basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

NOVEMBER 2023

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 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 sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

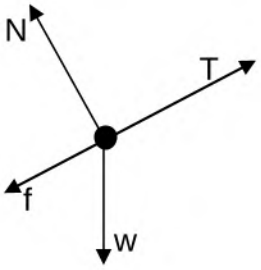
When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp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

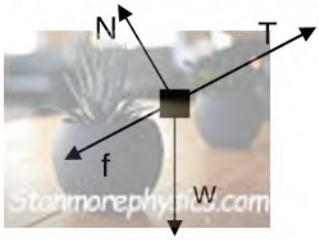
OR/*OF*

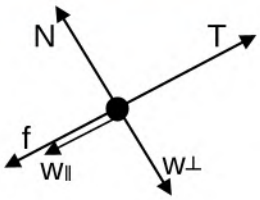
The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. (2 or 0)
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum in die rigting van die resulterende/netto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

2.2

ACCEPT/*AANVAAR*







	Accepted labels/*Aanvaarde benoemings*
N	F_N/Normal/F_{normal}/*$F_{normaal}$*/*Normaal*
f	(kinetic) friction/F_f/f_k/*(kinetiese) wrywing*/5,88 N/*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}/*F_{tou}*/tension/*spanning*

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*.
- If w is not shown but $w_{\parallel}$ and $w_{\perp}$ are shown, give 1 mark for both./
  Indien w nie getoon is nie maar $w_{\parallel}$ en $w_{\perp}$ *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:***

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

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

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

OPTION 1: For block B/*Vir blok B:*

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

OPTION 2: For blocks A and B combined/*Vir blokke A en B te same*

$F_{net} = ma$
$F - f_k - w_{\parallel} = ma$
$F - f_k + mg\sin\theta = ma$
$F - 19,11 - 13(9,8)\sin35°$ ✓$= (13)(2)$ ✓
$F = 118,18$ N ✓ (3)

2.4.1 INCREASE/*TOENEEM* ✓ (1)

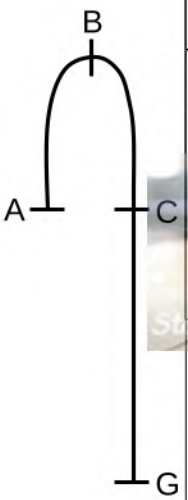
2.4.2 As θ decreases, normal force will increase./*Soos θ afneem sal normaalkrag toeneem*. ✓ **OR/*OF*** $N = mg\cos\theta$
Frictional force is directly proportional to normal force/*wrywing is direk eweredig aan normaalkrag* ✓ **OR/OF** $f \alpha N$ / $f = \mu_k N$ (2)
[16]

QUESTION 3/*VRAAG 3*

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

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*. ✓ • Final answer/*Finale antwoord*: 10,74 m·s^{-1} ✓ • If energy principles are used./Indien energiebeginsels gebruik word: max/maks $^1/_3$ for correct answer/ vir korrekte 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 equations leading to the velocity at which the ball strikes the ground./*Enige een van die korrekte vergelykings wat lei tot die snelheid waarmee die bal die grond tref..* ✓
- Correct substitution leading to the velocity at which the ball strikes the ground./*Korrekte vervanging wat lei tot die snelheid waarmee die bal die grond tref.* ✓
- Correct equation for ΔE_k./*Korrekte vergelyking vir* ΔE_k. ✓
- Correct substitution into ΔE_k *equation./Korrekte vervanging in* ΔE_k *vergelyking.* ✓
- Correct answer / *Korrekte antwoord* 68,31 J ✓
  Range / *Gebied* (67,91 – 69,34)

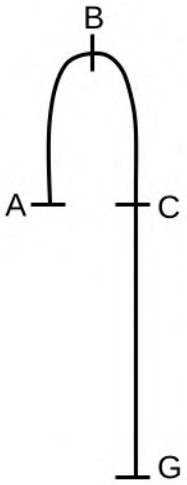
OPTION 1/*OPSIE 1*
A-G:
UPWARDS AS POSITIVE/
***OPWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(10,74)^2 + 2(-9,8)(-15,3)}$ ✓
$v_f = 20,38\ m\cdot s^{-1}$

