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Basic Education
REPUBLIC OF SOUTH AFRICA

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

GRADE/*GRAAD* 12

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

NOVEMBER 2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

**These marking guidelines consist of 28 pages.
*Hierdie nasienriglyne bestaan uit 28 bladsye.***

QUESTION 1/*VRAAG 1*

1.1   B ✓✓   (2)

1.2   A ✓✓   (2)

1.3   D ✓✓   (2)

1.4   B✓✓   (2)

1.5   B ✓✓   (2)

1.6   A ✓✓   (2)

1.7   D ✓✓   (2)

1.8   B ✓✓   (2)

1.9   C ✓✓   (2)

1.10   A ✓✓   (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 <u>acceleration is directly proportional to the resultant/net force</u> and <u>inversely proportional to the mass of the object</u>. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Die <u>versnelling is direk eweredig aan die netto/resulterende krag</u> en <u>omgekeerd eweredig aan die massa van die voorwerp.</u>
OR/*OF*
The <u>resultant/net force</u> acting on an object is <u>equal to the rate of change of momentum of the object in the direction of the resultant/net force</u>. (2 or 0)
Die <u>resulterende/netto krag</u> wat op 'n voorwerp inwerk is <u>gelyk aan die tempo van verandering van momentum in die rigting van die resulterende/netto krag. (2 of 0)</u>   (2)

2.2

	Accepted labels/*Aanvaarde benoemings*
N	F_N/Normal/F_{normal}/*$F_{normaal}$/Normaal*
f	(kinetic) friction/5,88 N /F_f/f_k/*(kinetiese) wrywing* /*F_w*
w	F_g/F_w/weight/mg/39,2 N/gravitational force *F_g/F_w/gewig/mg/39,2 N/gravitasiekrag*
T	F_T/F_{string}/tension/*spanning*/*F_{tou}*
Notes/*Aantekeninge*	
- Mark is awarded for label <u>and</u> arrow./*Punt word toegeken vir byskrif <u>en</u> pyltjie.* - Do not penalise for length of arrows./*Moenie vir die lengte van die pyltjies penaliseer nie.* - If w is not shown but w∥ and w⊥ are shown, give 1 mark for both./ *Indien w nie getoon is nie maar* w∥ *en* w⊥ *is getoon, ken 1 punt toe vir beide.* - If arrows do not touch the dot/*Indien pyle nie die kolletjie raak nie*: Max/*Maks* $^3/_4$ - 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* $^3/_4$	

(4)

2.3.1

For block A/*Vir blok A:*
UP THE INCLINE AS POSITIVE/
TEEN DIE SKUINSTE OP AS POSITIEF

$F_{net} = ma$
$T - f_k - w_{\parallel} = ma$ ⎫ ✓Any one /*Enige een*
$T - f_k - mgsin\theta = ma$ ⎭

$\underline{T - 5{,}88 - 4(9{,}8)sin35°}$ ✓ $= \underline{4(2)}$ ✓
$T = 36{,}36 \text{ N}$ ✓

DOWN THE INCLINE AS POSITIVE/
TEEN DIE SKUINSTE AF AS POSITIEF

$F_{net} = ma$
$- T + f_k + w_{\parallel} = ma$ ⎫ ✓Any one /*Enige een*
$- T + f_k + mgsin\theta = ma$ ⎭

$\underline{- T + 5{,}88 + 4(9{,}8)sin35°}$ ✓ $= \underline{4(-2)}$ ✓
$T = 36{,}36 \text{ N}$ ✓

(4)

2.3.2   **POSITIVE MARKING FROM QUESTION 2.3.1**
POSITIEWE NASIEN VANAF VRAAG 2.3.1

NOTE: If systems approach is used, learner gets mark for the answer only.
NOTA: Indien sisteem benadering gebruik word, kry leerder slegs 'n punt vir die antwoord.

For block B/*Vir blok B:*
UP THE INCLINE AS POSITIVE/
TEEN DIE SKUINSTE OP AS POSITIEF

$F_{net} = ma$
$F - T - f_k - w_{\parallel} = ma$
$F - T - f_k - mgsin\theta = ma$
$\underline{F - 36{,}36 - 13{,}23 - 9(9{,}8)sin35°}$ ✓ $= (9)(2)$ ✓
$F = 118{,}18 \text{ N}$ ✓

DOWN THE INCLINE AS POSITIVE/
TEEN DIE SKUINSTE AF AS POSITIEF

$F_{net} = ma$
$- F + T + f_k + w_{\parallel} = ma$
$- F + T + f_k + mgsin\theta = ma$
$\underline{-F + 36{,}36 + 13{,}23 + 9(9{,}8)sin35°}$ ✓ $= (9)(-2)$ ✓
$F = 118{,}18 \text{ N}$ ✓

(3)

2.4.1   INCREASES/*TOENEEM* ✓   (1)

2.4.2   • Since μ_k and m are constant, as θ decreases, <u>normal force/$w_{\perp}$/mgcosθ will increase.</u> ✓
Aangesien μ_k en m konstant is, soos *θ afneem sal* <u>*normaalkrag/$w_{\perp}$/mgcosθ toeneem*</u>.
OR/*OF*
$N = mgcos\theta$

• Frictional force is directly proportional to normal force/ ✓
Wrywing is direk eweredig aan normaalkrag
OR/OF $f \propto N$ /$f \propto w_{\perp}$ / $f \propto N$ / $f = \mu_k N$

(2)

[16]

QUESTION 3/*VRAAG 3*

3.1   Motion under the influence of gravitational force only. ✓✓ Accept weight/gravity.
Beweging slegs onder die invloed van gravitasiekrag. Aanvaar swaartekrag/gewig/gravitasie.
(2 or/*of* 0)
OR/*OF*
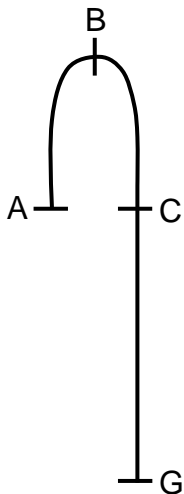Motion in which the only force acting is gravitational force. Accept weight/gravity.
Beweging waar die enigste krag wat inwerk, gravitasiekrag is. Aanvaar swaartekrag/gewig/gravitasie.(2 or/of 0)   (2)

> **NOTE: If projectile is defined: $^0/_2$**
>
> *NOTA: Indien projektiel gedefinieer is: $^0/_2$*

3.2

Marking criteria/*Nasienkriteria*
- Correct formula for v_i./*Korrekte formule vir v_i.*✓
- Correct substitution into formula./*Korrekte vervanging in formule.* ✓
- Correct final answer/*Korrekte finale antwoord*: 10,74 m·s^{-1} ✓

Note: If energy principles are used, max: $^1/_3$ for answer.
Nota: *Indien energiebeginsels gebruik word, maks: $^1/_3$ vir antwoord.*

OPTION 1/*OPSIE 1* **A-B:**	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(-9,8)(5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = v_i^2 + 2(9,8)(-5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓
OPTION 2/*OPSIE 2* **B-C:**	
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(-9,8)(-5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(9,8)(5,89)$ ✓ $v_i = 10,74$ m·s^{-1} ✓

(3)

