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SENIOR CERTIFICATE EXAMINATIONS/
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SENIORSERTIFIKAAT-EKSAMEN/
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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.

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 <u>acceleration that is directly proportional to the force</u> ✓ and <u>inversely proportional to the mass of the object</u>. ✓

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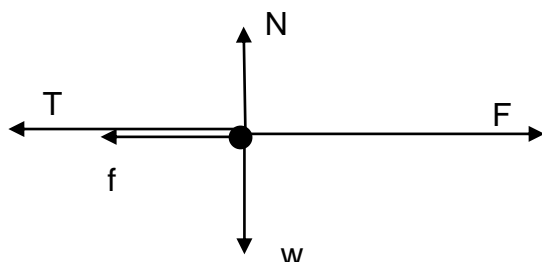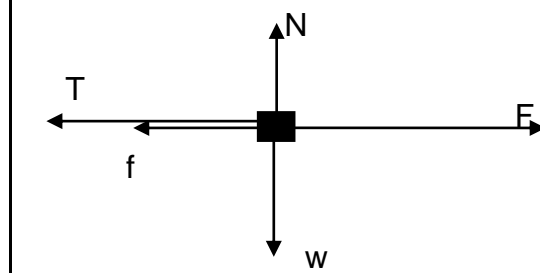
OR/*OF*

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

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

2.2

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:* $\frac{4}{5}$
- If arrows missing/*Indien pyltjies uitgelaat is*: Max./*Maks:* $\frac{4}{5}$ (5)

2.3

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

OPTION 3/*OPSIE 3*
$W_{net} = \Delta E_k$ ✓
$W_w + W_N + W_F + W_f + W_T = 0$
$0 + 0 + F\Delta x \cos\theta + f\Delta x \cos\theta + T\Delta x \cos\theta = 0$
<u>(29,6)cos0° + (10)cos180° + Tcos180° = 0</u> ✓
29,6 – 10 – T = 0
T = 19,6 N ✓

OPTION 4/*OPSIE 4*
$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$W_F + W_f + W_T = 0 + 0$
$F\Delta x \cos\theta + f\Delta x \cos\theta + T\Delta x \cos\theta = 0$
<u>(29,6)cos0° + (10)cos180° + Tcos180° = 0</u> ✓
29,6 – 10 – T = 0
T = 19,6 N ✓

(3)

2.4.1   8 kg block/*blok*

$F_{net} = ma$ ⎫ ✓Any one/*Enige een*
$F - (f + T) = ma$ ⎭
<u>50 – 10 – T</u> ✓ = 8a ✓
40 – T = 8a

2 kg block/*blok*
$F_{net} = ma$
$T - mg = ma$
<u>T – 2(9,8)</u> ✓ = 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 $9,8 \text{ m·s}^{-2}$ ✓ downwards / *afwaarts* ✓   (2)

3.3   3 (m) ✓   (1)

3.4.1

OPTION 1/*OPSIE 1*	
Gradient/*Gradiënt* = $\dfrac{y_2 - y_1}{x_2 - x_1}$ $-9,8$ ✓ $= \left(\dfrac{0 - v_i}{1,02 - 0}\right)$ ✓ $v_i = 10 \text{ m·s}^{-1}$ ✓ (9,996)	
OPTION 2/*OPSIE 2* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{0 = v_i + (-9,8)(1,02)}$ ✓ $v_i = 10 \text{ m·s}^{-1}$ ✓ (9,996)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{0 = v_i + (9,8)(1,02)}$ ✓ $v_i = -10$ $v_i = 10 \text{ m·s}^{-1}$ ✓ (9,996)
OPTION 3/*OPSIE 3* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{-v = v + (-9,8)(2,04)}$ ✓ $v = 10 \text{ m·s}^{-1}$ ✓ (9,996)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{v = -v + (9,8)(2,04)}$ ✓ $v = -10$ $v = 10 \text{ m·s}^{-1}$ ✓ (9,996)
OPTION 4/ *OPSIE 4* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\underline{0 = v_i(2,04) + \frac{1}{2}(-9,8)(2,04)^2}$ ✓ $v_i = 10 \text{ m·s}^{-1}$ ✓ (9,996)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\underline{0 = v_i(2,04) + \frac{1}{2}(9,8)(2,04)^2}$ ✓ $v_i = -10$ $v_i = 10 \text{ m·s}^{-1}$ ✓ (9,996)