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

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

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

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15,3 = \left(\frac{10,74 + v_f}{2}\right)3,18$ ✓
$v_f = -20,38\ m\cdot s^{-1}$



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

OPTION 5/*OPSIE 5*
B-G:

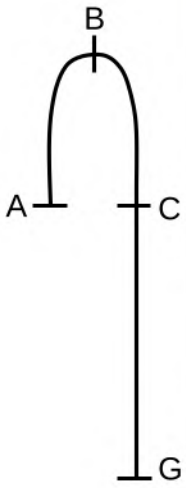
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$-21,19 = (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$
$t = 2,08$ s

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

OPTION 6/*OPSIE 6*
C-G:

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

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



OPTION 7/*OPSIE 7*
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

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

OPTION 8/*OPSIE 8*
B-G:

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

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

OPTION 9/*OPSIE 9*
C-G:

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

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

DURING COLLISION/*TYDENS BOTSING*

$\Delta E_k = E_{kf} - E_{ki}$
$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$
✓Any one/ *Enige een*

$\Delta E_k = \frac{1}{2}(0,5)(11,92^2 - (-20,38)^2)$ ✓
$\Delta E_k = -68,31$ J ✓

OPTION 10/*OPSIE 10*

A-G:

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

$(9,8)(0,5)(15,3)\cos0° = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓

$v_f = 20,38\ m\cdot s^{-1}$

OPTION 11/*OPSIE 11*

B-G:

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

$(9,8)(0,5)(21,19)\cos0° = \frac{1}{2}(0,5)v_f^2 - 0$ ✓

$v_f = 20,38\ m\cdot s^{-1}$

OPTION 12/*OPSIE 12*

C-G:

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

$(9,8)(0,5)(15,3)\cos0° = \frac{1}{2}(0,5)v_f^2 - \frac{1}{2}(0,5)(10,74)^2$ ✓

$v_f = 20,38\ m\cdot s^{-1}$

OPTION 13/*OPSIE 13*

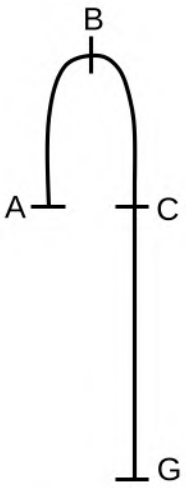
A-G OR/*OF* C-G:

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = [\frac{1}{2}m(v_f^2 - v_f^2)] + [mg(h_f - h_i)]$ ✓Any one/ *Enige een*
$0 = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$
$0 = [\frac{1}{2}(0,5)v_f^2 - (10,74)^2] + [0 - (0,5)(9,8)(15,3)]$ ✓
$v_f = 20,38\ m\cdot s^{-1}$

OPTION 14/*OPSIE 14*

B-G:

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



DURING COLLISION/*TYDENS BOTSING*

$\Delta E_k = E_{kf} - E_{ki}$
$\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$\Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓Any one/ *Enige een*

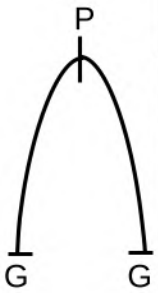
$\Delta E_k = \frac{1}{2}(0,5)(11,92^2 - (20,38)^2)$ ✓

$\Delta E_k = -68,31\ J$ ✓

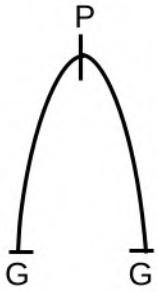
(5)

