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Training and Consultancy

The path to enlightened education

SUBJECT: SUBJECT NAME

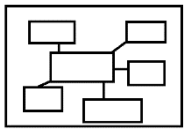
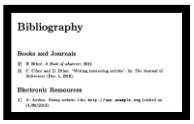
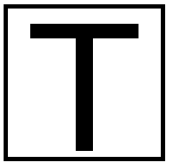
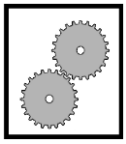
GRADE 12

LAST PUSH 2026

TEACHER SOLUTIONS MANUAL

PAPER 1: PHYSICS

ICON DESCRIPTION

 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS



CONTENTS **PAGE**

1. NEWTON'S LAWS OF MOTION.	2-9
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TOPIC 1: NEWTON'S LAWS OF MOTION

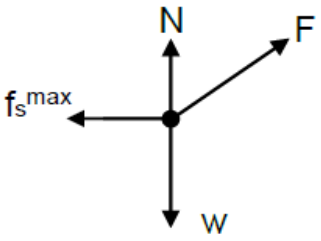
QUESTION 1

1.1 When the net/resultant force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

OR

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

1.2



Accepted labels/*Aanvaarde byskrifte*	
w	F_g /F_w /$F_{earth\ on\ P}$ /weight /mg /49 N /gravitational force *F_g /F_w /$F_{aarde\ op\ P}$ /gewig /mg /49 N /gravitasiekrag*
F	F_A /18 N / Applied force / *Toegepaste krag*
f_s^{max}	F_f / f_s /f /Friction (force) / (static) friction / *(statiese) wrywingskrag*
N	F_N /Normal (force) /F_{normal} /$F_{normaal}$ /*Normaal(krag)*

1.3 1.3.1

$F_x = F\cos\theta$ $15 = 18\cos\theta$ ✓ $\theta = 33{,}56^o$ ✓	**OR/*OF*** $9{,}95 = 15\tan\theta$ ✓ $\theta = 33{,}56^o$ ✓	**OR/*OF*** $9{,}95 = 18\sin\theta$ ✓ $\theta = 33{,}56^o$ ✓
NOTE/*NOTA:* If answer only/*Indien slegs antwoord* 1/2		

1.3.2

OPTION 1/*OPSIE 1*	
$f_s^{max} = \mu_s N$ $f_s^{max} = \mu_s(mg - F\sin\theta)$ ✓ Anyone/*Enigeen* 15✓ $= \mu_s$ [(5)(9,8) ✓ 18sin ✓ 33,56°] $\mu_s = 0{,}38$✓	
OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***
$F_{net} = 0$ $F_N + F_y - F_g = 0$ $F_N + F_y = F_g$ F_N = (5)(9,8) ✓ (18sin ✓ 33,56°) $F_N = 39{,}05$ N $f_s^{max} = \mu_s N$ ✓ 15✓ $= \mu_s(39{,}05)$ $\mu_s = 0{,}38$✓	$F_y = \sqrt{(18)^2 - (15)^2}$ ✓ $= 9{,}95$ N $F_{net} = 0$ $F_N + F_y - F_g = 0$ $F_N = F_g - F_y$ F_N = (5)(9,8) ✓ (9,95) $F_N = 39{,}05$ N $f_s^{max} = \mu_s N$ ✓ 15✓ $= \mu_s(39{,}05)$ $\mu_s = 0{,}38$✓

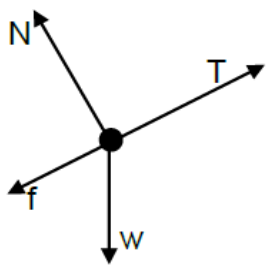
1.4 Increases. ✓

- Vertical component of F decreases;
- Normal force increases;
- μ_s remains constant, f_s^{max} is directly proportional to N.

QUESTION 2

2.1 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. ✓✓

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}*

2.3 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*
$T - f_k - mg\sin\theta = ma$

$T - 5,88 - 4(9,8)\sin35°$ ✓$= 4(2)$ ✓
$T = 36,36$ 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*
$-T + f_k + mg\sin\theta = ma$

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

2.3.2

For block B/*Vir blok B:*

UP THE INCLINE AS POSITIVE/
TEEN DIE SKUINSTE OP AS POSITIEF

$F_{net} = ma$
$F - T - f_k - w_{\parallel} = ma$
$F - T - f_k - mg\sin\theta = ma$

$F - 36,36 - 13,23 - 9(9,8)\sin35°$ ✓$= (9)(2)$ ✓
$F = 118,18$ N ✓

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

$F_{net} = ma$
$-F + T + f_k + w_{\parallel} = ma$
$-F + T + f_k + mg\sin\theta = ma$

$-F + 36,36 + 13,23 + 9(9,8)\sin35°$ ✓$= (9)(-2)$ ✓
$F = 118,18$ N ✓

2.4 2.4.1 INCREASES ✓

2.4.2
- Since μ_k and m are constant, as Θ decreases, normal force/$w_{\perp}$/ mgcos will increase. ✓

