into / *Korrekte vervangings in* $F\Delta x\cos\theta$. ✓
- Final answer / *Finale antwoord*: 284 089 N ✓ (283 510,63 N to/*tot* 284 200 N)

OPTION 1/*OPSIE 1*

From R to the wall / *Vanaf R na die muur*:

$\Delta U = mg(h_f - h_i)$
$= \underline{1\,250(9,8)(0 - 5,8)}$ ✓
$= -71\,050$ J

$\Delta K = -\Delta U = 71\,050$ J

Into the wall:/ *In die muur in*

$W_{net} = \Delta K$
$W_{wall/muur} = K_f - K_i$
$F_{wall\ /muur}\ \Delta x\cos\theta = K_f - K_i$
✓Any one/*Enige een*

$\underline{F_{wall/muur}(0,25)\cos180°}$ ✓ $= 0 \underline{- 71\,050}$ ✓
$F_{wall/muur} = 284\,089$ N ✓

OPTION 2/*OPSIE 2*

From R to the wall / *Vanaf R na die muur*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = (mgh_f - mgh_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
✓Any one/*Enige een*

$\underline{0 = 0 - (1\,250)(9,8)(5,8) + \frac{1}{2}(1\,250)(v_f^2 - 0)}$ ✓
$v_i = 10,66\ m\cdot s^{-1}$ (10,662)

Into the wall / *In die muur in*:

$W_{net} = \Delta K$
$W_{wall/muur} = K_f - K_i$
$F_{wall\ /muur}\ \Delta x\cos\theta = K_f - K_i$

$\underline{F_{wall/muur}(0,25)\cos180°}$ ✓ $= 0 \underline{- \frac{1}{2}(1\,250)(10,66)^2}$ ✓
$F_{wall/muur} = 284\,089$ N ✓ (284 195,61 N)

OPTION 3/*OPSIE 3*

With ground as reference/ *Met grond as verwysing*

From R to the wall / *Vanaf R na die muur*:

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = (mgh_f - mgh_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
✓Any one/ *Enige een*

$\underline{0 = (1\,250)(9,8)[h - (5,8+h)] + \frac{1}{2}(1\,250)(v_f^2 - 0)}$ ✓
$v_i = 10,66\ m\cdot s^{-1}$ (10,662)

Into the wall / *In die muur in*:

$W_{net} = \Delta K$
$W_{wall/muur} = K_f - K_i$
$F_{wall/muur}\ \Delta x\cos\theta = K_f - K_i$
✓Any one/*Enige een*

$\underline{F_{wall/muur}(0,25)\cos180°}$ ✓ $= 0 - \underline{\frac{1}{2}(1\,250)(10,66)^2}$ ✓
$F_{wall/muur} = 284\,089$N ✓ (284 195,61 N)

OPTION 4/*OPSIE 4*

From R to the wall / *Vanaf R na die muur*:

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

$W_{nc} = (mgh_f - mgh_i) + ½m(v_f^2 - v_i^2)$

$\underline{0 = 0 - (1\ 250)(9,8)(5,8) + ½(1\ 250)(v_f^2 - 0)}$ ✓

$v_i = 10,66\ m\cdot s^{-1}$ (10,662)

✓Any one/*Enige een*

Into the wall / *In die muur in*:

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

$W_{wall/muur} = ½m(v_f^2 - v_i^2) + (mgh_f - mgh_i)$

$F_{wall/muur}\Delta x\cos\theta = ½m(v_f^2 - v_i^2) + mgh_f - mgh_i$

$\underline{F_{wall/muur}(0,25)\cos 180°}$ ✓ $= \underline{½(1\ 250)(0 - 10,66^2)}$ ✓ + 0

$F_{wall/muur} = 284\ 089$ N ✓ (284 195,61)

OPTION 5/*OPSIE 5*

From R to the wall/*Vanaf R na die muur*:

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$

$(E_p + E_k)_{Top} = (E_p + E_k)_{Bottom/Onder}$

$(mgh + ½\ mv^2)_{Top/Bo} = (mgh + ½\ mv^2)_{Bottom/Onder}$

$\underline{(9,8)(5,8) + 0 = 0 + (½)v^2}$

$v = 10,662\ m\cdot s^{-1}$

✓Any one/*Enige een*

Into the wall / *In die muur in*:

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

$W_{wall\ /muur} = ½m(v_f^2 - v_i^2) + (mgh_f - mgh_i)$

$F_{wall/muur}\ \Delta x\cos\theta = ½m(v_f^2 - v_i^2) + mgh_f - mgh_i$

$F_{wall/muur}\ \underline{0,25\cos 180°}$✓ $= \underline{½(1\ 250)(0 - 10,66^2)}$ ✓ + 0

$F_{wall/muur} = 284\ 089$ N ✓

OPTION 6/*OPSIE 6*

For the total motion/*Vir die totale beweging*:

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

$W_{wall/muur} = \Delta K + mg(h_f - h_i)$

$F_{wall/muur}\ \Delta x\cos\theta = \Delta K + mgh_f - mgh_i$

✓Any one/*Enige een*

$F_{wall/muur}\ \underline{0,25\cos 180°}$✓ $= 0 + \underline{[\ 0 - 1\ 250(9,8)(5,8)]}$ ✓✓

$F_{wall/muur} = 284\ 200$ N✓

OPTION 7/*OPSIE 7*

From R to the wall/*Vanaf R na die muur*:

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$

$(E_p + E_k)_{Top} = (E_p + E_k)_{Bottom/Onder}$

$(mgh + ½\ mv^2)_{Top/Bo} = (mgh + ½\ mv^2)_{Bottom/Onder}$

✓Any one/*Enige een*

$\underline{(9,8)(5,8)} + 0 = 0 + \underline{(½)v^2}$ ✓

$v = 10,662\ m\cdot s^{-1}$

Into the wall / *In die muur in*:

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

$$0,25 = \left(\frac{10,66 + 0}{2}\right)\Delta t$$

$\Delta t = 0,0469$ s

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

$\underline{F_{wall/muur}\ (0,047)}$ ✓ $= \underline{1250(0 - 10,66)}$ ✓

$F_{wall/muur} = 283\ 510,63$ N ✓

OPTION 8/*OPSIE 8*

From R to the wall/*Vanaf R na die muur*:

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$
$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$
$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$
✓Any one/*Enige een*

$(9,8)(5,8) + 0 = 0 + (½)v^2$ ✓
$v = 10,66 \text{ m·s}^{-1}$

Into the wall / *In die muur in*:
$v_f^2 = v_i^2 + 2a\Delta x$
$0 = (10,66)^2 + (2)a(0,25)$✓
$a = -227,36 \text{ m·s}^{-1}$ (- 227,356)

$F_{wall/muur} = ma$
$F_{wall/muur} = (1\ 250)(-227,356)$ ✓
$F_{wall/muur} = -\ 284\ 200$ (-284 195)
$F_{wall/muur} = 284\ 200$ N ✓ (284 195) (5)

[14]

QUESTION 6/*VRAAG 6*

6.1 **NOTE:** -1 mark for each key word/phrase omitted in the correct context.
LET WEL: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

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

Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het.

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

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

6.2.1 700 Hz ✓
Learner/observer/listener velocity/speed = zero.
Luisteraar/waarnemer/leerder se spoed/snelheid = nul

OR/OF
No relative motion between source and listener. ✓
Geen relatiewe beweging tussen bron en luisteraar nie.

OR/OF
Listener and source both stationary.
Luisteraar en bron altwee in rus. (2)

6.2.2 Away ✓/ *Weg*
Observed frequency smaller (than actual frequency / frequency of source.) ✓
Waargenome frekwensie is kleiner as die werklike frekwensie/ frekwensie van die bron.

OR/*OF*
$f_L < f_s$

OR/*OF*
The (observed) frequency decreases / *Die (waargenome) frekwensie neem af* (2)

6.2.3

OPTION 1/*OPSIE 1*

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

$679{,}1 \overset{\checkmark}{=} \left(\frac{v - 10}{v}\right) \overset{\checkmark}{(700)}$ ✓

$\therefore$ v = 334,93 m·s^{-1} ✓(333,33 m·s^{-1})

OPTION 2/*OPSIE 2*

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

$658{,}2 \overset{\checkmark}{=} \left(\frac{v - 20}{v}\right) \overset{\checkmark}{(700)}$ ✓

$\therefore$ v = 334,93 m·s^{-1} ✓(333,33 m·s^{-1})

OPTION 3/*OPSIE 3*

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

$\frac{679{,}1}{658{,}2} \overset{\checkmark}{=} \frac{\frac{v - 10}{v} f_s}{\frac{v - 20}{v} f_s}$ ✓