OPTION 5/*OPSIE 5*
UPWARDS POSITIVE/
***OPWAARTS POSITIEF*:**

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

$$= \left(\frac{v_i + 0}{2} \right) (1{,}02)$$

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = v_i^2 + 2(-9{,}8) \left(\frac{v_i + 0}{2} \right) (1{,}02)$ ✓

$v_i = 10$ m·s⁻¹ ✓ (9,996)

DOWNWARDS POSITIVE/
AFWAARTS POSITIEF:

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

$$= \left(\frac{v_i + 0}{2} \right) (1{,}02)$$

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = v_i^2 + 2(9{,}8) \left(\frac{v_i + 0}{2} \right) (1{,}02)$ ✓

$v_i = -10$ m·s⁻¹
$v_i = 10$ m·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
$v_f = v_i + a\Delta t$ ✓
$v_f = \underline{0 + (-9{,}8)(1{,}02)}$
$v_f = 10$ m·s⁻¹
$v_i = 10$ m·s⁻¹ ✓

DOWNWARDS AS POSITIVE/
AFWAARTS POSITIEF
$v_f = v_i + a\Delta t$ ✓
$v_f = \underline{0 + (9{,}8)(1{,}02)}$ ✓
$v_f = 10$ m·s⁻¹
$v_i = 10$ m·s⁻¹ ✓

OPTION 7/*OPSIE 7*
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$ ✓
$mgh + 0 = 0 + \frac{1}{2} mv^2$
$\underline{(9{,}8)(5{,}09796) = \frac{1}{2} v^2}$ ✓
$(2)(9{,}8)(5{,}09796) = v^2$
$v_i = 10$ m·s⁻¹ ✓ (9,996)

OPTION 8/*OPSIE 8*
$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta y \cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$
$ma\Delta y \cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$
$\underline{(0{,}06)(9{,}8)(5{,}09796) = \frac{1}{2}(0{,}06)(v_f^2 - 0^2)}$ ✓
$v_i = 10$ m·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·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·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*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0^2 = (10)^2 + 2(-9,8)\Delta y}$ ✓ $\Delta y = -5,1$ m (-5,102) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m✓ (8,102)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0^2 = (-10)^2 + 2(9,8)\,\Delta y}$ ✓ $\Delta y = 5,1$ m (5,102) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m✓(8,102)
OPTION 2/ *OPSIE 2* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $\quad = \underline{(10)(1,02) + \frac{1}{2}(-9,8)(1,02)^2}$ ✓ $\Delta y = 5,1$ m (5,102) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓(8,102)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $\quad = \underline{(-10)(1,02) + \frac{1}{2}(9,8)(1,02)^2}$ ✓ $\Delta y = -5,1$ m (-5,102) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓(8,102)
OPTION 3/*OPSIE 3* **UPWARDS POSITIVE/** ***OPWAARTS POSITIEF*:** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $\quad = \left(\dfrac{0-10}{2}\right)(1,02)$ ✓ $\Delta y = -5,1$ m $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓	**DOWNWARDS POSITIVE/** ***AFWAARTS POSITIEF:*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $\quad = \left(\dfrac{0+10}{2}\right)(1,02)$ ✓ $\Delta y = 5,1$ m $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓
OPTION 4/ *OPSIE 4* **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $\quad = \underline{0 + \frac{1}{2}(-9,8)(1,02)^2}$ ✓ $\Delta y = -5,1$ m (-5,098) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓ (8,098)	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\quad = \underline{0 + \frac{1}{2}(9,8)(1,02)^2}$ ✓ $\Delta y = 5,1$ m (5,098) $h = 5,1 \; \underline{+ \, 3}$ ✓ $\quad = 8,1$ m ✓ (8,098)

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$

$w\Delta y\cos180° = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*

$\underline{(0,06)(9,8)(\Delta y)\cos180°} = \underline{\frac{1}{2}(0,06)(0 - 10^2)}$ ✓