OR

N = mgcos
Frictional force is directly proportional to normal force. ✓

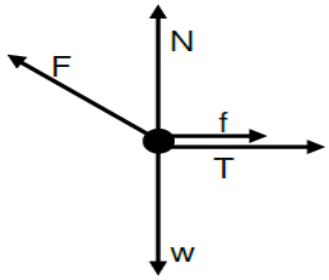
OR

$f \alpha N$ /$f \alpha w_{\perp}$ / $f \alpha N$ / $f = \mu_k N$

QUESTION 3

3.1 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. ✓✓

3.2



Accepted labels	
w	Fg/Fw/40,18 N/mg/weight/gravitational force
T	F_T/tension/Fstring
f	(kinetic) friction/F_f/f_k
N	F_N /Normal/F_{normal}
F	F_{app}/49 N

3.3 3.3.1 $f_k = \mu_k N$
$f_k = \mu_k(w - F_y)$
$f_k = \mu_k(mg\ F\sin\theta)$ ✓
$f_k = (0,35)[(4,1)(9,8)\ 49\sin 50°]$ ✓

$f_k = 0,93$ N ✓ (0,925 N)

3.3.2

For A/*Vir A*:
LEFT AS POSITIVE/
LINKS AS POSITIEF

$F_{net} = ma$
$F_x - T - f = ma$
$F\cos\theta - T - \mu_k F_N = ma$ ✓ Any one/ *Enige een*

$49\cos 50° - T - 0,93$ ✓ $= (4,1)a$
$T = 30,57 - 4,1a$ ... equation 1

For B/*Vir B*:
UPWARDS AS POSITIVE/
OPWAARTDS AS POSITIEF

$F_{net} = ma$
$T - F_g = ma$
$T - (2,3)(9,8)$ ✓ $= (2,3)a$ ✓ Any one/ *Enige een*
$T = 2,3a + 22,54$... equation 2

$30,57 - 4,1a = 2,3a + 22,54$
$a = 1,25\ m{\cdot}s^{-2}$ ✓

For A/*Vir A*:
RIGHT AS POSITIVE/
REGS AS POSITIEF

$$F_{net} = ma$$
$$-F_x + T + f = ma$$
$$-F\cos\theta + T + \mu_k F_N = ma$$

✓ Any one/ *Enige een*

$-49\cos 50^\circ + T + 0{,}93$ ✓ $= (4{,}1)a$

$T = 30{,}57 + 4{,}1a$ ... equation 1

For B/*Vir B*:
DOWNWARDS AS POSITIVE/
AFWAARTDS AS POSITIEF

$$F_{net} = ma$$
$$F_g - T = ma$$

$(2{,}3)(9{,}8) - T$ ✓ $= (2{,}3)a$

$T = 22{,}54 - 2{,}3a$... equation 2

✓ Any one/ *Enige een*

$30{,}57 + 4{,}1a = 22{,}54 - 2{,}3a$

$a = -1{,}25\ m\cdot s^{-2}$

$a = 1{,}25\ m\cdot s^{-2}$ ✓

3.4

$$F = G\frac{m_1 m_2}{r^2}$$ ✓

$$F = \frac{(6{,}67\times10^{-11})(6{,}5\times10^{20})(90)}{(550\times10^{3})^2}$$ ✓ ✓

$= 12{,}90$ N✓ (12,899 N)

OR/*OF*

$$g = \frac{Gm}{r^2}$$ ✓

$$g = \frac{(6{,}67\times10^{-11})(6{,}5\times10^{20})}{(550\times10^{3})^2}$$ ✓

$= 0{,}143...\ m\cdot s^{-2}$

$w = mg$

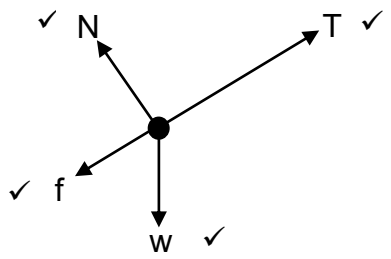
$= (90)(0{,}143..)$✓

$= 12{,}89$ N✓ (*downwards/afwaarts*)

QUESTION 4

4.1 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. ✓✓

4.2 For block m_1(8 kg)



4.3 For block m_1(8 kg)

$F_{net} = ma$ ✓ $\quad F_{net} = T - w_{par.} - f$

$F_{net} = 8a$ $\quad F_{net} = T - mg\sin\Theta - \mu_k mg\cos\Theta$

✓ $8a = T - (8)(9.8)\sin30^o - (0.2)(8)(9.8)\cos30^o$ ✓

$8a = T - 39.2 - 13.58$

$8a = T - 52.78$ ……..(1)

For block m_2(8 kg)

$F_{net} = ma$ $\quad F_{net} = w - T$

$F_{net} = 8a$ $\quad F_{net} = mg - T$

$8a = (8)(9.8) - T$ ✓

$8a = 78.4 - T$ ……(2)