3.3.1   **POSITIVE MARKING FROM QUESTION 3.2.**
POSITIEWE NASIEN VANAF VRAAG 3.2

Marking criteria/*Nasienkriteria*
- Any one of the correct formulae leading to the velocity at which the ball strikes the ground./*Enige een van die korrekte formules wat lei tot die snelheid waarmee die bal die grond tref.* ✓
- Correct substitution leading to the velocity at which the ball strikes the ground (values of v_i and v_f can be swopped)./*Korrekte vervanging wat lei tot die snelheid waarmee die bal die grond tref (waardes van v_i en v_f kan omgeruil word).* ✓
- Correct formula for ΔE_k/$E_{k\ lost}$./*Korrekte formule vir ΔE_k/$E_{k\ verlore}$.* ✓
- Correct substitution into ΔE_k/$E_{k\ lost}$ *formula* (values of v_i and v_f can be swopped, ignore negative v_i or v_f values)./
Korrekte vervanging in ΔE_k/$E_{k\ verlore}$ formule (waardes van v_i en v_f kan omgeruil word, ignoreer negatiewe v_i of v_f waardes). ✓
- Correct final answer/*Korrekte finale antwoord: +/- 68,31 J* ✓
Range/*Gebied:* (67,91 – 69,34J)

Note: Accept if downwards is taken as positive.
Nota: Aanvaar indien afwaarts as positief geneem is.

OPTION 1/*OPSIE 1*
A-G:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(10,74)^2 + 2(-9,8)(-15,3)}$ ✓
$v_f = -20,38$ m·s^{-1}

OPTION 2/*OPSIE 2*
B-G:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0^2 + \underline{2(-9,8)(-21,19)}$ ✓
$v_f = -20,38$ m·s^{-1}

OPTION 3/*OPSIE 3*
C-G:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(-10,74)^2 + 2(-9,8)(-15,3)}$ ✓
$v_f = -20,38$ m·s^{-1}

OPTION 4/*OPSIE 4*
A-G:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-15,3 = (10,74)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
$t = 3,18$ s

$\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15,3 = \left(\dfrac{10,74 + v_f}{2}\right)3,18$ ✓
$\underline{\hspace{6cm}}$
$v_f = -20,38$ m·s^{-1}

DURING COLLISION/
TYDENS BOTSING
$\Delta E_k = E_{kf} - E_{ki}$
$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ⎫ ✓Any one/
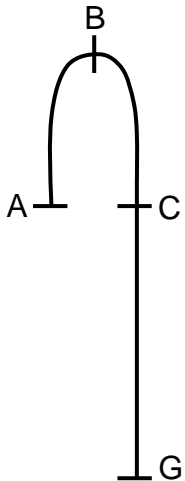$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$ ⎭ *Enige een*
$\Delta E_k = \frac{1}{2}(0,5)[(11,92)^2 - (20,38)^2]$ ✓
ΔE_k/$E_{k\ lost} = -68,31$ J ✓

OR/*OF*

$\Delta E_k = \frac{1}{2}(0,5)[(20,38)^2 - (11,92)^2]$ ✓
ΔE_k/$E_{k\ lost} = 68,31$ J ✓

OPTION 5/*OPSIE 5*
B–G:

$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-21,19 = (0)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 2,08 \text{ s}$$

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$$
$$-21,19 = \left(\frac{0 + v_f}{2}\right)2,08 \checkmark$$
$$v_f = -20,38 \text{ m·s}^{-1}$$

OPTION 6/*OPSIE 6*
C–G:

$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-15,3 = (-10,74)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 0,98 \text{ s}$$

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$$
$$-15,3 = \left(\frac{-10,74 + v_f}{2}\right)0,98 \checkmark$$
$$v_f = -20,48 \text{ m·s}^{-1}$$

OPTION 7/*OPSIE 7*
A–G:

$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-15,3 = (10,74)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 3,18 \text{ s}$$

$$v_f = v_i + a\Delta t \checkmark$$
$$v_f = \underline{10,74 + (-9,8)(3,18)} \checkmark$$
$$v_f = -20,42 \text{ m·s}^{-1}$$

OPTION 8/*OPSIE 8*
B–G:

$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-21,19 = (0)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 2,08 \text{ s}$$

$$v_f = v_i + a\Delta t \checkmark$$
$$v_f = 0 + \underline{(-9,8)(2,08)} \checkmark$$
$$v_f = -20,38 \text{ m·s}^{-1}$$

OPTION 9/*OPSIE 9*
C–G:

$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-15,3 = (-10,74)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 0,98 \text{ s}$$

$$v_f = v_i + a\Delta t \checkmark$$
$$v_f = \underline{-10,74 + (-9,8)(0,98)} \checkmark$$
$$v_f = -20,34 \text{ m·s}^{-1}$$

DURING COLLISION/
TYDENS BOTSING

$$\Delta E_k = E_{kf} - E_{ki}$$
$$\Delta E_k = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$\Delta E_k = \tfrac{1}{2}m(v_f^2 - v_i^2)$$

$\checkmark$Any one/
Enige een

$$\Delta E_k = \tfrac{1}{2}(0,5)[(11,92)^2 - (20,38)^2] \checkmark$$
$$\Delta E_k / E_{k \text{ lost}} = -68,31 \text{ J} \checkmark$$

OR/*OF*

$$\Delta E_k = \tfrac{1}{2}(0,5)[(20,38)^2 - (11,92)^2] \checkmark$$
$$\Delta E_k / E_{k \text{ lost}} = 68,31 \text{ J} \checkmark$$

Diagram labels: B, A, C, G

OPTION 10/*OPSIE 10*

A-G:
$$W_{net} = \Delta E_k$$
$$w\Delta y\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$ ✓Any one/ *Enige een*
$$\underline{(0,5)(9,8)(15,3)\cos0°} = \tfrac{1}{2}(0,5)v_f^2 - \tfrac{1}{2}(0,5)(10,74)^2 ✓$$
$$v_f = 20,38 \text{ m·s}^{-1}$$

OPTION 11/*OPSIE 11*

B-G:
$$W_{net} = \Delta E_k$$
$$w\Delta y\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$ ✓Any one/ *Enige een*
$$\underline{(0,5)(9,8)(21,19)}\cos0° = \tfrac{1}{2}(0,5)v_f^2 - 0 ✓$$
$$v_f = 20,38 \text{ m·s}^{-1}$$

OPTION 12/*OPSIE 12*

C-G:
$$W_{net} = \Delta E_k$$
$$w\Delta y\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$ ✓Any one/ *Enige een*
$$\underline{(0,5)(9,8)(15,3)\cos0°} = \tfrac{1}{2}(0,5)v_f^2 - \tfrac{1}{2}(0,5)(10,74)^2 ✓$$
$$v_f = 20,38 \text{ m·s}^{-1}$$

OPTION 13/*OPSIE 13*

A-G OR/*OF* C-G:
$$W_{nc} = \Delta K + \Delta U$$
$$W_{nc} = [\tfrac{1}{2} m(v_f^2 - v_i^2)] + [mg(h_f - h_i)]$$ ✓Any one/ *Enige een*
$$0 = [\tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2] + [mgh_f - mgh_i]$$
$$0 = [\underline{\tfrac{1}{2}(0,5) v_f^2 - (10,74)^2}] + [0 \underline{-(0,5)(9,8)(15,3)}] ✓$$
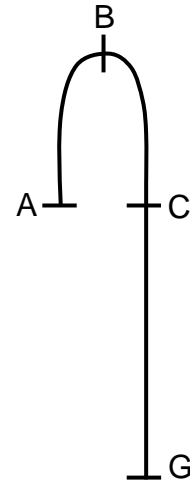$$v_f = 20,38 \text{ m·s}^{-1}$$