$\Delta y = 5,1$ m

$h = 5,1 \underline{+ 3}$ ✓
$= 8,1$ m ✓

OPTION 6/ *OPSIE 6*

$(E_{mech})_{3\,m(ref/verw)} = (E_{mech})_{Top/Bo}$

$(E_P + E_K)_{3\,m(ref/verw)} = (E_P + E_K)_{Top/Bo}$ } ✓Any one/*Enige een*

$(mgh + \frac{1}{2}mv^2)_{3\,m\,(ref/verw)} = (mgh + \frac{1}{2}mv^2)_{Top/Bo}$

$\underline{(0) + \frac{1}{2}(0,06)(10)^2} = \underline{(0,06)(9,8)(h) + 0}$ ✓

$h = 5,1$ m

$h = 5,1$ m

$h = 5,1 \underline{+ 3}$ ✓
$= 8,1$ 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***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-3 = \underline{10}\,\Delta t + \underline{\frac{1}{2}(-9,8)\Delta t^2}$ ✓	$+3 = \underline{-10}\,\Delta t + \underline{\frac{1}{2}(9,8)\Delta t^2}$ ✓
$\Delta t = 2,31\,\underline{s\,(2,306)}$	$\Delta t = 2,31\,\underline{s\,(2,306)}$
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{0 + \frac{1}{2}(-9,8)(2,31 - 1,02)^2}$ ✓	$= \underline{0 + \frac{1}{2}(9,8)(2,31 - 1,02)^2}$ ✓
$\Delta y = -8,15$ m (8,1)	$\Delta y = 8,15$ m (8,1)
$h = 8,15$ m (8,1) ✓	$h = 8,15$ m (8,1) ✓

OPTION 8/ *OPSIE 8*

$(E_{mech})_{3\,m\,(ref/verw)} = (E_{mech})_{Top/Bo}$

$(E_P + E_K)_{3\,m(ref/verw)} = (E_P + E_K)_{Top/Bo}$ } ✓Any one/*Enige een*

$(mgh + \frac{1}{2}mv^2)_{3\,m(ref/verw)} = (mgh + \frac{1}{2}mv^2)_{Top/Bo}$

$\underline{(0,06)(9,8)(3) + \frac{1}{2}(0,06)(10)^2}$ ✓ $= \underline{(0,06)(9,8)(h) + 0}$ ✓

$h = 8,1$ m ✓

OPTION 9/*OPSIE 9*

$W_{nc} = \Delta E_p + \Delta E_k$

$0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓Any one/*Enige een*

$0 = \underline{(0,06)(9,8)(h_f - 3)}$ ✓ $\underline{+ \frac{1}{2}(0,06)(0 - 10^2)}$ ✓

$h = 8,1$ m ✓

<u>**Marking criteria Options 10 to 11/*Nasienkriteria Opsies 10 tot 11***</u>
- 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 ✓

<u>**OPTION 10/*OPSIE 10***</u>
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·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·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)

<u>**OPTION 11/*OPSIE 11***</u>
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·s^{-1}
 	
   $v_f = v_i + a\Delta t$
$-12,60 = 0 + (-9,8)\Delta t$
$\Delta t = 1,29$ s (1,286)
 	
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
   $= \underline{0 + \frac{1}{2}(-9,8)(1,29)^2}$ ✓
$\Delta y = -8,1$ 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·s^{-1}
	
	   $v_f = v_i + a\Delta t$
	$12,60 = 0 + (9,8)\Delta t$
	$\Delta t = 1,29$ s (1,286)
	
	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
	   $= \underline{0 + \frac{1}{2}(9,8)(1,29)^2}$ ✓
	$\Delta y = 8,1$ m (8,098)
	$h_1 = 8,1$ m ✓ (8,098 – 8,102)

<u>**OPTION 12/*OPSIE 12***</u>
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* ⎤ ✓
            = $\frac{1}{2}$ bh   ⎦
            = $\frac{1}{2}$ (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 v*ervanging✓
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

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

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

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

$= \underline{0 + \frac{1}{2}(0,06)(10,78^2 \overset{✓}{-} 12,60^2)}$ ✓

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

$= -1,28$ J ✓ (-1,2785)

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

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

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
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$\quad = 0 + \frac{1}{2}(-9,8)(1,1)^2$ ✓
$\quad = -5,93$ m
$\Delta y = 5,93$ m (5,929)

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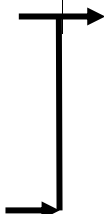$\quad = 0 + \frac{1}{2}(9,8)(1,1)^2$ ✓
$\quad = -5,93$ m
$\Delta y = 5,93$ m