3.3.2 **POSITIVE MARKING FROM QUESTION 3.3.1**
POSITIEWE NASIEN VANAF VRAAG 3.3.1

Marking criteria/*Nasienkriteria*
- Correct equation to calculate Δt./*Korrekte vergelyking 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:	**G-P:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = \underline{11,92 + (-9,8)\ \Delta t}$ ✓	$0 = \underline{(-11,92) + (9,8)\Delta t}$ ✓
$\Delta t = 1,22$ s ✓	$\Delta t = 1,22$ s ✓
OPTION 2/*OPSIE 2*	
P-G:	**P-G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-11,92 = 0 + (-9,8)\ \Delta t}$ ✓	$\underline{11,92 = 0 + (9,8)\Delta t}$ ✓
$\Delta t = 1,22$ s ✓	$\Delta t = 1,22$ s ✓
OPTION 3/*OPSIE 3*	
G - G:	**G - G:**
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-11,92 = 11,92 + (-9,8)\ \Delta t}$ ✓	$\underline{11,92 = -11,92 + (9,8)\ \Delta t}$ ✓
$\Delta t = 2,43$ s	$\Delta t = 2,43$ s
Time to reach $h_{max} = \frac{2,43}{2}$	Time to reach $h_{max} = \frac{2,43}{2}$
$= 1,22$ s ✓	$= 1,22$ 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	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $7,25 = (11,92)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 1,22$ s ✓ **OR/*OF*** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $7,25 = \left(\frac{11,92 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ 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*** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-7,25 = \left(\frac{-11,92 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ 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*** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-7,25 = \left(\frac{0 - 11,92}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ 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*** $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $7,25 = \left(\frac{0 + 11,92}{2}\right)\Delta t$ ✓ $\Delta t = 1,22$ s ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta E_k$

$w\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$

$(0,5)(9,8)\Delta y\cos 180^\circ = ½(0,5)(0 - (11,92)^2)$

$\Delta y = 7,25$ m

OR/*OF*

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

$W_{nc} = [\ ½\ m(v_f^2 - v_f^2\ )\ ] + [\ mg(h_f - h_i)\ ]$

$0 = [\ ½mv_f^2 - ½mv_i^2\ ] + [\ mgh_f - mgh_i\ ]$

$0 = ½(0,5)[(0 - (11,92)^2] + (0,5)(9,8)\Delta h$

$\Delta h = 7,25$ m

OR/*OF*

$\sum E_{Mi} = \sum E_{Mf}$

$½mv_i^2 + mgh_i = ½mv_f^2 + mgh_f$

$½\ (0,5)(11,92)^2 + 0 = 0 + (0,5)(9,8)(h_f)$

$\Delta h = 7,25$ m

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓

$7,25 = (11,92)\Delta t + ½(-9,8)\Delta t^2$ ✓

$\Delta t = 1,22$ s ✓

OR/*OF*

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

$7,25 = \left(\frac{11,92 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 1,22$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓

$-7,25 = (-11,92)\Delta t + ½(9,8)\Delta t^2$ ✓

$\Delta t = 1,22$ s ✓

OR/*OF*

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

$-7,25 = \left(\frac{-11,92 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 1,22$ 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 ($m\cdot s^{-1}$) ✓ (1)

3.4.2 10,74 ($m\cdot s^{-1}$) ✓ (1)

3.4.3 1,22 (s) ✓ (1)

[16]

QUESTION 4/*VRAAG 4*

4.1 591 N to the right/*na regs* ✓ (1)

4.2

RIGHT AS POSITIVE/ *REGS AS POSITIEF:*	**LEFT AS POSITIVE/ LINKS *AS POSITIEF:***
OPTION 1/*OPSIE 1*	
$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ $ma\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $-591(0,02)$✓ = $(0,03)(0 - v_i)$ ✓ $v_i = 394\ m{\cdot}s^{-1}$ ✓	$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ $ma\Delta t = m(v_f - v_i)$ ✓Any one/ *Enige een* $591(0,02)$✓ = $(0,03)(0 - v_i)$ ✓ $v_i = -394\ m{\cdot}s^{-1}$ $v_i = 394\ m{\cdot}s^{-1}$ ✓
OPTION 2/*OPSIE 2*	
$F_{net} = ma$ $-591 = (0,03)a$ ✓ $a = -19\ 700\ m{\cdot}s^{-1}$ $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (-19\ 700)(0,02)$ ✓ $v_i = 394\ m{\cdot}s^{-1}$ ✓	$F_{net} = ma$ $591 = (0,03)a$ ✓ $a = 19\ 700\ m{\cdot}s^{-1}$ $v_f = v_i + a\Delta t$ ✓ $0 = v_i + (19\ 700)(0,02)$ ✓ $v_i = -394\ m{\cdot}s^{-1}$ $v_i = 394\ m{\cdot}s^{-1}$ ✓