OPTION 14/*OPSIE 14*

B-G:
$$W_{nc} = \Delta K + \Delta U$$
$$W_{nc} = [\tfrac{1}{2} m(v_f^2 - v_{ii}^2)] + [mg(h_f - h_i)]$$ ✓Any one/ *Enige een*
$$0 = [\tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2] + [mgh_f - mgh_i]$$
$$0 = [\underline{\tfrac{1}{2}(0,5) v_f^2 - 0}] + [0 \underline{-(0,5)(9,8)(21,19)}] ✓$$
$$v_f = 20,38 \text{ m·s}^{-1}$$

OPTION 15/*OPSIE 15*
$$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$$
$$-15,3 = (10,74)\Delta t + \tfrac{1}{2}(-9,8)\Delta t^2$$
$$t = 3,18 \text{ s}$$

$$F_{net}\Delta t = \Delta p$$
$$mg\Delta t = m(v_f - v_i)$$ ✓Any one/*Enige een*
$$\underline{(-9,8)(3,18)} = v_f - 10,74 ✓$$
$$v_i = -20,38 \text{ m·s}^{-1} ✓$$

OPTION 16/*OPSIE 16*
$$(E_k + E_P)_{top} = (E_k + E_P)_{bottom}$$
$$(0 + mgh)_{top} = (\tfrac{1}{2}mv_i^2 + 0)_{bottom}$$ ✓Any one/ *Enige een*
$$0 + \underline{(0,5)(9,8)(21,19)} = \tfrac{1}{2}(0,5)v^2 + 0 ✓$$
$$v_i = 20,3795 \text{ m·s}^{-1} ✓$$

DURING COLLISION/*TYDENS BOTSING*
$$\Delta E_k = E_{kf} - E_{ki}$$
$$\Delta E_k = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$ ✓Any one/ *Enige een*
$$\Delta E_k = \tfrac{1}{2}m(v_f^2 - v_i^2)$$
$$\Delta E_k = \tfrac{1}{2}(0,5)[(11,92)^2 - (20,38)^2] ✓$$
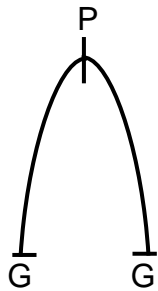$$\Delta E_k/E_{k \text{ lost}} = -68,31 \text{ J} ✓$$

OR/*OF*

$$\Delta E_k = \tfrac{1}{2}(0,5)[(20,38)^2 - (11,92)^2] ✓$$
$$\Delta E_k/E_{k \text{ lost}} = 68,31 \text{ J} ✓$$

(5)

3.3.2

Marking criteria/*Nasienkriteria*
- Correct formula to calculate Δt./*Korrekte formule om Δt te bereken.* ✓
- Correct substitution to calculate Δt./*Korrekte vervanging om Δt te bereken.* ✓
- Correct final answer./*Korrekte finale antwoord:* 1,22 s ✓

OPTION 1/*OPSIE 1* **G-P:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = \underline{11{,}92 + (-9{,}8)\,\Delta t}$ ✓ $\Delta t = 1{,}22$ s ✓	**G-P:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = \underline{(-11{,}92) + (9{,}8)\Delta t}$ ✓ $\Delta t = 1{,}22$ s ✓
OPTION 2/*OPSIE 2* **P-G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{-11{,}92 = 0 + (-9{,}8)\,\Delta t}$ ✓ $\Delta t = 1{,}22$ s ✓	**P-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{11{,}92 = 0 + (9{,}8)\Delta t}$ ✓ $\Delta t = 1{,}22$ s ✓
OPTION 3/*OPSIE 3* **G - G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{-11{,}92 = 11{,}92 + (-9{,}8)\,\Delta t}$ ✓ $\Delta t = 2{,}43$ s t to reach h_{max}/t tot $h_{maks} = \dfrac{2{,}43}{2}$ $= 1{,}22$ s ✓	**G - G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $\underline{11{,}92 = -11{,}92 + (9{,}8)\,\Delta t}$ ✓ $\Delta t = 2{,}43$ s t to reach h_{max}/t tot $h_{maks} = \dfrac{2{,}43}{2}$ $= 1{,}22$ s ✓
OPTION 4/*OPSIE 4* **G-P:** **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (11{,}92)^2 + 2(-9{,}8)\Delta y$ $\Delta y = 7{,}25$ m	$\Delta y = v_i\Delta t + \tfrac{1}{2}a\Delta t^2$ ✓ $\underline{7{,}25 = (11{,}92)\Delta t + \tfrac{1}{2}(-9{,}8)\Delta t^2}$ ✓ $\Delta t = 1{,}22$ s ✓ **OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $\underline{7{,}25 = \left(\dfrac{11{,}92 + 0}{2}\right)\Delta t}$ ✓ $\Delta t = 1{,}22$ s ✓
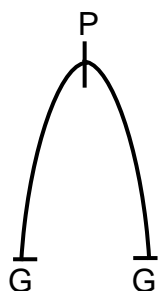
	G-P: **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ $0 = (-11,92)^2 + 2(9,8)\Delta y$ $\Delta y = -7,25$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-7,25 = (-11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2$✓ $\Delta t = 1,22$ s ✓ **OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $-7,25 = \left(\dfrac{-11,92 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ s ✓
	OPTION 5/*OPSIE 5* **P-G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ $(-11,92)^2 = 0 + 2(-9,8)\Delta y$ $\Delta y = -7,25$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-7,25 = \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 1,22$ s ✓ **OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $-7,25 = \left(\dfrac{0 - 11,92}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ s ✓
	P-G: **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f^2 = v_i^2 + 2a\Delta y$ $(11,92)^2 = 0 + 2(9,8)\Delta y$ $\Delta y = 7,25$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $7,25 = (11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 1,22$ s ✓ **OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $7,25 = \left(\dfrac{0 + 11,92}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ s ✓

OPTION 6/*OPSIE 6*	UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*
$W_{net} = \Delta E_k$ $w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(0,5)(9,8)\Delta y\cos180^\circ = \frac{1}{2}(0,5)(0 - (11,92)^2$ $\Delta y = 7,25$ m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\underline{7,25 = (11,92)\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓ $\Delta t = 1,22$ s ✓
OR/*OF*	**OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓
$W_{nc} = \Delta K + \Delta U$ $W_{nc} = [\ \frac{1}{2}m(v_f^2 - v_f^2)\ ] + [\ mg(h_f - h_i)\ ]$ $\quad 0 = [\ \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\ ] + [\ mgh_f - mgh_i\ ]$ $\quad 0 = \frac{1}{2}(0,5)[(0 - (11,92)^2] + (0,5)(9,8)\Delta h$ $\Delta h = 7,25$ m	$7,25 = \left(\dfrac{11,92 + 0}{2}\right)\Delta t$ ✓ $\underline{\Delta t = 1,22\ s}$ ✓
OR/*OF*	**DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-7,25 = (-11,92)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 1,22$ s ✓
$\sum E_{Mi} = \sum E_{Mf}$ $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$ $\frac{1}{2}(0,5)(11,92)^2 + 0 = 0 + (0,5)(9,8)(h_f)$ $\Delta h = 7,25$ m	**OR/*OF*** $\Delta y = \left(\dfrac{v_i + v_f}{2}\right)\Delta t$ ✓ $-7,25 = \left(\dfrac{-11,92 + 0}{2}\right)\Delta t$ ✓ $\underline{\quad\Delta t = 1,22\ s}$ ✓
OPTION 7/*OPSIE 7* **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $F_{net}\Delta t = \Delta p = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $\underline{(0,5)(9,8)\Delta t = (0,5)[0 - (11,92)]}$ ✓ $\Delta t = 1,22$ s ✓	**UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $F_{net}\Delta t = \Delta p = m(v_f - v_i)$ ✓ $mg\Delta t = m(v_f - v_i)$ $\underline{(0,5)(9,8)\Delta t = (0,5)[0 - (-11,92)]}$ ✓ $\Delta t = 1,22$ s ✓