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$\quad = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$

$\quad = (0,06)(9,8)(5,93 - 8,10) + 0$ ✓

$\quad = -1,28$ 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

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

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

$\quad = \left(\dfrac{10,78 + 0}{2} \right)(1,1)$ ✓

$\Delta y = 5,93$ m
OR/*OF*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (10,78)^2 + 2(-9,8)\Delta y$ ✓
$\Delta y = 5,93$ m
DOWNWARDS AS POSITIVE
AFWAARTS AS POSITIEF
$v_f = v_i + a\Delta t$
$0 = v_i + (9,8)(1,1)$
$v_i = -10,78$
$v_i = 10,78$ m·s^{-1}

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

$\quad = \left(\dfrac{-10,78 - 0}{2} \right)(1,1)$ ✓

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

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$\quad = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$

$\quad = (0,06)(9,8)(5,93 - 8,10) + 0$ ✓

$\quad = -1,28$ 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 <u>total</u> (linear) <u>momentum</u> of an isolated/closed <u>system remains constant</u> (is conserved). ✓✓
Die <u>totale (liniêre) momentum</u> in 'n geïsoleerde/ <u>geslote sisteem bly konstant (behoue).</u>

<u>Accept/Aanvaar</u>
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

<u>OPTION 1/OPSIE 1</u>	**<u>OPTION 1/OPSIE 1</u>**
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\sum p_i = \sum p_f$ ⎫ ✓Any one/	$\sum p_i = \sum p_f$ ⎫ ✓Any one/
$(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ ⎭ *Enige een*	$(m_1 + m_2)v_i = m_1v_{2f} + m_2v_{Bf}$ ⎭ *Enige een*
$\underline{(2m + 3m)v}$ ✓$= (3m)(-\frac{1}{3}v) + 2mv_{Bf}$ ✓	$\underline{(2m + 3m)(-v)}$✓$= (3m)(\frac{1}{3}v) + 2mv_{Bf}$ ✓
	$v_{Bf} = -3v$
$v_{Bf} = 3v$ ✓upwards/*opwaarts* ✓	$v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓

<u>OPTION 2/OPSIE 2</u>	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta p_{iA} = -\Delta p_{iB}$ ⎫ ✓Any one/	$\Delta p_{iA} = -\Delta p_{iB}$ ⎫ ✓Any one/
$m_A(v_{Af} - v_{Aif}) = -m_A(v_{Bf} - v_{Bi})$ ⎭ *Enige een*	$m_A(v_{Af} - v_{Aif}) = -m_A(v_{Bf} - v_{Bi})$ ⎭ *Enige een*
$\underline{3m(-\frac{1}{3}v - v)}$ ✓$= \underline{-(2m)(v_{Bf} - v)}$ ✓	$\underline{3m[\frac{1}{3}v - (-v)]}$ ✓$= \underline{(2m)[v_{Bf} - (-v)]}$ ✓
$v_{Bf} = 3v$ ✓ upwards/*opwaarts* ✓	$v_{Bf} = -3v$
	$v_{Bf} = 3v$ ✓ upwards/*opwaarts*✓

(5)

4.3   Impulse/*Impuls* ✓   (1)

4.4
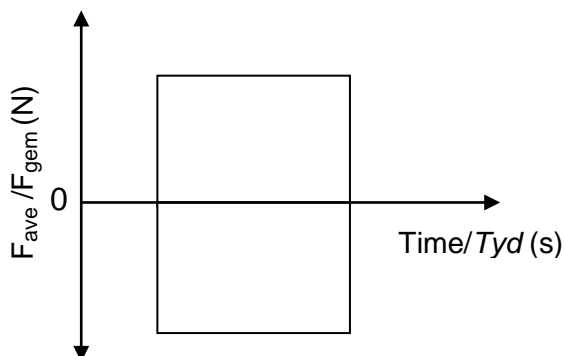
Marking criteria/*Nasienkriteria*
Exact mirror image *Presiese spieëlbeeld* ✓✓
IF/*INDIEN* Mirror image at different times / *Spieëlbeeld by verskillende tye* Max/*maks* $\frac{1}{2}$
Note/*Let wel*: If graph is drawn as given in question paper – no mirror image/*Indien grafiek geteken word soos in vraestel – 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*	**OPTION 2/***OPSIE 2*
$P = \dfrac{W}{\Delta t}$ ⎱ ✓Any one/*Enige een* $= \dfrac{\Delta mgh}{\Delta t}$ ⎰ $= \dfrac{(1\ 250)(9,8)(5,8)}{60}$ ✓ $= 1\ 184,17$ W ✓ (1 184,167)	$P = \dfrac{W}{\Delta t}$ $= \dfrac{F\Delta x\cos\theta}{\Delta t}$ or/*of* $\dfrac{F\Delta y\cos\theta}{\Delta t}$ ✓Any one/*Enige een* $= \dfrac{mg\Delta x\cos 0°}{\Delta t}$ $= \dfrac{(1250)(9,8)(5,8)\cos 0°}{60}$ ✓ $= 1\ 184,17$ W ✓ (1 184,167)