Equation (1) $\quad 8a = T - 52.78$

\+

Equation (2) $\quad 8a = 78.4 - T$

$16a = 25.78$ ✓

$a = 1.60\ m.s^{-2}$ ✓

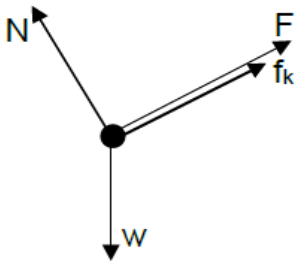
4.4 The force that m_2 exerts on the earth. ✓

4.5 Down the incline. ✓

QUESTION 5

5.1 A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it. ✓✓

5.2



	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}

5.3

OPTION 1/*OPSIE 1*

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$F_{net} = 0$
$F_{net} = ma$
$F_{g//} - F - f_k = ma$ ✓Any one/*Enige een*
$mg\sin\theta - F - f_k = ma$
$25(9,8)\sin30° - F - 40 = 25(0)$ ✓
$F = 82,5$ N ✓

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$F_{net} = 0$
$F_{net} = ma$
$-F_{g//} + F + f_k = ma$ ✓Any one/*Enige een*
$-mg\sin\theta + F + f_k = ma$
$-25(9,8)\sin30° + F + 40 = 25(0)$ ✓
$F = 82,5$ N✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$
$W_F + W_f + W_{Fg} = 0$ ✓Any one/*Enige een*
$F\Delta x\cos\theta + f\Delta x\cos\theta + mg\sin\Phi\Delta x\cos\theta = 0$
$F\cos180° + 40\cos180° + (25)(9,8)\sin30°\cos0° = 0$ ✓
$F = 82,5$ N ✓

5.4

$F_{net} = 0$
$F_{g//} = f$
$F_{g//} - f = F_{net} = 0$ ✓Any one/*Enige een*
OR/*OF* $f = \mu_k N$ ✓

NOTE: mark only awarded with correct substitution of $F_{g//}$
NOTA:*punt toegeken slegs indien korrekte vervanging van* $F_{g//}$

$mg\sin\theta$ ✓$= \mu_k mg\cos\theta$ ✓ **OR/*OF*** $\mu_k = \frac{mg\sin\theta}{mg\cos\theta}$ ✓✓

$\mu_k = \frac{\sin\theta}{\cos\theta}$

5.5

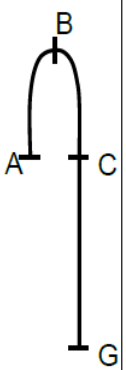
OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$\tan\theta = 0,19$ $\theta = 10,76°$ ✓ $f_k = \mu_k mg\cos\theta$ $= \underline{(0,19)(25)(9,8)\cos 10,76°}$ ✓ $= 45,73$ N ✓ (Range/*Gebied*: 45,73 – 45,74 N)	$\tan\theta = 0,19$ $\theta = 10,76°$ ✓ $f_k = F_{g\parallel} = mg\sin\theta$ $= \underline{(25)(9,8)\sin 10,76°}$ ✓ $= 45,73$ N ✓ (Range/*Gebied*: 45,73 – 45,74 N)

TOPIC 2: VERTICAL PROJECTILE MOTION

QUESTION 1

1.1 Motion under the influence of weight/gravitational force only. ✓✓

1.2



OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
A-B:	**B-C:**
UPWARDS AS POSITIVE/	**UPWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***OPWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{0 = 15 + (-9,8)\Delta t}$ ✓	$\underline{-15 = 0 + (-9,8)\Delta t}$ ✓
$\Delta t = 1,53$ (s) ✓	$\Delta t = 1,53$ (s) ✓
DOWNWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
AFWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{0 = -15 + (9,8)\Delta t}$ ✓	$\underline{15 = 0 + (9,8)\Delta t}$ ✓
$\Delta t = 1,53$ (s) ✓	$\Delta t = 1,53$ (s) ✓

OPTION 3/*OPSIE 3* A-C:	
UPWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-15 = 15 + (-9,8)\Delta t}$ ✓	$\underline{15 = -15 + (9,8)\Delta t}$ ✓
$\Delta t = 3,06$	$\Delta t = 3,06$
$p = 3,06 \div 2$	$p = 3,06 \div 2$
$p = 1,53$ (s) ✓	$p = 1,53$ (s) ✓

OPTION 1/*OPSIE 1* A-G:	OPTION 2/*OPSIE 2* A-G:
UPWARDS AS POSITIVE/	**UPWARDS AS POSITIVE/**
***OPWAARTS AS POSITIEF*:**	***OPWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f = v_i + a\Delta t$ ✓
$v_f^2 = \underline{(15)^2 + 2(-9,8)(-5)}$ ✓	$= \underline{(15) + (-9,8)(3,36)}$ ✓
$v_f = -17,97$	$= -17,93$
$v_f = 17,97$ (m·s^{-1}) ✓	$= 17,93$ (m·s^{-1}) ✓
DOWNWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
***AFWAARTS AS POSITIEF*:**	***AFWAARTS AS POSITIEF*:**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f = v_i + a\Delta t$ ✓
$v_f^2 = \underline{(-15)^2 + 2(9,8)(5)}$ ✓	$= \underline{(-15) + (9,8)(3,36)}$ ✓
$v_f = 17,97$ (m·s^{-1}) ✓	$= 17,93$ (m·s^{-1}) ✓