(3)

3.4   **POSITIVE MARKING FROM QUESTIONS 3.2 AND 3.3.2**
      POSITIEWE NASIEN VANAF VRAE 3.2 EN 3.3.2

3.4.1   11,92 (m·s⁻¹) ✓   (1)

3.4.2   10,74 (m·s⁻¹) ✓   (1)

3.4.3   1,22 (s) ✓   (1)
                                                                                            [16]

QUESTION 4/*VRAAG 4*

4.1　　　591 N to the right/original direction of bullet/Accept East ✓
　　　　　591 N na regs/in oorspronklike rigting van koeël/Aanvaar Oos　　　　(1)

4.2

Marking criteria/*Nasienkriteria*
• Any correct formula for conservation of momentum./*Enige korrekte formule vir behoud van momentum.* ✓
• Correct substitutions. /*Korrekte vervangings.* ✓✓
• Correct final answer./*Korrekte finale antwoord:* 395,58 m·s⁻¹✓
Range/*Gebied*: (394 to 395,58 m·s⁻¹)

OPTION 1/*OPSIE 1*

$$F_{net} \Delta t = \Delta p = m(v_f - v_i)$$
$$(591)(0,02) = 2,7[v_f - (-3)]$$
$$v_f = 1,38 \text{ m·s}^{-1}$$

$$\Sigma p_i = \Sigma p_f \quad ✓\text{Any one/}$$
$$m_b v_{bi} + m_t v_{ti} = \{m_b + m_t\}v_f \quad \text{Enige een}$$
$$\underline{(0,03)v_{bi}+(2,7)(-3)}✓=\underline{(0,03+2,7)(1,38)}✓$$
$$(0,03)v_{bi} = 11,86$$
$$v_i = 395,58 \text{ m·s}^{-1}✓$$

OR/*OF*

$$\Delta p_{(bullet)} = -\Delta p_{(trolley)} ✓$$
$$m(v_f - v_i) = \underline{-(591)(0,02)} ✓$$
$$\underline{(0,03)(1,38 - v_i)} ✓ = -11,82$$
$$1,38 - v_i = -394$$
$$v_i = 395,38 \text{ m·s}^{-1}✓$$

(4)

4.3

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 <u>total</u> (linear) <u>momentum</u> in an <u>isolated system</u> is <u>conserved/remains constant</u>. ✓✓
Die <u>totale</u> (lineêre) <u>momentum</u> in 'n <u>geïsoleerde sisteem</u> bly <u>behoue/konstant.</u>

Accept for 1 mark/*Aanvaar vir 1 punt*
In a <u>isolated system</u> the <u>total momentum before a collision is equal to the total momentum after a collision</u>.
In 'n <u>geïsoleerde sisteem</u> is die <u>totale momentum voor 'n botsing gelyk aan die totale momentum na 'n botsing</u>.

(2)

4.4   **POSITIVE MARKING FROM QUESTION 4.2.**
        POSITIEWE NASIEN VANAF VRAAG 4.2.

OPTION 1/*OPSIE 1*
RIGHT AS POSITIVE/*REGS AS POSITIEF*
$\sum p_i = \sum p_f$ ⎫ ✓Any one/*Enige een* $m_x v_{ix} + m_y v_{iy} = m_x v_{fx} + m_y v_{fy}$ ⎭ $\underline{(0,03)(395,58) + (2,7)(-3)}$ ✓ $\underline{= v_f (0,03 + 2,7)}$✓ $\therefore v_f = 1,38 \text{ m·s}^{-1}$ ✓   Range/*Gebied*: (1,36 – 1,38 m·s⁻¹)
LEFT AS POSITIVE/*LINKS AS POSITIEF*
$\sum p_i = \sum p_f$ ⎫ ✓Any one/*Enige een* $m_x v_{ix} + m_y v_{iy} = m_x v_{fx} + m_y v_{fy}$ ⎭ $\underline{(0,03)(-395,58) + (2,7)(3)}$ ✓ $\underline{= v_f (0,03 + 2,7)}$✓ $\therefore v_f = -1,38 \text{ m·s}^{-1}$ $v_f = 1,38 \text{ m·s}^{-1}$ ✓   Range/*Gebied*: (1,36 –1,38 m·s⁻¹)
OPTION 2/*OPSIE 2*
$F_{net} \Delta t = \Delta p = m(v_f - v_i)$ ✓ $\underline{(591)(0,02)}$ ✓ $\underline{= 2,7[v_f - (-3)]}$ ✓ $v_f = 1,38 \text{ m·s}^{-1}$ ✓   Range/*Gebied*: (1,36 – 1,38 m·s⁻¹)
OPTION 3/*OPSIE 3*
RIGHT AS POSITIVE/*REGS AS POSITIEF*
$\Delta p_{(bullet)} + \Delta p_{(trolley)} = 0$ ⎫ ✓Any one/Enige een $m_1(v_{1f} - v_{1i}) + m_2(v_{2f} - v_{2i}) = 0$ ⎭ $\underline{(0,03)(v_f - 395,58)}$ ✓ $+ \underline{(2,7)(v_f + 3)}$ ✓ $= 0$ $v_f = 1,38 \text{ m·s}^{-1}$ ✓Range/*Gebied*:(1,36 – 1,38 m·s⁻¹)
LEFT AS POSITIVE/*LINKS AS NEGATIEF*
$\Delta p_{(bullet)} + \Delta p_{(trolley)} = 0$ ⎫ ✓Any one/Enige een $m_1(v_{1f} - v_{1i}) + m_2(v_{2f} - v_{2i}) = 0$ ⎭ $\underline{(0,03)(v_f + 395,58)}$ ✓ $+ \underline{(2,7)(v_f - 3)}$ ✓ $= 0$ $v_f = -1,38 \text{ m·s}^{-1}$ $v_f = 1,38 \text{ m·s}^{-1}$ ✓ Range/*Gebied*:(1,36 – 1,38 m·s⁻¹)

(4)

[11]