OPTION 3/*OPSIE 3*

$P = \dfrac{W}{\Delta t}$

$= \dfrac{F\Delta x\cos\theta}{\Delta t}$ or/*of* $\dfrac{F\Delta y\cos\theta}{\Delta t}$ ✓Any one/*Enige een*

$= \dfrac{mg\Delta x\cos 180°}{\Delta t}$ ✓

$= \dfrac{(1250)(9,8)(5,8)\cos 180°}{60}$

$= -1\ 184,17$ W   (-1 184,167)

Power dissipated by the crane/*Drywing verkwis deur hyskraan* =1 184,17 W✓

OPTION 4/*OPSIE 4*

$P_{ave} = Fv_{ave}$ ✓

    $= 1\ 250(9,8)\dfrac{5,8}{60}$ ✓

    $= 1\ 184,17$ 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 <u>work done</u> (in moving an object between two points) <u>is independent of the path taken.</u> ✓✓
    'n Konserwatiewe krag is 'n krag waarvoor <u>die arbeid wat verrig is (om 'n voorwerp tussen twee punte te beweeg) onafhanklik is van die pad wat gevat word.</u>
    OR/*OF*
    A conservative force is a force for which the <u>work done</u> in moving an object <u>in a closed path is zero.</u>
    'n Konserwatiewe krag is 'n krag waarvoor die <u>arbeid verrig</u> om 'n voorwerp <u>in 'n geslote pad te beweeg, nul is.</u>   (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*
       $W_{net} = \Delta K$
$W_{wall/muur} = K_f - K_i$ } ✓Any one/*Enige een*
$F_{wall\ /muur}\ \Delta x\cos\theta = K_f - K_i$
$\underline{F_{wall/muur}(0,25)\cos180°}$ ✓ $= 0\ \underline{-\ 71\ 050}$ ✓
         $F_{wall/muur} = 284\ 089$ 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·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·s^{-1} (10,662)
Into the wall / *In die muur in*:
       $W_{net} = \Delta K$
$W_{wall/muur} = K_f - K_i$ } ✓Any one/*Enige een*
$F_{wall/muur}\ \Delta x\cos\theta = K_f - K_i$
$\underline{F_{wall/muur}(0,25)\cos180°}$ ✓ $= 0 - \frac{1}{2}(1\ 250)(10,66)^2$ ✓
       $F_{wall/muur} = 284\ 089$N ✓ (284 195,61 N)

OPTION 4/*OPSIE 4*
From R to the wall / *Vanaf R na die muur*:

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

$W_{nc} = (mgh_f - mgh_i) + \frac{1}{2}m(v_f^2 - v_i^2)$

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

$v_i = 10,66$ m·s^{-1} (10,662)

Into the wall / *In die muur in*:

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

$W_{wall/muur} = \frac{1}{2}m(v_f^2 - v_i^2) + (mgh_f - mgh_i)$

$F_{wall/muur}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2) + mgh_f - mgh_i$

$F_{wall/muur}(0,25)\cos180°$ ✓ $= \frac{1}{2}(1\,250)(0 - 10,66^2)$ ✓ $+ 0$

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

✓Any one/*Enige een*

OPTION 5/*OPSIE 5*
From R to the wall/*Vanaf R na die muur*:

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

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

$(mgh + \frac{1}{2}mv^2)_{Top/Bo} = (mgh + \frac{1}{2}mv^2)_{Bottom/Onder}$

$(9,8)(5,8) + 0 = 0 + (\frac{1}{2})v^2$

$v = 10,662$ m·s^{-1}

Into the wall / *In die muur in*:

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

$W_{wall/muur} = \frac{1}{2}m(v_f^2 - v_i^2) + (mgh_f - mgh_i)$

$F_{wall/muur}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2) + mgh_f - mgh_i$

$F_{wall/muur}\,0,25\cos180°$✓ $= \frac{1}{2}(1\,250)(0 - 10,66^2)$ ✓ $+ 0$

$F_{wall/muur} = 284\,089$ N ✓

✓Any one/*Enige een*

OPTION 6/*OPSIE 6*
For the total motion/*Vir die totale beweging*:

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

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

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

$F_{wall/muur}\,0,25\cos180°$✓ $= 0 + [\,0 - 1\,250(9,8)(5,8)]$ ✓✓

$F_{wall/muur} = 284\,200$ N✓

✓Any one/*Enige een*

OPTION 7/*OPSIE 7*
From R to the wall/*Vanaf R na die muur*:

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

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

$(mgh + \frac{1}{2}mv^2)_{Top/Bo} = (mgh + \frac{1}{2}mv^2)_{Bottom/Onder}$

$(9,8)(5,8) + 0 = 0 + (\frac{1}{2})v^2$ ✓

$v = 10,662$ m·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

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

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

$F_{wall/muur} = 283\,510,63$ N ✓

✓Any one/*Enige een*

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*
⎭

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

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

$F_{wall/muur} = ma$
$F_{wall/muur} = \underline{(1\ 250)(-227,356)}$ ✓
$F_{wall/muur} = -284\ 200$ (-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 <u>change in frequency (or pitch) of the sound</u> detected by a listener because <u>the sound source and the listener have different velocities relative to the medium of sound propagation</u>. ✓✓

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

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

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

(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*
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ ✓   **OR/*OF*** $f_L = \dfrac{v - v_L}{v} f_s$
$679{,}1 = \left(\dfrac{v - 10}{v}\right)(700)$ ✓
$\therefore v = 334{,}93 \text{ m·s}^{-1}$ ✓ $(333{,}33 \text{ m·s}^{-1})$

OPTION 2/*OPSIE 2*
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ ✓   **OR/*OF*** $f_L = \dfrac{v - v_L}{v} f_s$
$658{,}2 = \left(\dfrac{v - 20}{v}\right)(700)$ ✓
$\therefore v = 334{,}93 \text{ m·s}^{-1}$ ✓ $(333{,}33 \text{ m·s}^{-1})$

OPTION 3/*OPSIE 3*	**Note/*Aantekening*:**
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \dfrac{v - v_L}{v} f_s$ $\dfrac{679{,}1}{658{,}2} = \dfrac{\dfrac{v - 10}{v} f_s}{\dfrac{v - 20}{v} f_s}$ ✓ $1{,}032 = \dfrac{v - 10}{v - 20}$ $v = 332{,}50 \text{ m·s}^{-1}$ ✓	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*: $332{,}50 \text{ m·s}^{-1}$ ✓

OPTION 4/*OPSIE 4*	
$f_L = \dfrac{v - v_L}{v} f_s$ ✓ $f_L = -\dfrac{f_s}{v} v_L + f_s$ Gradient $= -\dfrac{f_s}{v}$ ✓ $\dfrac{658{,}2 - 679{,}1}{20 - 10}$ ✓ $= -\dfrac{700}{v}$ ✓ $v = 334{,}93 \text{ m·s}^{-1}$ ✓	

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

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

7.2

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

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

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

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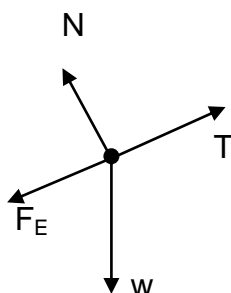
Accept the following symbols:/*Aanvaar die volgende simbole:*
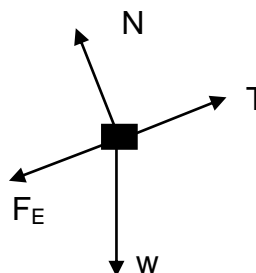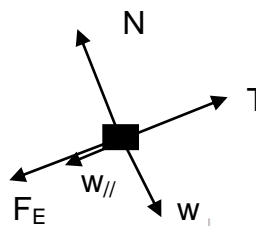
N ✓	F_N / Normal / *Normaal* / Normal force /*Normaalkrag*
w ✓	F_g,/mg / weight / $F_{Earth\ on\ sphere}$ / 0,098 N / gravitational force / g*ewig* / $F_{aarde\ op\ sfeer}$ / *gravitasiekrag*
T ✓	Tension / *Spanning* / F_T / F_A / F_s /F_p
F_E ✓	F_R / F/ Coulombic Force / Electrostatic force / *Coulombkrag*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