OPTION 3/*OPSIE 3* C-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-15)^2 + 2(-9,8)(-5)}$ ✓ $v_f = -17,97$ $v_f = 17,97\ (m\cdot s^{-1})$ ✓	**C-G:** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(15)^2 + 2(9,8)(5)}$ ✓ $v_f = 17,97\ (m\cdot s^{-1})$ ✓
OPTION 4/*OPSIE 4* B-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (-15)^2 + 2(-9,8)\Delta y$ $\Delta y = -11,48$ m From B to C $= -11,48 + (-5)$ $= -16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(0)^2 + 2(-9,8)(-16,48)}$ ✓ $v_f = -17,97$ $v_f = 17,97\ (m\cdot s^{-1})$ ✓	**B-G** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (15)^2 + 2(9,8)\Delta y$ $\Delta y = 11,48$ m From B to C $= 11,48 + 5$ $= 16,48$ m $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(0)^2 + 2(9,8)(16,48)}$ ✓ $v_f = 17,97\ (m\cdot s^{-1})$ ✓

1.4 Inelastic. ✓

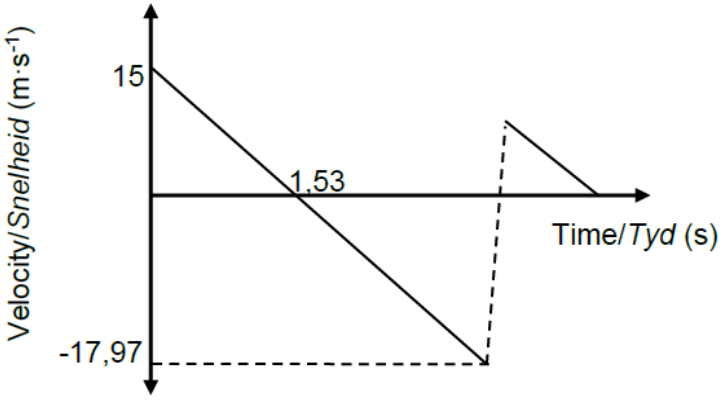
The height decreased/smaller. ✓

The velocity with which the ball strikes the ground is not the same as the velocity with which it left the ground. / Kinetic energy is converted to heat and sound energy / Kinetic energy is NOT conserved. / The kinetic energy is not the same before and after the ball strikes the ground. ✓

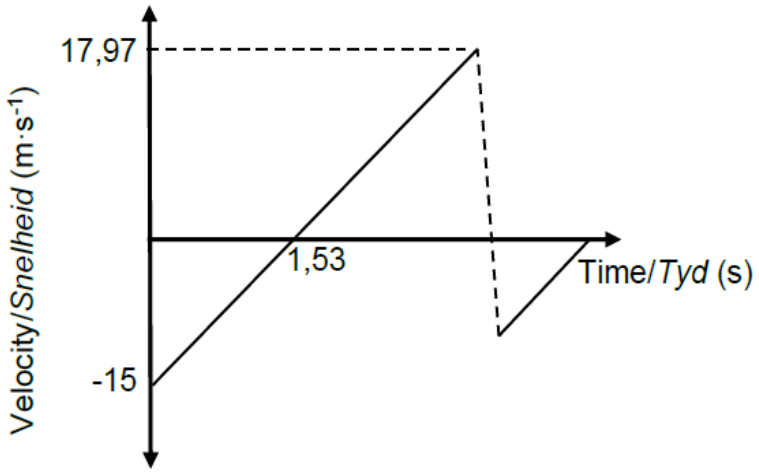
ACCEPT: Kinetic energy is lost.

NOTE: DO NOT ACCEPT ANY CALCULATION AS AN EXPLANATION.

1.5 **UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:**



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



QUESTION 2

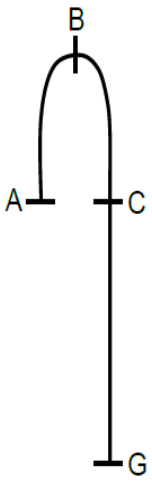
2.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓

OR

Motion in which the only force acting is gravity/weight/gravitational force.