QUESTION 5/*VRAAG 5*

5.1
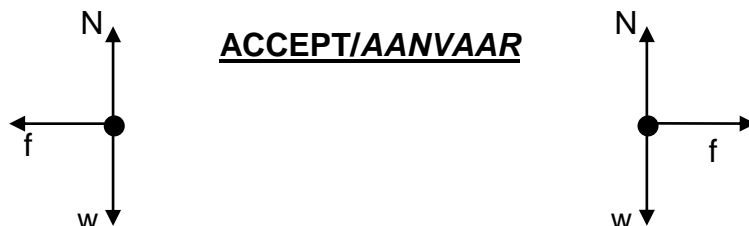
ACCEPT/*AANVAAR*

Accepted labels/*Aanvaarde benoemings*	
w	F_w /F_g /$F_{Earth\ on\ trolley}$/$F_{Aarde\ op\ trollie}$ /mg /gravitational force/ *gravitasiekrag*/weight/*gewig*
f	F_f /f_k/(kinetic) Friction/*(kinetiese) wrywing*/F_w
N	F_N /$F_{surface\ on\ trolley}$ /$F_{oppervlak\ op\ trollie}$ /Normal/*Normaal*

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./*Moenie vir die lengte van die pyltjies penaliseer nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te): Max/Maks* ⅔
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* ⅔
- If force(s) do not make contact with the dot /*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/Maks ⅔

(3)

5.2   Initial kinetic energy/*Aanvanklike kinetiese energie*/E_{kA} /E_{ki}/K_i✓   (1)

5.3

> **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 <u>net/total work</u> done (on an object) is <u>equal</u> to the <u>change</u> in the object's <u>kinetic energy</u>. ✓✓
Die <u>netto/totale arbeid</u> wat (op 'n voorwerp) verrig is, is <u>gelyk</u> aan die <u>verandering</u> in die voorwerp se <u>kinetiese energie</u>.
OR/*OF*
The <u>work</u> done on an object by a <u>resultant/net force</u> is <u>equal</u> to the <u>change</u> in the object's <u>kinetic energy</u>. ✓✓
Die <u>arbeid</u> verrig op in voorwerp deur die <u>resultante/netto krag</u> is <u>gelyk</u> aan die <u>verandering</u> in die voorwerp se <u>kinetiese energie</u>.

(2)

5.4

Marking criteria/*Nasienkriteria*
OPTION 1/*OPSIE 1*
- Relating frictional force to gradient./*Verband tussen wrywingskrag en helling.* ✓
- Correct subtitution of two values or ratio from the graph./*Korrekte vervanging van twee waardes of verhouding vanaf die grafiek.* ✓✓
- Formula to calculate mass./*Formule om massa te bereken.* ✓
- Correct substitution of µ and 9,8./*Korrekte vervanging van µ en 9,8.* ✓
- Correct final answer/*Korrekte finale antwoord: 2,27 kg* ✓

$$\text{gradient} = \frac{\Delta y}{\Delta x} = \frac{\Delta x}{E_{ki}} = \frac{1}{f} \quad ✓$$

$$\frac{1,5}{6} \text{ OR/}OF \frac{3}{12} \text{ OR/}OF \frac{4,5}{18} = \frac{1}{4} \begin{matrix} ✓ \\ ✓ \end{matrix}$$

$$f = 4 \text{ N}$$

$f_k = \mu_k F_N$ ✓
$\underline{4 = (0,18)(m)(9,8)}$ ✓
$m = 2,27 \text{ kg}$ ✓

Marking criteria/*Nasienkriteria*
OPTIONS 2 TO 5/*OPSIES 2 TOT 5*
- Correct formula for work./*Korrekte formule vir arbeid.* ✓
- Correct substitution of two co-ordinate values from the graph. Correct negative ΔE_k value (any two correct co-ordinates used). ✓✓
  Korrekte vervanging van twee koördinaat waardes vanaf die grafiek
  Korrekte negatiewe ΔE_k waarde (enige twee korrekte koördinate gebruik).
- Formula to calculate mass./*Formule om massa te bereken.* ✓
- Correct substitution of µ and 9,8./*Korrekte invervanging van µ en 9,8.* ✓
- Correct final answer/*Korrekte finale antwoord: 2,27 kg* ✓

OPTION 2/*OPSIE 2*

$$\left.\begin{matrix} W_{nc} = \Delta K + \Delta U \\ W_{net} = \Delta E_k \\ W_{net} = E_{kf} - E_{ki} \\ W_f = \Delta E_k \\ W_f = E_{kf} - E_{ki} \\ f\Delta x\cos 180° = E_{kf} - E_{ki} \end{matrix}\right\} ✓\text{Any one/}\\ \quad\quad\quad Enige\ een$$

$$- f(1,5) ✓ = 0 - 6 ✓$$
OR/*OF*
$$- f(3) = 0 - 12$$
OR/*OF*
$$- f(4,5) = 0 - 18$$

$$f = 4 \text{ N}$$

$f_k = \mu_k F_N$ ✓
$\underline{4 = (0,18)(m)(9,8)}$ ✓
$m = 2,27 \text{ kg}$ ✓

OPTION 3/*OPSIE 3*
$W_{net} = F_{net} \Delta x\cos \theta$ ✓
$- 6 ✓ = f(1,5)\cos 180°$ ✓ **OR/*OF***
$- 12 = f(3)\cos 180°$ **OR/*OF***
$- 18 = f(4,5)\cos 180°$
$f = 4 \text{ N}$

OPTION 4/*OPSIE 4*

$f_k = \mu_k N$ ✓

$\quad = \underline{0,18(9,8)(m)}$ ✓

$\quad = 1,76m$

$$W_{net} = \Delta E_k$$
$$F_{net}\Delta x\cos\theta = E_{kf} - E_{ki}$$
$$f_k\Delta x\cos\theta = E_{kf} - E_{ki}$$
$$\mu_k N\Delta x\cos\theta = E_{kf} - E_{ki}$$
$$\mu_k N\Delta x\cos 180^o = E_{kf} - E_{ki}$$

✓Any one/*Enige een*

$- (1,76m)(4,5)$ ✓ $= 0 - 18$ ✓

OR/*OF*

$\quad - (1,76m)(3) = 0 - 12$

OR/*OF*

$\quad - (1,76m)(1,5) = 0 - 6$

$\qquad m = 2,27 \text{ kg}$ ✓

OPTION 5/*OPSIE 5*

$$W_{net} = \Delta E_k \text{ ✓}$$
$$\underset{✓}{\mu_k m g}\Delta x\cos\theta = E_{kf} - E_{ki}$$
$$\underline{(0,18)(m)(9,8)}\underset{✓}{\underline{(4,5)}}\cos 180^o = 0 - 18 \text{ ✓}$$

$\qquad m = 2,27 \text{ kg}$ ✓

OPTION 6/*OPSIE 6*

$f_k = \mu_k N$ ✓

$\quad = \underline{0,18(9,8)(m)}$ ✓

$\quad = 1,76m$

$\quad F_{net} = ma$
$-1,76m = ma$
$\qquad a = -1,764 \text{ m·s}^{-2}$
$v_f^2 = v_i^2 + 2a\Delta y$
$\underline{0 = v_i^2 + 2(-1,764)(4,5)}$ ✓
$v_i = 3,98 \text{ m·s}^{-1}$

$\Delta E_k = \frac{1}{2}m\Delta v^2$✓
$\underline{-18 = \frac{1}{2}m(0-3,98^2)}$ ✓
$\quad m = 2,27 \text{ kg}$ ✓

(6)

[12]