(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.*

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

(2)

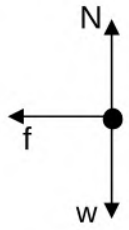
4.4

POSITIVE MARKING FROM QUESTION 4.2. *POSITIEWE NASIEN VANAF VRAAG 4.2.*
RIGHT AS POSITIVE/*REGS AS POSITIEF*
$\sum p_i = \sum p_f$ $m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ ✓Any one/*Enige een* $(0,03)(394) + (2,7)(-3)$ ✓ = $v_f(0,03 + 2,7)$✓ $\therefore v_f = 1,36\ m{\cdot}s^{-1}$ ✓
LEFT AS POSITIVE/*LINKS AS POSITIEF*
$\sum p_i = \sum p_f$ $m_xv_{ix} + m_yv_{iy} = m_xv_{fx} + m_yv_{fy}$ ✓Any one/*Enige een* $(0,03)(-394) + (2,7)(3)$ ✓ = $v_f(0,03 + 2,7)$✓ $\therefore v_f = -1,36\ m{\cdot}s^{-1}$ $\therefore v_f = 1,36\ m{\cdot}s^{-1}$ ✓

(4)
[11]

QUESTION 5/*VRAAG 5*

5.1



Accepted labels/*Aanvaarde benoemings*	
w	F_w /F_g /mg /gravitational force/*gravitasiekrag*/weight/*gewig*
f	F_f /f_k/(kinetic) Friction/*(kinetiese) wrywing*/F_w
N	F_N /Normal/*Normaal*

Notes/*Aantekeninge:*

- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows./*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/*Oorspronklike kinetiese energie* ✓ (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 net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓
Die netto/totale arbeid wat (op 'n voorwerp) verrig is, is gelyk aan die verandering in die voorwerp se kinetiese energie.
OR/*OF*
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. ✓✓
Die arbeid verrig op in voorwerp deur die resultante/netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie.

(2)

5.4

Marking criteria/*Nasienkriteria*

- OPTION 1/*OPSIE 1*: Relating frictional force to gradient/*Verband tussen wrywingskrag en helling* ✓
  OPTION 2 and 3/*OPSIE 2 en 3*: Correct formulae for work / *Korrekte verfgelyking vir arbeid* ✓
- Correct subtitution of two values or ratio from the graph/*korrekte invervanging 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 invervanging van μ en 9,8* ✓
- Final answer/*finale antwoord* ✓

OPTION 1/*OPSIE 1*

$m = \frac{\Delta y}{\Delta x}$

$f = \frac{E_{ki}}{\Delta x}$

$\frac{1}{f} = \frac{\Delta x}{E_{ki}}$

$\boxed{\frac{1}{f} = \text{gradient}}$ ✓

$\frac{1,5}{6} = \frac{3}{12} = \frac{4,5}{18} = \frac{1}{4}$ ✓

$f = 4\ N$

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta K + \Delta U$
$W_{net} = \Delta E_k$
$W_{net} = E_{kf} - E_{ki}$
$W_f = \Delta E_k$
$W_f = E_{kf} - E_{ki}$
$f\Delta x \cos 180° = E_{kf} - E_{ki}$

✓Any one/ *Enige een*

$-f(1,5)$ ✓ $= 0 - 6$ ✓

OR/*OF*

$-f(3) = 0 - 12$

OR/*OF*

$-f(4,5) = 0 - 18$

$f = 4\ N$

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***

$-18 = f(4,5)\cos 180°$

$f = 4\ N$

$f_k = \mu_k F_N$ ✓

$\underline{4 = (0,18)(m)(9,8)}$ ✓

$m = 2,27\ kg$ ✓

(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 (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/*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