$1{,}032 = \frac{v - 10}{v - 20}$

v = 332,50 m·s^{-1} ✓

Note/*Aantekening*:
If ratio is used/*Indien verhoudings gebruik:*
- Any correct formula/*Enige korrekte formule* ✓
- Any correct f value/E*nige korrekte f waarde* ✓
- Any correct substitution/*Enige korrekte vervanging* - v_L ✓
- Correct ratio/*Regte verhouding* ✓
- Final answer/*Finale antwoord*: 332,50 m·s^{-1}✓

OPTION 4/*OPSIE 4*

$f_L = \frac{v - v_L}{v} f_s$ ✓

$f_L = -\frac{f_s}{v} v_L + f_s$

Gradient $= -\frac{f_s}{v}$ ✓

$\frac{658{,}2 - 679{,}1}{20 - 10}$ ✓ $= -\frac{700}{v}$ ✓

v = 334,93 m·s^{-1} ✓

(5)
[11]

QUESTION 7/*VRAAG 7*

7.1

NOTE: -1 mark for each key word/phrase omitted in the correct context. If the word "force" is omitted 0 marks
***LET WEL**: -1 punt vir elke sleutel woord/frase in die korrekte konteks weggelaat. Indien die woord "krag" uitgelaat word 0 punte.*

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

Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. (2)

7.2

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

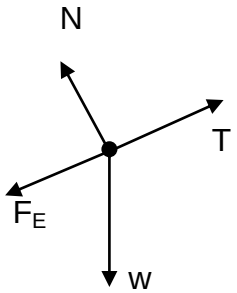
$$1{,}2 \times 10^{-3} = \frac{(9 \times 10^{9})(6 \times 10^{-9})(5 \times 10^{-9})}{r^2} \checkmark$$

$$r = 0{,}015 \text{ m} \checkmark (0{,}02 \text{ m})$$

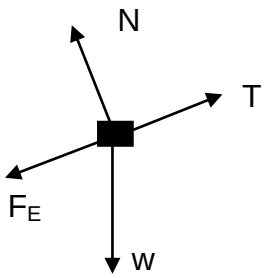
Note /*Aantekening*:
- 1 mark for all substitutions/ *1 punt vir alle vervangings*
- If negative charge substituted / *Indien negatiewe lading vervang is* Max / *Maks* 2/3

(3)

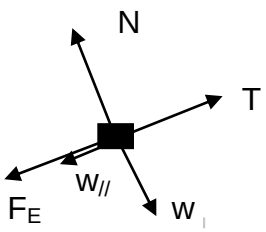
7.3



ACCEPT/*AANVAAR*



ACCEPT/*AANVAAR*



Accept the following symbols:/*Aanvaar die volgende simbole:*	
N ✓	F_N / Normal / *Normaal* / Normal force /*Normaalkrag*
w ✓	F_g,/mg / weight / $F_{Earth\ on\ sphere}$ / 0,098 N / *g*ravitational force / g*ewig* / $F_{aarde\ op\ sfeer}$ / *gravitasiekrag*
T ✓	Tension / *Spanning* / F_T / F_A / F_s /F_p
F_E ✓	F_R / F/ Coulombic Force / Electrostatic force / *Coulombkrag* / *elektrostatiese krag*

Notes/*Aantekeninge*
- Mark awarded for label and arrow / *Punt toegeken vir benoeming en pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te)* Max/*Maks* $\frac{3}{4}$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{3}{4}$
- If w is not shown but $w_{//}$ and $w_{\perp}$ are shown give 1 mark for both.
  Indien w nie aangetoon is nie maar $w_{//}$ and $w_{\perp}$ *is getoon, ken 1 punt toe vir beide.*

(4)

7.4.1

$F_{net} = ma$
$T - F_E - w_{||} = ma$ } ✓Any one/*Enige een*
$T - F_E - w_{||} = 0$
$T - \underline{1,2 \times 10^{-3}}$ ✓ $\underline{- (0,01)(9,8)\sin 25°}$✓ = 0
$T = 0,04$ N ✓ (0,0426 N)

OR/OF
$F_{net} = ma$ ✓
$T - F_E - w_{||} = ma$
$T - F_E - w_{||} = 0$
$T - \underline{1,2 \times 10^{-3}}$ ✓ $\underline{- (0,01)(9,8)\cos 65°}$✓ = 0
$T = 0,04$ N ✓ (0,0426 N)

(4)