Notes/*Aantekeninge*
- Mark awarded for label <u>and</u> arrow / *Punt toegeken vir benoeming <u>en</u> 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

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

OR/OF
$F_{net} = ma$ ✓
$T - F_E - w_{ll} = ma$
$T - F_E - w_{ll} = 0$
$T - \underline{1,2 \times 10^{-3}}$ ✓ $\underline{- (0,01)(9,8)\cos 65°}$✓ $= 0$
$T = 0,04$ N ✓ (0,0426 N)   (4)

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

$E = k\dfrac{Q}{r^2}$

$E_{net} = E_R + E_S$

$E_{net} = E_R + (-E_S)$ } ✓Any one/*Enige een*

$E_{net} = k\dfrac{Q_R}{r^2} - k\dfrac{Q_S}{r^2}$

$E_{net} = k\dfrac{Q_R}{r^2} + k\dfrac{Q_S}{r^2}$

$E_{net} = \dfrac{(9 \times 10^9)(5 \times 10^{-9})}{(0,015 + 0,03)^2}$ ✓ $- \dfrac{(9 \times 10^9)(6 \times 10^{-9})}{(0,03)^2}$ ✓

$= -37\ 777,78$
$= 37\ 777,78$ N·C^{-1}✓ (3,78 x 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*
$R_s = R_1 + R_2$ $\quad = 4 + 3$ ✓ $\quad = 7\ \Omega$ $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ ✓ $\dfrac{1}{R_p} = \dfrac{1}{7} + \dfrac{1}{7}$ ✓ $R_p = 3,5\ \Omega$ ✓	$R_s = R_1 + R_2$ $\quad = 4 + 3$ ✓ $\quad = 7\ \Omega$ $R_p = \dfrac{R_1 R_2}{R_1 + R_2}$ ✓ $R_p = \dfrac{(7)(7)}{7 + 7}$ ✓ $\quad = 3,5\ \Omega$ ✓

(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* v*ervanging wanneer skakelaar oop is* ✓
- Correct substitution when switch is closed /*Korrekte* v*ervanging wanneer skakelaar gesluit is* ✓

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

Vervanging in formule $\varepsilon = I(R + r)$ of $\varepsilon = V_{eks} + Ir$:
- 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*
$I = \dfrac{V}{R}$ ✓ ◄— (Any one / *Enige een*)	—► $I = \dfrac{V}{R}$
$I = \dfrac{2,8}{7}$ ✓	$I = \dfrac{2,63}{3,5}$ ✓
$\quad = 0,4\ A$	$\quad = 0,75\ A$
$\varepsilon = I(R + r)$ ✓ $\quad = 0,4(7 + r)$ ✓	$\varepsilon = I(R + r)$ $\quad = 0,75(3,5 + r)$ ✓
OR	**OR**
$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,8 + (0,4)r$ ✓	$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,63 + (0,75)r$ ◄
$0,4(7 + r) = 0,75(3,5 + r)$ $r \quad = 0,49\ \Omega$ ✓	**OR/*OF*** $2,8 + (0,4)r = 2,63 + (0,75)r$ $r \quad = 0,49\ \Omega$ ✓

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

(2)
[16]

QUESTION 9/*VRAAG 9*

9.1   Slip rings/*sleepringe* ✓   (1)

9.2   Allows the slips rings to rotate while <u>maintaining contact with the external circuit.</u>
         Laat die sleepringe toe om te roteer terwyl dit <u>kontak met die eksterne stroombaan behou.</u>
         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 <u>change in the magnetic flux linkage</u> ✓✓ with the coil. **(2 or 0)**
         *Volgens die beginsel van elektromagnetiese induksie word 'n emk/stroom geïnduseer as gevolg van die <u>verandering in magnetiese-vloedkoppeling</u> met die spoel. **(2 of 0)***