2.2 2.2.1

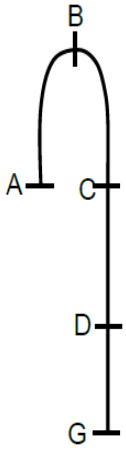
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
A-B:	**B-C:**
UPWARDS AS POSITIVE/	**UPWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***OPWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = 12 + (-9,8)\Delta t$ ✓	$-12 = 0 + (-9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓	$\Delta t = 1,22$ s ✓
DOWNWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
AFWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$0 = -12 + (9,8)\Delta t$ ✓	$12 = 0 + (9,8)\Delta t$ ✓
$\Delta t = 1,22$ s ✓	$\Delta t = 1,22$ s ✓



OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
A-C:	**A-C:**
UPWARDS AS POSITIVE/	**UPWARDS AS POSITIVE/**
OPWAARTS AS POSITIEF	***OPWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-12 = 12 + (-9,8)\Delta t$ ✓	$0 = (12)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s	$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓	$\Delta t_{up} = 1,23$ s ✓
DOWNWARDS AS POSITIVE/	**DOWNWARDS AS POSITIVE/**
AFWAARTS AS POSITIEF	***AFWAARTS AS POSITIEF***
$v_f = v_i + a\Delta t$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$12 = -12 + (9,8)\Delta t$ ✓	$0 = (-12)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 2,45$ s	$\Delta t = 2,45$ s
$\Delta t_{up} = 1,23$ s ✓	$\Delta t_{up} = 1,23$ s ✓

2.2.2

OPTION 1/*OPSIE 1*	
A-G: **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(12)^2 + 2(-9,8)(-25)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	**A-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-12)^2 + 2(9,8)(25)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*
OPTION 2/*OPSIE 2*	
C-G: **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(-12)^2 + 2(-9,8)(-25)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	**C-G:** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = \underline{(12)^2 + 2(9,8)(25)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*
OPTION 3/*OPSIE 3*	
B-G **UPWARDS AS POSITIVE/** **OPWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + \underline{2(-9,8)(-32,35)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*	**B-G** **DOWNWARDS AS POSITIVE/** **AFWAARTS AS POSITIEF** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (0)^2 + \underline{2(9,8)(32,35)}$ ✓ $v_f = 25,18\ m\cdot s^{-1}$ ✓ downwards ✓ *afwaarts*



OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*:

A-D:

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

$\underline{v_f^2 = (12)^2 + 2(-9,8)(-23,1)}$ ✓

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

C-D:

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

$\underline{v_f^2 = (-12)^2 + (2)(-9,8)(-23,1)}$ ✓

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

D-G:

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

$\underline{(-25,18)^2 = (v_i)^2 + 2(-9,8)(-1,9)}$ ✓

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

B-D

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

$v_f^2 = 0 + \underline{2(-9,8)(-30,447)}$ ✓

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

D-G:

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

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

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

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

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

D-G:

$v_f = v_i + a\Delta t$ ✓

$\underline{-25,18 = -24,43 + (-9,8)\Delta t}$ ✓

$\Delta t = 0,08\ s$ ✓

D-G:

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

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

$\Delta t = 0,08\ s$ ✓

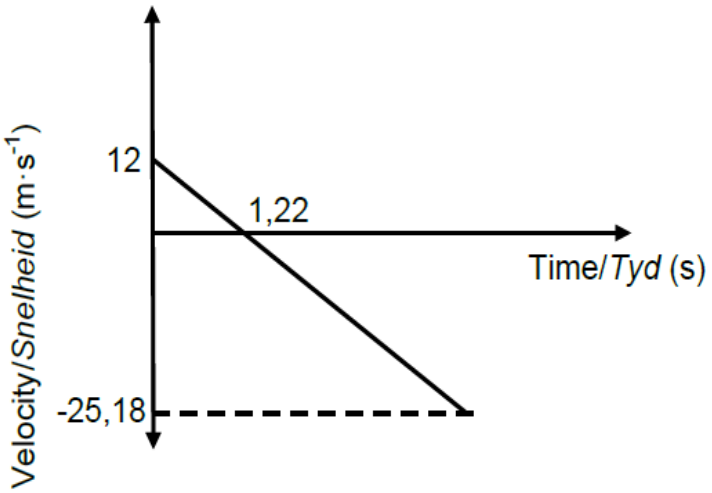
D-G:

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

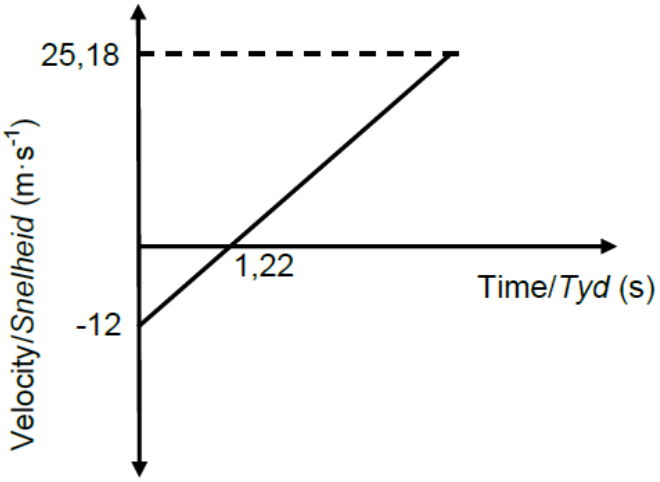
$-1,9 = \left(\frac{-24,43 - 25,18}{2}\right)\Delta t$ ✓