QUESTION 6/*VRAAG 6*

6.1.1
> **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 change in frequency (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 (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/*OF*
An (apparent) change in observed/detected frequency (pitch), as a result of the relative motion between a source and an observer (listener).
'n (Skynbare) verandering in waargenome frekwensie (toonhoogte), as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer (luisteraar).   (2)

6.1.2
> $$f_L = \frac{v \pm v_L}{v \pm v_s} f_S \quad \textbf{OR/\textit{OF}} \quad f_L = \frac{v}{v + v_s} f_S \checkmark$$
>
> $$512{,}64\checkmark = \overbrace{\left(\left(\frac{v}{v + 25}\right)\right)}^{\checkmark}(550)\checkmark$$
>
> $$v = 343{,}04 \text{ m·s}^{-1} \checkmark \quad \text{Range/\textit{Gebied:} } (332{,}14 - 343{,}04 \text{ m·s}^{-1})$$
    (5)

6.1.3   a)   Remains the same/*Bly dieselfde* ✓   (1)

b)   Remains the same/*Bly dieselfde* ✓   (1)

c)   Decreases/*Afneem* ✓   (1)

6.2.1   AWAY FROM/*WEG VAN* ✓   (1)

6.2.2
> **Marking criteria/*Nasienkriteria:***
> Second mark is only awarded if red is linked to lower frequency/longer wavelength./*Tweede punt word slegs toegeken indien vergelyking getref word tussen rooi en laer frekwensie en langer golflengte.*

- A lower frequency/longer wavelength ✓ is detected.
- The spectral lines are shifted to the red end of the spectrum. ✓
- *'n Laer frekwensie/langer golflengte word waargeneem.*
- *Die spektrale lyne word geskuif na die rooi end van die spektrum.*   (2)

[13]

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.*

Electric field is a <u>region/space</u> in which an electric <u>charge</u> experiences a <u>force</u>.✓✓
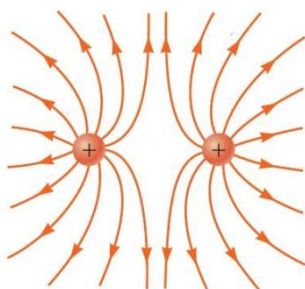*'n <u>Gebied/ruimte</u> waarin 'n elektriese <u>lading</u> 'n <u>krag</u> ondervind.*

NOTE: If electric field at a point is defined: $^0/_2$
NOTA: Indien elektiese veld by 'n punt gedefinieer is: $^0/_2$

(2)

7.2

Criteria for sketch/Kriteria vir skets	Marks/*Punte*
Correct direction of field lines./*Korrekte rigting van veldlyne.*	✓
Correct shape of the electric field lines between charges and on the outside of the charges./*Korrekte vorm van elektrieseveld tussen ladings en die buitekant van die ladings.*	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge./*Geen veldlyne wat mekaar kruis nie. Veldlyne moet die lading raak, maar nie die lading binnegaan nie.*	✓
Note: If learner draws field pattern of two opposite charges: $^0/_3$	
If only one charge is drawn, max: $^1/_3$ for direction.	
Nota: Indien leerder elektrieseveld van twee teenoorgestelde ladings teken: $^0/_3$.	
Indien slegs een lading geteken is, maks: $^1/_3$ vir rigting.	

(3)

7.3

Marking criteria/*Nasienkriteria*
• Formula/*Formule*: $E = \dfrac{kQ}{r^2}$. ✓
• Correct substitution for either A or B ✓/*Korrekte vervanging vir of A of B.*
• Substitution of 27 or –27 for E_{net}. ✓/*Vervanging van 27 of –27 vir $E_{net.}$*
• Subtraction of/*Aftrek van* ($E_A – E_B$ **OF/OR** $E_B – E_A$) ✓
• Correct final answer/*Korrekte finale antwoord*: 0,87 (m) ✓

OPTION 1/*OPSIE 1*

$E = \dfrac{kQ}{r^2}$ ✓

$E_A = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{r^2}$

$E_B = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{(2r)^2}$

⟩ ✓Any one/*Enige een*

$E_{net} = E_A – E_B$

$27\,✓ = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{r^2} \overset{✓}{-} \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{4r^2}$

r = 0,87 (m) ✓

OR/*OF*

$E = \dfrac{kQ}{r^2}$ ✓

$E_A = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{r^2}$

$E_B = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{(2r)^2}$

⟩ ✓Any one/*Enige een*

$E_{net} = E_B – E_A$

$–27\,✓ = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{4r^2} \overset{✓}{-} \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)}{r^2}$

r = 0,87 (m) ✓

OPTION 2/*OPSIE 2*
Marking criteria/*Nasienkriteria:*

- Formula for Coulomb's law./Formule vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's formula for either F_A or F_B./ ✓
  Korrekte vervanging in Coulomb se formule vir of F_A *of* F_B.
- Substitution of 27q or –27q for F_{net}. ✓/*Vervanging van 27q of –27q vir* F_{net}.
- Subtraction of/*Aftrek van* ($F_A – F_B$ **OF/*OR*** $F_B – F_A$) ✓
- Correct final answer/*Korrekte finale antwoord*: 0,87 (m)✓

$$F = \frac{kQ_1Q_2}{r^2} ✓$$

$$F_A = \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{r^2}$$

✓Any one/*Enige een*

$$F_B = \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{(2r)^2}$$

$$F_{net} = F_A – F_B$$

$$27q ✓= \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{r^2} ✓ - \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{4r^2}$$

$$r = 0,87 \text{ (m)} ✓$$

OR/*OF*

$$F = \frac{kQ_1Q_2}{r^2} ✓$$

$$F_A = \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{r^2}$$

✓Any one/*Enige een*

$$F_B = \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{(2r)^2}$$

$$–F_{net} = F_B – F_A$$

$$–27q ✓= \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{4r^2} ✓ - \frac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)(q)}{r^2}$$

$$r = 0,87 \text{ (m)} ✓$$

(5)

7.4

OPTION 1/*OPSIE 1*
$F = Eq$ ✓
$\quad = (27)(1,6 \times 10^{-19})$ ✓
$\quad = 4,32 \times 10^{-18}$ N ✓
Note: Do not penalize for -1,6 x 10^{-19}, but penalize for negative final answer.
Nota: Moenie penaliseer vir -1,6 x 10^{-19} nie, maar wel vir negatiewe finale antwoord.

POSITIVE MARKING FROM QUESTION 7.3.
POSITIEWE NASIEN VANAF VRAAG 7.3.