7.4.2 **POSITIVE MARKING FROM QUESTION 7.2**
POSITIEWE NASIEN VANAF VRAAG 7.2

$E = k\frac{Q}{r^2}$
$E_{net} = E_R + E_S$
$E_{net} = E_R + (-E_S)$
$E_{net} = k\frac{Q_R}{r^2} - k\frac{Q_S}{r^2}$
$E_{net} = k\frac{Q_R}{r^2} + k\frac{Q_S}{r^2}$
} ✓Any one/*Enige een*

$E_{net} = \frac{(9\times10^9)(5\times10^{-9})}{(0,015+0,03)^2}$ ✓ $- \frac{(9\times10^9)(6\times10^{-9})}{(0,03)^2}$ ✓
$= -37\,777,78$
$= 37\,777,78$ N·C^{-1}✓ ($3,78 \times 10^4$) down (the incline) / towards the charges
afwaarts (teen skuinsvlak) /na die ladings ✓

(5)
[18]

QUESTION 8/*VRAAG 8*

8.1 (a) (Electrical) energy/work (*Elektriese*) *energie/arbeid* ✓
(b) Unit charge/*eenheidslading* ✓ (Accept/ *Aanvaar* coulomb) (2)

8.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$R_s = R_1 + R_2$ $= 4 + 3$ ✓ $= 7\ \Omega$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{R_p} = \frac{1}{7} + \frac{1}{7}$ ✓ $R_p = 3,5\ \Omega$ ✓	$R_s = R_1 + R_2$ $= 4 + 3$ ✓ $= 7\ \Omega$ $R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓ $R_p = \frac{(7)(7)}{7 + 7}$ ✓ $= 3,5\ \Omega$ ✓

(4)

8.3.1 **POSITIVE MARKING FROM QUESTION 8.2/*POSITIEWE NASIEN VANAF VRAAG 8.2***

Marking criteria/*Nasienkriteria*

Calculation of current when switch is open and when closed/ *Berekening van stroom wanneer skakelaar S oop is en gesluit is:*

- Suitable formula for opem or closed switch /*Geskikte formule vir geslote of oop skakelaar*✓
- Correct substitution when switch is open /*Korrekte vervanging wanneer skakelaar oop is* ✓
- Correct substitution when switch is closed /*Korrekte vervanging wanneer skakelaar gesluit is* ✓

Substitution into formula $\mathcal{E} = I(R + r)$ or $\mathcal{E} = V_{ext} + Ir$:

Vervanging in formule $\mathcal{E} = I(R + r)$ of $\mathcal{E} = V_{eks} + Ir$:

- Formula/*Formule* ✓
- Substitution in formula for open switch/ *Vervanging in formule vir oop skakelaar* ✓
- Substitution in formula for closed switch/ *Vervanging in formule vir geslote skakelaar* ✓

Calculating r / *Berekening van r*

- Equating the equations / *Stel twee vergelykings gelyk aan mekaar* ✓
- Final answer/*Finale antwoord*: 0,49 Ω ✓

When the switch is OPEN/*Wanneer die skakelaar OOP is*	When the switch is CLOSED/*Wanneer die skakelaar GESLUIT is*
$I = \frac{V}{R}$ ✓ ← (Any one / *Enige een*) →	$I = \frac{V}{R}$
$I = \frac{2,8}{7}$ ✓	$I = \frac{2,63}{3,5}$ ✓
$= 0,4$ A	$= 0,75$ A
$\mathcal{E} = I(R + r)$ ✓ $= 0,4(7 + r)$ ✓	$\mathcal{E} = I(R + r)$ $= 0,75(3,5 + r)$ ✓
OR $\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,8 + (0,4)r$ ✓	**OR** $\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,63 + (0,75)r$ ✓
$0,4(7 + r) = 0,75(3,5 + r)$ $r = 0,49\ \Omega$ ✓	**OR/*OF*** $2,8 + (0,4)r = 2,63 + (0,75)r$ $r = 0,49\ \Omega$ ✓

(8)

8.3.2 **POSITIVE MARKING FROM QUESTION 8.3.1/**
POSITIEWE NASIEN VANAF VRAAG 8.3.1
Option depends on the equation in which r is substituted/
Opsie hang af van die vergelyking waarin r vervang is

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,8 + (0,4)r$ $= 2,8 + (0,4)(0,49)$ ✓ $= 3$ V ✓	$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,63 + (0,75)r$ $= 2,63 + (0,75)(0,49)$ ✓ $= 3$ V ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\varepsilon = I(R + r)$ $= 0,4(7 + 0,49)$ ✓ $= 3$ V ✓	$\varepsilon = I(R + r)$ $= 0,75(3,5 + 0,49)$ ✓ $= 2,99$ V ✓