         Accept/*Aanvaar*
         When the coil rotates there is a <u>change of magnetic flux</u> 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 <u>verandering in magnetiese-vloed</u>koppeling 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***
$T = \dfrac{1}{f} = \dfrac{1}{50}$ ✓ $= 0,02$ 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 ✓

(Right column lower rows:)

OPTION 3/*OPSIE 3*
$t = \dfrac{1,5}{50}$ ✓✓ $= 0,03$ s ✓

OPTION 4/*OPSIE 4*
$t = \dfrac{3}{4}(0,04)$ ✓✓ $= 0,03$ s ✓

(3)

9.6

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$= \frac{311}{\sqrt{2}} \checkmark$$

$$= 219,91 \text{ V}$$

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

$$= \frac{219,91}{100} \checkmark$$

$$= 2,2 \text{ A } (2,199)$$

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$W = \dfrac{V^2 \,\Delta t}{R}$ ✓ $= \dfrac{(219,11)^2}{100}(60)$ ✓✓ $= 29\ 016,24$ J ✓	$W = VI\Delta t$ ✓ $= (219,91)\checkmark(2,2)\checkmark(60)$ ✓ $= 29\ 028,12$ J ✓ $(29\ 013,61 - 29\ 028,12)$	$W = I^2R\Delta t$ ✓ $= (2,2^2)\checkmark\checkmark(100)(60)$ $= 29\ 040$ 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 $P = \dfrac{W}{\Delta t}$ ✓ $483,605 = \dfrac{W}{60}$ ✓ $W = 29\ 016,30$ J ✓	$P_{ave} = \dfrac{V_{rms}^2}{R}$ $= \dfrac{(219,11)^2}{100}$ ✓ $= 483,605$ W $P = \dfrac{W}{\Delta t}$ ✓ $483,605 = \dfrac{W}{60}$ ✓ $W = 29\ 016,30$ J ✓	$P_{ave} = I_{rms}^2 R$ $= (2,2)^2$ ✓(100) $= 483,605$ W $P = \dfrac{W}{\Delta t}$ ✓ $483,605 = \dfrac{W}{60}$ ✓ $W = 29\ 016,30$ J ✓

(5)

[14]

Physical Sciences P1/Fisiese Wetenskappe V1   23   DBE/2021
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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 <u>wavelength</u> of the incident radiation/light <u>increases</u> the maximum <u>kinetic energy of the emitted electrons decreases</u>. ✓✓/
Soos die <u>golflengte</u> van die invallende straling/lig <u>toeneem</u> <u>verminder die</u> maksimum <u>kinetiese energie van die vrygestelde elektrone</u>.

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

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

OR/OF

$E_{k(max)}$ α $\dfrac{1}{\lambda}$

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

(2)

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10.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$W_o = hf_o$ $E = \dfrac{hc}{\lambda_o}$ $E = \dfrac{hc}{\lambda}$ ⎫ ✓Any one/*Enige een*	$E = W_o + E_{k(max)}$ $W_0 = \dfrac{hc}{\lambda_o} + 0$ ⎫ ✓Any one/*Enige een* $E = \dfrac{hc}{\lambda_o} + 0$
$W_o = \dfrac{(6,63\times10^{-34})(3\times10^8)\ ✓}{4,9\times10^{-7}\ ✓}$ $= 4,06 \times10^{-19}$ J ✓ $(4,059 \times 10^{-19})$	$W_o = \dfrac{(6,63\times10^{-34})(3\times10^8)\ ✓}{4,9\times10^{-7}\ ✓}$ $= 4,06 \times10^{-19}$ J ✓ $(4,059 \times 10^{-19})$

(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

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

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

$W_o = 5,26 \times 10^{-19}$ 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

$E = W_0 + E_{k(max)}$
$\dfrac{hc}{\lambda} = W_0 + E_{k(max)}$ ⎫ ✓Any one/*Enige een*

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

$E_{k(max)} = 3,57 \times 10^{-18}$ J ✓ $(3,572 \times10^{-18}$ or/*of* $35,72 \times 10^{-19})$

(4)

[13]

TOTAL/*TOTAAL*: **150**