OPTION 2/*OPSIE 2*

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = F_A - F_B$ ✓

$F_{net} = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)\left(1,6 \times 10^{-19}\right)}{(0,87)^2} - \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)\left(1,6 \times 10^{-19}\right)}{(1,74)^2}$

$\quad = 4,28 \times 10^{-18}$ N ✓

OR/*OF*

$F = \dfrac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = F_B - F_A$ ✓

$F_{net} = \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)\left(1,6 \times 10^{-19}\right)}{(1,74)^2} - \dfrac{\left(9 \times 10^9\right)\left(3 \times 10^{-9}\right)\left(1,6 \times 10^{-19}\right)}{(0,87)^2}$

$\quad = -4,28 \times 10^{-18}$ N
$\quad = 4,28 \times 10^{-18}$ N ✓

(3)

[13]

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 underlined potential difference (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓
Die potensiaalverskil (spanning) oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.
OR/*OF*
The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if temperature is constant. ✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil (spanning) oor die geleier indien die temperatuur konstant is.
OR/*OF*
The ratio of potential difference to current is constant provided the temperature remains the same. ✓✓
Die verhouding van potensiaalverskil tot stroom is konstant indien die temperatuur konstant bly.   (2)

8.2.1

| **Marking criteria/*Nasienkriteria*** |
| • Any correct formula to calculate the effective resistance of any of the two parallel combinations./*Enige korrekte formule om die effektiewe weerstand van enige een van die parallel kombinasies te bereken.*✓ |
| • Correct substitution in formula to calculate effective resistance of both parallel combinations./*Korrekte vervanging in formule om effektiewe weerstand van beide parallel gedeeltes te bereken.* ✓✓ |
| • Adding the 10 Ω to the first parallel combination and using this to calculate the external resistance (R$_{ext}$)/*Bymekaartel van 10 Ω en die gebruik daarvan om die eksterne weerstand te bereken* ✓ |
| • Correct final answer/*Korrekte finale antwoord*: 7,5 Ω ✓ |

OPTION 1/*OPSIE 1*

$R_{12L} = R_L + \left(\dfrac{R_1 R_2}{R_1 + R_2} \right)$

$= \underline{10} + \dfrac{10 \times 10}{10 + 10}$ ✓ ✓

$= 15 \ \Omega$

✓ Any one/enige een

$R_p = \left(\dfrac{R_3 R_{12L}}{R_3 + R_{12L}} \right)$

$R_p = \dfrac{15 \times 15}{15 + 15}$ ✓

$R_p = 7,5 \ \Omega$ ✓

OPTION 2/*OPSIE 2*

$\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ **OR/*OF*** $R_{12} = \left(\dfrac{R_1 R_2}{R_1 + R_2} \right)$

$\dfrac{1}{R_{12}} = \dfrac{1}{10} + \dfrac{1}{10}$ ✓   **OR/*OF*** $\dfrac{10 \times 10}{10 + 10}$ ✓

$R_{12} = 5 \ \Omega$

$R_{12L} = R_L + R_{12}$

$= \underline{10} + 5$ ✓

$= 15 \ \Omega$

✓ Any one/enige een

$\dfrac{1}{R_p} = \dfrac{1}{R_{12L}} + \dfrac{1}{R_3}$

$\dfrac{1}{R_p} = \dfrac{1}{15} + \dfrac{1}{15}$ ✓

$R_p = 7,5 \ \Omega$ ✓   (5)

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

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$\varepsilon = I(R + r)$ ✓ $\underline{12} = I(7,5 + 0,5)$ ✓ $I = 1,5$ A ✓	$R = \dfrac{V}{I}$ / $R_T = \dfrac{\varepsilon}{I}$ ✓ $\left(7,5 + 0,5\right) = \dfrac{12}{I}$ ✓ $I = 1,5$ A ✓

(3)

8.2.3 **POSITIVE MARKING FROM QUESTIONS 8.2.1 AND 8.2.2**
POSITIEWE NASIEN VANAF VRAE 8.2.1 EN 8.2.2

Marking criteria/*Nasienkriteria*
- Substitution of the correct current or potential difference for R_3./
  Vervanging van die korrekte stroom of potensiaalverskil vir R_3.✓
- Correct formula for power, leading to the answer./*Korrekte formule vir drywing wat lei tot die antwoord.* ✓
- Correct substitution to calculate power./*Korrekte vervanging om drywing te bereken.*✓
- Correct final answer/*Korrekte finale antwoord*: 8,44 W.✓

$1,5 = 2I_{R3}$ $I = 0,75$ A	$R_{ext} = \dfrac{V_{ext}}{I}$ $V = (7,5)(1,5)$ $V = 11,25$ V $R_3 = \dfrac{V_{ext}}{I}$ $15 = \dfrac{11,25}{I}$ $I = 0,75$ A	$I_{R_3} = \dfrac{R_{II}}{R_3} \times I_{total}$ $= \dfrac{7,5}{15} \times 1,5$ $= 0,75$ A	$I_{R_3} = \left(\dfrac{R_S}{R_S + R_3}\right)$ $I = \left(\dfrac{15}{15 + 15}\right)(1,5)$ $= 0,75$ A

OPTION 1/ *OPSIE 1*	OPTION 2/ *OPSIE 2*	OPTION 3/ *OPSIE 3*	OPTION 4/ *OPSIE 4*
$P = I^2R$✓ $= (0,75)^2 15$✓✓ $= 8,44$ W✓	$V = IR$ $= (0,75)(15)$✓ $= 11,25$ V $P = \dfrac{V^2}{R}$✓ $= \dfrac{(11,25)^2}{15}$✓ $= 8,44$ W✓	$V = IR$ $= (0,75)(15)$✓ $= 11,25$ V $P = VI$✓ $= (11,25)(0,75)$ ✓ $= 8,44$ W✓	$\varepsilon = V_{ext} + Ir$ $12 = V_{ext} + (1,5)(0,5)$✓ $V_{ext} = 11,25$ V $P = \dfrac{V^2}{R}$✓ $= \dfrac{(11,25)^2}{15}$✓ $= 8,44$ W✓

(4)

8.3.1   INCREASES/*NEEM TOE* ✓   (1)

8.3.2
- Total resistance of the circuit increases and total current in circuit decreases.✓
- $V_{internal}$/internal volts/V_{lost} decreases and $V_{external}$/external volts /V_{RL} increases. ✓
- Power output increases ✓ therefore brightness increases.
- *Totale weerstand van die stroombaan neem toe en die totale stroom neem af.*
- *V_{intern}/interne volts/$V_{verlore}$ neem af en $V_{ekstern}$/eksterne volts /V_{RL} neem toe*
- *Drywing neem toe daarom sal die herlderheid toeneem.*
  OR/*OF*
- $\varepsilon = I(R + r)$
  $12 = I(15 + 0,5)$
  $I = 0,77$ A ✓
- I_L has increased/*I_L het toegeneem* ✓
- Power output increases ✓ therefore brightness increases.
  Drywing neem toe daarom sal die herlderheid toeneem.   (3)
                                                                                     [18]

QUESTION 9/*VRAAG 9*

9.1.1   Split ring/Commutator/*Splitring*/*Kommutator* ✓   (1)

9.1.2   Electrical to mechanical/kinetic ✓
          Elektries na meganies/*kineties* ✓   (1)

9.1.3   Clockwise/*Kloksgewys* ✓✓   (2)

9.1.4   Any **two** of the following./Enige **twee** van die volgende:

- Increase the strength of the magnetic field e.g. use stronger magnets/bring magnets closer/use curved magnets./
Toename in die sterkte van die magneetveld bv. gebruik sterker magnete/bring magnete nader aan mekaar/gebruik geboë magnete.
- Increase the current./use battery with higher potential difference./more cells in series./Increase EMF./
Verhoog die stroom./gebruik battery met hoër potensiaalverskil./meer selle in serie./verhoog EMK.
- Increase the area of the coil./*Vergroot die oppervlakte van die spoel.*
- Increase the number of turns in the coil./*Vermeerder die aantal windings in die spoel.*

                                                           (2)