(2)
[16]

QUESTION 9/*VRAAG 9*

9.1 Slip rings/*sleepringe* ✓ (1)

9.2 Allows the slips rings to rotate while maintaining contact with the external circuit.
Laat die sleepringe toe om te roteer terwyl dit kontak met die eksterne stroombaan behou.
OR/*OF*
Transfer/conduct current to the external circuit. ✓
Dra stroom oor/Gelei stroom na eksterne stroombaan.
OR/*OF*
Connection between external circuit and coil/slip rings/internal circuit.
Verbinding tussen eksterne stroombaan en spoel/sleepringe/interne stroombaan. (1)

9.3 According to the principle of electromagnetic induction, an emf/current is induced as a result of the change in the magnetic flux linkage ✓✓ with the coil. **(2 or 0)**
Volgens die beginsel van elektromagnetiese induksie word 'n emk/stroom geïnduseer as gevolg van die verandering in magnetiese-vloedkoppeling met die spoel. ***(2 of 0)***

Accept/*Aanvaar*
When the coil rotates there is a change of magnetic flux linked/associated with the coil and according to the principle of electromagnetic induction, an emf/current is induced in the coil. **(2 or 0)**
Wanneer die spoel roteer is daar 'n verandering in magnetiese-vloedkoppeling met die spoel en volgens die beginsel van elektromagnetiese induksie word 'n stroom/emk in die spoel geïnduseer. ***(2 of 0)***
Accept/*Aanvaar*
There is relative motion between the conductor and the magnetic field.**(2 or 0)**
Daar is relatiewe beweging tussen die geleier en die magneetveld . ***(2 of 0)*** (2)

9.4 **P** to/*na* **Q** ✓✓ (2)

9.5

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$T = \frac{1}{f} = \frac{1}{50}$ ✓ = 0,02 s t = (1,5)(0,02) ✓ = 0,03 s ✓ **OR/*OF*** t = (0,02) + ½ (0,02) ✓ = 0,03 s ✓	50 waves/*golwe* = 1 s ✓ 1,5 waves/*golwe* ✓ = 0,03 s ✓
OPTION 3/*OPSIE 3*	
$t = \frac{1,5}{50}$ ✓✓ = 0,03 s ✓	
OPTION 4/*OPSIE 4*	
$t = \frac{3}{4}(0,04)$ ✓✓ = 0,03 s ✓	

(3)

9.6

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$
$= \frac{311}{\sqrt{2}}$ ✓
= 219,91 V

$I_{rms} = \frac{V_{rms}}{R}$
$= \frac{219,91}{100}$ ✓
= 2,2 A (2,199)

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$W = \frac{V^2 \Delta t}{R}$ ✓ ✓✓ $= \frac{(219,11)^2}{100}(60)$ = 29 016,24 J ✓	W = VIΔt ✓ = (219,91)✓(2,2)✓(60) ✓ = 29 028,12 J ✓ (29 013,61– 29 028,12)	$W = I^2R\Delta t$ ✓ $= (2,2^2)$✓✓(100)(60) = 29 040 J ✓ (29 013,61 – 29 040)

OPTION 4/*OPSIE 4*	**OPTION 5/*OPSIE 5***	**OPTION 6/*OPSIE 6***
$P_{ave} = V_{rms}I_{rms}$ = (219,11)(2,2) ✓ = 483,605 W $P = \frac{W}{\Delta t}$ ✓ $483,605 = \frac{W}{60}$ ✓ W = 29 016,30 J ✓	$P_{ave} = \frac{V_{rms}^2}{R}$ $= \frac{(219,11)^2}{100}$ ✓ = 483,605 W $P = \frac{W}{\Delta t}$ ✓ $483,605 = \frac{W}{60}$ ✓ W = 29 016,30 J ✓	$P_{ave} = I_{rms}^2 R$ $= (2,2)^2$ ✓(100) = 483,605 W $P = \frac{W}{\Delta t}$ ✓ $483,605 = \frac{W}{60}$ ✓ W = 29 016,30 J ✓

(5)
[14]

QUESTION 10/*VRAAG 10*

10.1 $11,6 \times 10^{-19}$ J ✓

ACCEPT/*AANVAAR*
$11,6 \times 10^{-19}$ to/*tot* $11,8 \times 10^{-19}$ J ✓ (1)

10.2 As the wavelength of the incident radiation/light increases the maximum kinetic energy of the emitted electrons decreases. ✓✓/
Soos die golflengte van die invallende straling/lig toeneem verminder die maksimum kinetiese energie van die vrygestelde elektrone.