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

$512{,}64 ✓ = \left(\frac{v}{v + 25}\right)^{✓} (550)$ ✓

$v = 343{,}04 \text{ m·s}^{-1}$ ✓

(5)

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

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

c) Increases/*Toeneem* ✓ (1)

6.2.1 AWAY FROM/*WEG VAN* ✓ (1)

6.2.2

- A lower frequency/longer wavelength ✓ is detected.
- This lower frequency/longer wavelength corresponds to the red end of the spectrum. ✓

- *'n Laer frekwensie/langer golflengte word waargeneem*
- *Hierdie laer frekwensie/langer golflengte stem ooreen met die rooi ent van die spektrum*

(2)
[13]

QUESTION 7/*VRAAG 7*

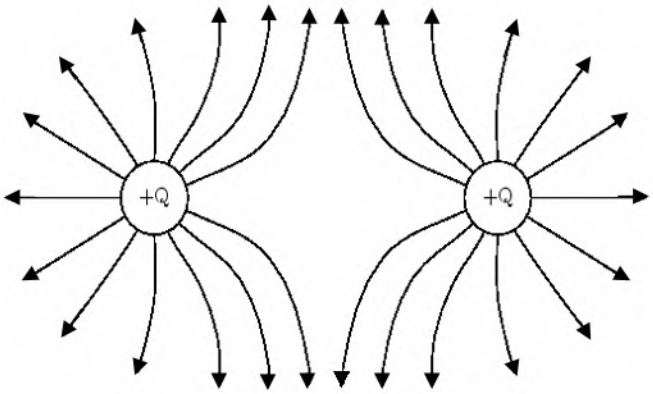
7.1.

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 region in space in which an electric charge experiences a force.✓✓
'n Gebied in die ruimte waarin 'n elektriese lading 'n krag ondervind. (2)

NOTE: If electric field at a point is defined 0/2 **NOTA: Indien elektiese veld by 'n punt gedefinieer is 0/2**

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/ *Korrekte vorm van elektrieseveld*	✓
No field lines crossing each other. Field lines must touch the sphere, but not go inside the sphere/ *Geen veldlyne wat mekaar kruis nie. Veldlyne moet die sfeer raak, maar nie die sfeer binnegaan nie.*	✓

(3)

7.3

Marking criteria/*Nasienkriteria*

- Formula/*Vergelyking* $E = \frac{kQ}{r^2}$. ✓
- Correct substitution for each A ✓and B ✓/*Korrekte vervanging vir elkeen A en B*.
- Subtraction/*Aftrek van* ($E_A - E_B$) ✓
- Final answer/*Finale antwoord*: 0,87 (m) ✓

NOTE: If $E_B - E_A$ is used in the subtraction, mark for final answer must be forfeited.

OPTION 1/*OPSIE 1*

$E = \frac{kQ}{r^2}$ ✓

$E_A = \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2}$ ✓

$E_B = \frac{(9 \times 10^9)(3 \times 10^{-9})}{(2r)^2}$ ✓

$27 = \frac{(9 \times 10^9)(3 \times 10^{-9})}{r^2} \checkmark \frac{(9 \times 10^9)(3 \times 10^{-9})}{4r^2}$

$r = 0,87$ (m) ✓

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*

- Equation for Coulomb's law./Vergelyking vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's equation for F_A. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_A.
- Correct substitution into Coulomb's equation for F_B. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_B.
- Subtraction/*Aftrek van* ($F_A - F_B$) ✓
- Final answer/*Finale antwoord*: 0,87 m ✓

NOTE: If $F_B - F_A$ is used in the subtraction, mark for final answer must be forfeited.