$\Delta t = 0,08\ s$ ✓

TAKING UPWARDS AS POSITIVE



TAKING DOWNWARDS AS POSITIVE



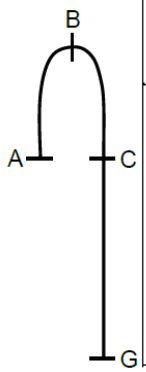
Criteria for graph	
Straight line starting at v = 12 m·s^{-1} with negtive final velocity or straight line starting at v = -12 m·s^{-1} with positive final velocity.	✓
Straight line cuts time axis at time calculated in Question 2.2.1	✓
Correct final velocity as calculated in Question 2.2.2 is indicated.	✓

QUESTION 3

3.1 Motion under the influence of gravitational force only. ✓✓

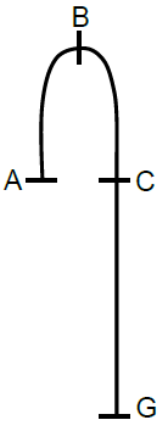
Accept weight/gravity.

3.2



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

3.3 3.3.1



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

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

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

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

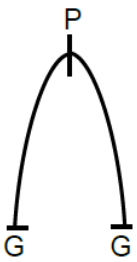
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-15,3 = \left(\frac{10,74 + v_f}{2}\right)3,18$ ✓
$v_f = -20,38\ m\cdot s^{-1}$

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

OR/*OF*

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

3.3.2



OPTION 1/*OPSIE 1* **G-P:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = 11{,}92 + (-9{,}8)\,\Delta t$ ✓ $\Delta t = 1{,}22$ s ✓	**G-P:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = (-11{,}92) + (9{,}8)\Delta t$ ✓ $\Delta t = 1{,}22$ s ✓
OPTION 2/*OPSIE 2* **P-G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-11{,}92 = 0 + (-9{,}8)\,\Delta t$ ✓ $\Delta t = 1{,}22$ s ✓	**P-G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $11{,}92 = 0 + (9{,}8)\Delta t$ ✓ $\Delta t = 1{,}22$ s ✓
OPTION 3/*OPSIE 3* **G - G:** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-11{,}92 = 11{,}92 + (-9{,}8)\,\Delta t$ ✓ $\Delta t = 2{,}43$ s t to reach h_{max}/t tot $h_{maks} = \frac{2{,}43}{2}$ $= 1{,}22$ s ✓	**G - G:** **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $11{,}92 = -11{,}92 + (9{,}8)\,\Delta t$ ✓ $\Delta t = 2{,}43$ s t to reach h_{max}/t tot $h_{maks} = \frac{2{,}43}{2}$ $= 1{,}22$ s ✓

3.4 3.4.1 11,92 ($m \cdot s^{-1}$) ✓

3.4.2 10,74 ($m \cdot s^{-1}$) ✓

3.4.3 1,22 (s) ✓

QUESTION 4

4.1 4.1.1

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

Ball A/*Bal A*

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

$= 12t + \frac{1}{2}(-9,8)t^2$ ✓ .....Eqn (1)

Ball B/*Bal B*

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

$= -5,4(t-2) + \frac{1}{2}(-9,8)(t-2)^2$ ✓..... Eqn (2)

$12t + \frac{1}{2}(-9,8)t^2 = -5,4(t-2) + \frac{1}{2}(-9,8)(t-2)^2$ ✓

$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

Ball A/*Bal A*

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

$= -12t + \frac{1}{2}(9,8)t^2$ ✓ .....Eqn (1)

Ball B/*Bal B*

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

$= 5,4(t-2) + \frac{1}{2}(9,8)(t-2)^2$ ✓.....Eqn (2)

$-12t + \frac{1}{2}(9,8)t^2 = 5,4(t-2) + \frac{1}{2}(9,8)(t-2)^2$ ✓

$t = 4$ (s) ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

Take time for ball B as x/Neem tyd vir bal B as x

Ball A/*Bal A*

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

$= 12(x+2) + \frac{1}{2}(-9,8)(x+2)^2$ ✓

$=(-4,9)x^2 - (7,6)x + (4,4)$ .....Eqn (1)

Ball B/*Bal B*

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

$= (-5,4)x + \frac{1}{2}(-9,8)x^2$ ✓

$= (-5,4)x + (-4,9)x^2$ ..... Eqn (2)

$(-4,9)x^2 - (7,6)x + (4,4) = (-5,4)x + (-4,9)x^2$ ✓

$x = 2$

$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

Ball A/*Bal A*

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

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

$=(4,9)x^2 + (7,6)x + (-4,4)$ .....Eqn (1)

Ball B/*Bal B*

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

$= (5,4)x + \frac{1}{2}(9,8)x^2$ ✓ ..... Eqn (2)

$\boxed{(4,9)x^2 + (7,6)x + (-4,4) = (5,4)x + (4,9)x^2}$ ✓

$x = 2$

$t = 4$ (s) ✓

<u>OPTION 3/*OPSIE 3*</u>:

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$

$-12 = 12 + (-9,8)t$

$\Delta t = 2,45$ s

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

Ball A: $\Delta y = (-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2$ .....Eq 1 ✓

Ball B: $\Delta y = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ....Eq 2 ✓

Equating

$(-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2 = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$

$12 = -12 + (9,8)\Delta t$

$\Delta t = 2,45$ s

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

Ball A: $\Delta y = (12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2$ .....Eq 1 ✓

Ball B: $\Delta y = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ....Eq 2 ✓

Equating

$(12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2 = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

4.1.2

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 2*</u>**
Ball A/*Bal A*	**Ball B/*Bal B***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$=\boxed{(12)(4) + \frac{1}{2}(-9,8)(4)^2}$ ✓	$=\boxed{(-5,4)(4 - 2) + \frac{1}{2}(-9,8)(4 - 2)^2}$ ✓
$\Delta y = -30,4$ m	$\Delta y = -30,4$ m
$Z = 30,4$ (m) ✓	$Z = 30,4$ (m) ✓

Ball A/*Bal A* $v_f = v_i + a\Delta t$ $v_f = 12 + (-9,8)(4)$ $v_f = -27,2\ m{\cdot}s^{-1}$	**OPTION 3/*OPSIE 3*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-27,2)^2 = (12)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = -30,4\ m$ $Z = 30,4\ (m)$ ✓
	OPTION 4/*OPSIE 4* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{12 + (-27,2)}{2}\right)4$ ✓ $\Delta y = -30,4\ m$ $Z = 30,4\ (m)$ ✓
Ball B/*Bal B* $v_f = v_i + a\Delta t$ $v_f = -5,4 + (-9,8)(4 - 2)$ $v_f = -25\ m{\cdot}s^{-1}$	**OPTION 5/*OPSIE 5*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-25)^2 = (-5,4)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = -30,4\ m$ $Z = 30,4\ (m)$ ✓
	OPTION 6/*OPSIE 6* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-5,4 + (-25)}{2}\right)(4 - 2)$ ✓ $\Delta y = -30,4\ m$ $Z = 30,4\ (m)$ ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*	
OPTION 1/*OPSIE 1* **Ball A/*Bal A*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (-12)(4) + \frac{1}{2}(9,8)(4)^2$ ✓ $\Delta y = 30,4\ m$ $Z = 30,4\ (m)$ ✓	**OPTION 2/*OPSIE 2*** **Ball B/*Bal B*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (5,4)(4 - 2) + \frac{1}{2}(9,8)(4 - 2)^2$ ✓ $\Delta y = 30,4\ m$ $Z = 30,4\ (m)$ ✓
Ball A/*Bal A* $v_f = v_i + a\Delta t$ $v_f = -12 + (9,8)(4)$ $v_f = 27,2\ m{\cdot}s^{-1}$	**OPTION 3/*OPSIE 3*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(27,2)^2 = (12)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -30,4\ m$ $Z = 30,4\ (m)$ ✓
	OPTION 4/*OPSIE 4* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $= \left(\frac{-12 + 27,2}{2}\right)4$ ✓ $\Delta y = 30,4\ m$ $Z = 30,4\ (m)$ ✓

Ball B/*Bal B*

$v_f = v_i + a\Delta t$

$v_f = 5,4 + (9,8)(4 - 2)$

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

OPTION 5/*OPSIE 5*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(25)^2 = (5,4)^2 + 2(9,8)\ \Delta y$ ✓

$\Delta y = 30,4\ m$

$z = 30,4\ (m)$ ✓

OPTION 6/*OPSIE 6*

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

$= \left(\frac{5,4 + 25}{2}\right)(4 - 2)$ ✓

$\Delta y = 30,4\ m$

$z = 30,4\ (m)$ ✓

4.1.3

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

OPTION 1/*OPSIE 1*

Ball A/*Bal A*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0 = (12)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = 7,35\ m$

Ball A/*Bal A*

$v_f = v_i + a\Delta t$

$0 = 12 + (-9,8)\Delta t$

$\Delta t = 1,22\ s$

OPTION 2/*OPSIE 2*

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

$= \left(\frac{12 + 0}{2}\right)1,22$ ✓

$\Delta y = 7,32\ m$

OPTION 3/*OPSIE 3*

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

$= (12)(1,22) + \frac{1}{2}(-9,8)(1,22)^2$ ✓

$\Delta y = 7,35\ m$

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

OPTION 1/*OPSIE 1*

Ball A/*Bal A*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0 = (-12)^2 + 2(9,8)\Delta y$ ✓