9.2.1
> **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.*

Root-mean-square current is the <u>alternating current</u> (AC) that dissipates the <u>same amount of energy/heating effect</u> as an <u>equivalent direct current</u> (DC) <u>current</u>. ✓✓
Die wortelgemiddeldekwadraat-stroom is die <u>wisselstroom</u> (WS) wat <u>dieselfde hoeveelheid energie/verhittingseffek</u> as 'n <u>ekwivalente gelykstroom</u> (GS) het.   (2)

> Note: If energy or heating effect is omitted: $^0/_2$
> *Nota: Indien energie of verhittingseffek uitgelaat is:* $^0/_2$

9.2.2
$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \quad ✓$$
$$= \frac{3,6}{\sqrt{2}} \quad ✓$$
$$= 2,55 \text{ A} \quad ✓$$

                                                                (3)

9.2.3

Marking criteria/*Nasienkriteria*
- Formula for W./*Formule vir W.* ✓
- Correct substitution for W./*Korrekte* v*ervanging vir W.* ✓
- Correct final answer./*Korrekte finale antwoord*: 69 168 J ✓ (6,92 x 10³)
  (Range/*Gebied:* 69 167,56 J – 69 168,44 J*)*

OPTION 1/*OPSIE 1*

$W = VI\Delta t$ ✓
$= \underline{(220)(2,62)(120)}$ ✓
$= 69\ 168\ J$ ✓ (6,92 x 10³ J)

OPTION 2/*OPSIE 2*

$V = IR$
$220 = 2,62R$
$R = 83,97\ \Omega$

$W = I^2R\Delta t$ ✓
$= \underline{(2,62)^2(83,97)(120)}$ ✓
$= 69\ 168,44\ J$ ✓ (6,92 x 10³ J)

$W = \dfrac{V^2}{R}\Delta t$ ✓

$= \underline{\left(\dfrac{220^2}{83,97}\right)(120)}$ ✓

$= 69\ 167,56\ J$ ✓ (6,92 x 10³ J)

OPTION 3/*OPSIE 3*

$P_{ave} = V_{rms}I_{rms}$
$\quad = (220)(2,62)$
$\quad = 576,4\ W$

$P_{ave} = I^2_{rms}R$
$\quad = (2,62)^2(83,97)$
$\quad = 576,4\ W$

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

$\quad = \dfrac{(220)^2}{83,97}$
$\quad = 576,4\ W$

$W = P\Delta t$ ✓
$= \underline{(576,4)(120)}$ ✓
$= 69\ 168\ J$ ✓ (6,92 x 10³ J)

OPTION 4/*OPSIE 4*

$q = I\Delta t$
$q = (2,62)(120)$
$q = 314,4\ C$

$W = Vq$ ✓
$W = 220 \times 314,4$ ✓
$W = 69168\ J$ ✓ (6,92 x 10³ J)

(3)

[14]

QUESTION 10/*VRAAG 10*

10.1.1

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

NOTE: If reference to frequency: $^0/_2$
NOTA: Indien na frekwensie verwys word: $^0/_2$

(2)

10.1.2

OPTION 1/*OPSIE 1*
$E = hf$ ✓
$E = \underline{(6,63 \times 10^{-34})(2,8 \times 10^{16})}$ ✓
$E = 1,86 \times 10^{-17}$ (J) ✓
Since/*Aangesien* $E > W_0$ (or $E - W_0 > 0$)✓, electrons will be ejected/*elektrone sal vrygestel word*

OPTION 2/*OPSIE 2*
$W_0 = hf_0$✓
$\underline{6,63 \times 10^{-19}} = (6,63 \times 10^{-34})f_0$ ✓
$f_0 = 1 \times 10^{15}$ (Hz) ✓
Since/*Aangesien* $f > f_0$ (or $f - f_0 > 0$)✓, electrons will be ejected/*elektrone sal vrygestel word*

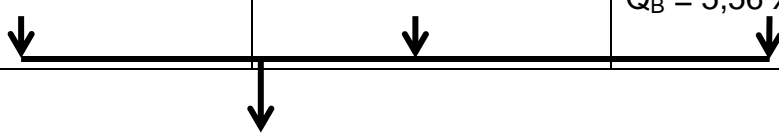| **OPTION 3/*OPSIE 3*** |
|---|
| $W_0 = \dfrac{hc}{\lambda_0}$ |
| ✓ both/*beide*　　$6,63 \times 10^{-19} = \dfrac{(6,63 \times 10^{-34})(3 \times 10^8)}{\lambda_0}$　　✓ any one/*enige een* |
| $\lambda_0 = 3 \times 10^{-7}$ (m) |
| $v = f\lambda$ |
| $\underline{3 \times 10^8} = 2,8 \times 10^{16}\lambda$　　✓ both/*beide* |
| $\lambda = 1,07 \times 10^{-8}$ (m) |
| Since/*Aangesien* $\lambda_0 > \lambda$ (or $\lambda_0 - \lambda > 0$) ✓, electrons will be ejected/*elektrone sal vrygestel word.* |

OPTION 4/*OPSIE 4*
$\left.\begin{array}{l} E = W_0 + E_{k(max)} \\ hf = W_0 + E_{k(max)} \end{array}\right\}$ ✓ Any one/*Enige een*
$\underline{(6,63 \times 10^{-34})(2,8 \times 10^{16})} = 6,63 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 1,79 \times 10^{-17}$ (J) ✓
Since/*Aangesien* $E_{k(max)} > 0$, ✓ electrons will be ejected/*elektrone sal vrygestel word*

(4)

10.1.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$F = \dfrac{kQ_1Q_2}{r^2}$ ✓ ✓ $0,027 = \dfrac{(9 \times 10^9)(5,4 \times 10^{-6})Q_2}{(0,1)^2}$ ✓ $Q_2 = 5,56 \times 10^{-9}$ C	$E = \dfrac{kQ}{r^2}$ ✓ $E = \dfrac{9 \times 10^9(5,4 \times 10^{-6})}{0,1^2}$ $E = 4\,860\,000$ N·C^{-1} $(4,86 \times 10^6)$ $E = \dfrac{F}{q}$ ✓ $4860000 = \dfrac{0,027}{q}$ ✓ $q = 5,56 \times 10^{-9}$ C	$E = \dfrac{F}{q}$ $= \dfrac{0,027}{5,4 \times 10^{-6}}$ ✓ $= 5\,000$ N·C^{-1} (5×10^3) $E = \dfrac{kQ}{r^2}$ ✓ $5000 = \dfrac{(9 \times 10^9)Q_B}{0,1^2}$ ✓ $Q_B = 5,56 \times 10^{-9}$ C

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

$n = \dfrac{5,56 \times 10^{-9}}{1,6 \times 10^{-19}}$ ✓

$n = 3,47 \times 10^{10}$ (electrons/*elektrone*) ✓

number of photons/*aantal fotone* = n = $3,47 \times 10^{10}$ ✓ $(3,475 \times 10^{10})$ (6)

10.2.1   (Line) Absorption/*(Lyn) Absorbsie*✓   (1)

10.2.2   Continuous spectrum of white light/rainbow of colours✓ with dark/black lines✓
(replacing specific frequencies)./*Kontinue spektrum van wit lig/reënboog van
kleure met donker/swart lyne (wat spesifieke frekwensies vervang).*   (2)

10.2.3   Diagram B ✓✓   (2)

[17]

TOTAL/*TOTAAL*:   150