$F = \frac{kQ_1Q_2}{r^2}$ ✓

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

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

$F_{net} = F_A - F_B$

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

$r = 0,87$ m ✓

(5)

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7.4

OPTION 1/*OPSIE 1*

$F = Eq$ ✓

$= \underline{(27)(1,6 \times 10^{-19})}$ ✓

$= 4,32 \times 10^{-18}$ N ✓

OPTION 2/*OPSIE 2*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = F_A - F_B$

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

$= 4,28 \times 10^{-18}$ 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 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. (2)

8.2.1

Marking criteria/*Nasienkriteria*

- Any correct equation 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 equation to calculate effective resistance of both parallel combinations /*Korrekte invervanging in vergelyking 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 10Ω en die gebruik daarvan om die eksterne weerstand te bereken* ✓
- Final answer/*Finale antwoord*: 7,5 Ω ✓

OPTION 1/*OPSIE 1*

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

$$= \underline{10 +} \overset{\checkmark}{} \frac{10 \times 10}{10 + 10} \checkmark$$

$$= 15\ \Omega$$

✓ Any one/ enige een

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

$$R_p = \frac{15 \times 15}{15 + 15} \checkmark$$

$$R_p = 7{,}5\ \Omega \checkmark$$

OPTION 2/*OPSIE 2*

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{OR/OF} \quad R_{12} = \left(\frac{R_1 R_2}{R_1 + R_2}\right) \checkmark$$

$$\frac{1}{R_{12}} = \frac{1}{10} + \frac{1}{10} \quad \text{OR/OF} \quad \frac{10 \text{ x } 10}{10 + 10} \checkmark$$

$$R_{12} = 5\ \Omega$$

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

$$= \underline{10 +} \ 5 \checkmark$$

$$= 15\ \Omega$$

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

$$\frac{1}{R_p} = \frac{1}{15} + \frac{1}{15} \checkmark$$

$$R_p = 7{,}5\ \Omega \checkmark$$

(5)

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

OPTION 1/*OPSIE 1*

$\varepsilon = I(R + r)$ ✓

$\underline{12 = I\,(7{,}5 + 0{,}5)}$ ✓

$I = 1{,}5\ A$✓

OPTION 2/*OPSIE 2*

$$R = \frac{V}{I} \checkmark$$

$$(7{,}5 + 0{,}5) = \frac{12}{I} \checkmark$$

$I = 1{,}5\ A$ ✓

(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 for R_3./*Invervanging van die korrekte stroom vir R_3.*✓
- Correct equation for power, leading to the answer./*Korrekte vergelyking vir drywing wat lei tot die antwoord*. ✓
- Correct substitution to calculate power./*Korrekte invervanging om drywing te bereken.*✓
- Correct final answer/*Korrekte finale antwoord*: 8,44 W.✓

$1,5 = 2I_{R3}$
$I = 0,75$ A

$R_{ext} = \frac{V_{ext}}{I}$
$V = (7,5)(1,5)$
$V = 11,25$ V

$R_3 = \frac{V_{ext}}{I}$
$15 = \frac{11,25}{I}$
$I = 0,75$ A

OPTION 1/*OPSIE 1*
$P = I^2R$✓
$= \underline{(0,75)^2}15$✓
$= 8,44$ W✓

OPTION 2/*OPSIE 2*
$V = IR$
$= (0,75)(15)$
$= 11,25$ V
$P = \frac{V^2}{R}$✓
$= \frac{(11,25)^2}{15}$ ✓
$= 8,44$ W✓

OPTION 3/*OPSIE 3*
$V = IR$
$= (0,75)(15)$
$= 11,25$ V
$P = VI$✓
$= \underline{(11,25)(0,75)}$ ✓
$= 8,44$ W✓

(4)

8.3.1 INCREASES/*NEEM TOE* ✓ (1)

8.3.2
- Total resistance of the circuit increases and current in circuit decreases.✓
- $V_{internal}$/internal volts/V_{lost} decreases. and $V_{external}$/external volts /V_{RL} increases. ✓
- V_L increases and Power output increases ✓ therefore brightness increases.