OR/*OF*
As the wavelength of the incident radiation/light decreases the maximum kinetic energy of the emitted electrons increases. /
Soos die golflengte van die invallende straling/lig afneem vermeerder die maksimum kinetiese energie van die vrygestelde elektrone.

OR/*OF*
The maximum kinetic energy is inversely proportional to the wavelength./
Die maksimum kinetiese energie is omgekeerd eweredig aan die golflengte.

OR/OF
$E_{k(max)} \alpha \frac{1}{\lambda}$ (2)

10.3 **NOTE:** -1 mark for each key word/phrase omitted in the correct context.
LET WEL: *-1 punt vir elke sleutelwoord/frase weggelaat in die korrekte konteks.*

The work function of a metal/surface is the minimum energy needed to remove/release an electron from a (metal) surface. ✓✓
Die werksfunksie van 'n metaal/oppervlak is die minimum energie wat benodig word om 'n elektron vanaf die (metaal) oppervlak vry te stel. (2)

10.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$W_o = hf_o$ $E = \frac{hc}{\lambda_o}$ $E = \frac{hc}{\lambda}$ ✓Any one/*Enige een* $W_o = \frac{(6,63\times10^{-34})(3\times10^{8})}{4,9\times10^{-7}}$ ✓ ✓ $= 4,06\times10^{-19}$ J ✓ $(4,059\times10^{-19})$	$E = W_o + E_{k(max)}$ $W_0 = \frac{hc}{\lambda_o} + 0$ ✓Any one/*Enige een* $E = \frac{hc}{\lambda_o} + 0$ $W_o = \frac{(6,63\times10^{-34})(3\times10^{8})}{4,9\times10^{-7}}$ ✓ ✓ $= 4,06\times10^{-19}$ J ✓ $(4,059\times10^{-19})$

(4)

Accept any set of co-ordinates for calculation of W_o see table below
Aanvaar enige stel ko-ordinate vir die berekening van W_o sien tabel hieronder

$E = W_o + E_{k(max)}$
$\frac{hc}{\lambda} = W_o + E_{k(max)}$
✓Any one/*Enige een*

$\frac{(6,63\times10^{-34})(3\times10^{8})}{1,5\times10^{-7}}$ ✓ $= W_o + 8 \times 10^{-19}$ ✓

$W_o = 5,26 \times 10^{-19}$ J ✓

Table of values for W_o /*Tabel van waardes vir W_o*

		Q 10.4	**Q 10.5**
λ	**$E_{K(max)}$**	**W_o**	**$E_{K(max)}$**
$4,9 \times 10^{-7}$	0	$4,06 \times 10^{-19}$	$3,572 \times 10^{-18}$
$0,75 \times 10^{-7}$ – $0,8 \times 10^{-7}$	$14,0 \times 10^{-19}$	$1,252 \times 10^{-18}$ – $1,08625 \times 10^{-18}$	$2,726 \times 10^{-18}$
$1,5 \times 10^{-7}$	8×10^{-19}	$5,26 \times 10^{-19}$	$3,452 \times 10^{-18}$
2×10^{-7}	$6,0 \times 10^{-19}$ - $6,2 \times 10^{-19}$	$3,745 \times 10^{-19}$ – $3,95 \times 10^{-19}$	$3,6035 \times 10^{-18}$ – $3,945 \times 10^{-18}$
3×10^{-7}	$3,6 \times 10^{-19}$	$3,03 \times 10^{-19}$	$3,675 \times 10^{-18}$
4×10^{-7}	$1,6 \times 10^{-19}$	$3,3725 \times 10^{-19}$	$3,64075 \times 10^{-18}$

10.5 **POSITIVE MARKING FROM QUESTION 10.4**
POSITIEWE NASIEN VANAF VRAAG 10.4

$E = W_o + E_{k(max)}$
$\frac{hc}{\lambda} = W_o + E_{k(max)}$
✓Any one/*Enige een*

$\frac{(6,63\times10^{-34})(3\times10^{8})}{0,5\times10^{-7}}$ ✓ $= 4,06\times10^{-19}$ ✓ $+ E_{k(max)}$

$E_{k(max)} = 3,57 \times 10^{-18}$ J ✓ $(3,572 \times 10^{-18}$ or/*of* $35,72 \times 10^{-19})$ (4)

[13]

TOTAL/*TOTAAL*: 150

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