- *Totale weerstand van die stroombaan neem toe en die stroom neem af.*
- *V_{intern}/interne volts/$V_{verlore}$ neem af. and $V_{ekstern}$/externe volts /V_{RL} neem toe.* ✓
- *V_L neem toe en 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 or bring magnets closer /*Toename in die sterkte van die magneetveld bv. Gebruik sterker magnete of bring magnete nader aan mekaar* ✓
Increase the current /*Verhoog die stroom*. ✓
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.*
Use battery with higher potential difference / *Gebruik battery met hoër potensiaalverskil* (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 alternating current that dissipates the same amount of energy as an equivalent DC current. ✓✓
Die wortelgemiddeldekwadraat-stroom is die wisselstroom wat dieselfde hoeveelheid energie verbruik as 'n ekwivalente gelykstroom. (2)

9.2.2

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{3,6}{\sqrt{2}} \checkmark$$
$$= 2,55 \text{ A} \checkmark$$ (3)

9.2.3

Marking criteria/*Nasienkriteria*

- Formula for W./*Formule vir W.* ✓
- Correct substitution for W./*Korrekte vervanging vir W.* ✓
- Correct final answer./*Korrekte finale antwoord*:
- 69 168 J ($6,92 \times 10^3$) (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 ✓ ($6,92 \times 10^3$)

OPTION 2/*OPSIE 2*

$V = IR$

$220 = 2,62R$

$R = 83,97\ \Omega$

$W = I_{rms}^2 R\Delta t$✓

$= \underline{(2,62)^2(83,97)(120)}$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

$W = \frac{V_{rms}^2}{R}\Delta t$ ✓

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

= 69 168 J ✓ ($6,92 \times 10^3$)

OPTION 3/*OPSIE 3*

$P_{ave} = V_{rms}I$

$= (220)(2,62)$

$= 576,4$ W

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

$= (2,62)^2(83,97)$

$= 576,4$ W

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

$= \frac{(220)^2}{83,97}$

$= 576,4$ W

$W = P\Delta t$ ✓

$= (576,4)(120)$ ✓

= 69 168 J ✓ ($6,92 \times 10^3$)

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

NOTE: If reference to frequency 0/2
NOTA: Indien na frekwensie verwys word 0/2

10.1.2

OPTION 1/*OPSIE 1*

$E = hf$ ✓
$E = (6,63 \times 10^{-34})(2,8 \times 10^{16})$ ✓
$E = 1,86 \times 10^{-17}$ J ✓

Since/*aangesien* $E > W_0$ (or $E - W_0 > 0$)✓, electrons will be ejected/*elektrone sal vrygestel word*

OPTION 2/*OPSIE 2*

$W_0 = hf_0$ ✓
$6,63 \times 10^{-19} = (6,63 \times 10^{-34})f_0$ ✓
$f_0 = 1 \times 10^{15}$ Hz ✓

Since/*aangesien* $f > f_0$ (or $f - f_0 > 0$)✓, electrons will be ejected/ *elektrone sal vrygestel word*

OPTION 3/*OPSIE 3*

$W_0 = \frac{hc}{\lambda_0}$

✓ any one/ *enige een*

$6,63 \times 10^{-19} = \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{\lambda_0}$

$\lambda_0 = 3 \times 10^{-7}$ m

✓ any one/ *enige een*

$v = f\lambda$
$3 \times 10^{8} = 2,8 \times 10^{16}\lambda$
$\lambda = 1,07 \times 10^{-8}$ m

✓ both/*beide*

Since/aangesien $\lambda_0 > \lambda$ (or $\lambda_0 - \lambda > 0$)✓, electrons will be ejected/*elektrone sal vrygestel word.*

OPTION 4/*OPSIE 4*

$E = W_0 + E_{k(max)}$
$hf = W_0 + E_{k(max)}$
} ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(2,8 \times 10^{16}) = 6,63 \times 10^{-19} + E_{k(max)}$ ✓
$E_{k(max)} = 1,79 \times 10^{-17}$ J ✓

Since/*aangesien* $E_{k(max)} > 0$, ✓ electrons will be ejected/*elektrone sal vrygestel word* (4)

10.1.3

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$0,027$ ✓ $= \frac{(9 \times 10^9)(5,4 \times 10^{-6})Q_2}{(0,1)^2}$ ✓

$Q_2 = 5,56 \times 10^{-9}$ C

$n = \frac{Q}{e}$ ✓

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

$n = 3,47 \times 10^{10}$ (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

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