$\Delta y = 7,35$ m

Ball A/*Bal A*

$v_f = v_i + a\Delta t$

$0 = -12 + (9,8)\Delta t$

$\Delta t = 1,22$ s

OPTION 2/*OPSIE 2*

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

$= \left(\frac{-12 + 0}{2}\right)1,22$ ✓

$\Delta y = -7,32$ m

OPTION 3/*OPSIE 3*

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

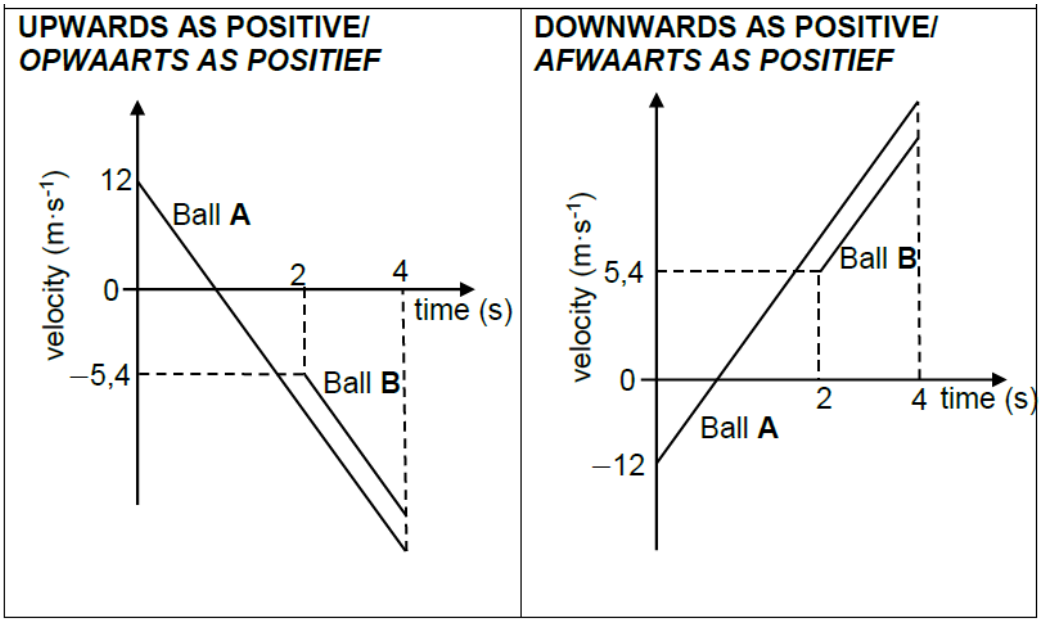
$= (-12)(1,22) + \frac{1}{2}(9,8)(1,22)^2$ ✓

$\Delta y = -7,35$ m

$Y = 7,35 + 30,4$ ✓

$= 37,75$ (m) ✓

4.2



QUESTION 5

5.1 Motion under the influence of gravity/weight/gravitational force only. ✓✓

OR

Motion in which the only force acting is the gravitational force.

5.2 5.2.1

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$\underline{-15,2 = (0) + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$\Delta t = 1,76$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$\underline{15,2 = (0) + \frac{1}{2}(9,8)\Delta t^2}$ ✓

$\Delta t = 1,76$ s ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$v_f^2 = (0)^2 + (2)(-9,8)(-15,2)$

$v_f = -17,26\ m\cdot s^{-1}$ →

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$v_f^2 = (0)^2 + (2)(9,8)(15,2)$

$v_f = 17,26\ m\cdot s^{-1}$ →

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓

$\underline{-17,26 = (0) + (-9,8)\Delta t}$ ✓

$\Delta t = 1,76$ s ✓

OR/*OF*

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

$-15,2 = \left(\frac{0 - 17,26}{2}\right)\Delta t$ ✓

$\Delta t = 1,76$ s ✓

OPTION 3/*OPSIE 3*

$(E_{mech})_{top} = (E_{mech})_{bottom}$

$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$

$(mgh + \frac{1}{2}mv_i^2)_{top} = (mgh + \frac{1}{2}mv_f^2)_{bottom}$

$(9,8)(15,2) + 0 = 0 + (\frac{1}{2})(v_f)^2$

$v_f = 17,26\ m\cdot s^{-1}$ →

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$v_f = v_i + a\Delta t$ ✓

$\underline{17,26 = (0) + (9,8)\Delta t}$ ✓

$\Delta t = 1,76$ s ✓

OPTION 4/*OPSIE 4*

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

$W_{nc} = \Delta K + mg(h_f - h_i)$

$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$

$0 = \frac{1}{2}(v_f^2 - 0) + (9,8)(15,2)$

$v_f = 17,26\ m\cdot s^{-1}$ →

OR/*OF*

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

$15,2 = \left(\frac{0 + 17,26}{2}\right)\Delta t$ ✓

$\Delta t = 1,76$ s ✓

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$

$w\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(9,8)(15,2)\cos 180° = 0 - \frac{1}{2}(v_f)^2$

$v_f = 17,26\ m\cdot s^{-1}$ →

OPTION 6/*OPSIE 6*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$F_{net}\Delta t = \Delta p = m(v_f - v_i)$

$mg\Delta t = m(v_f - v_i)$

✓Any one/ *Enige een*

$\underline{-9,8\Delta t = -17,26 - (0)}$ ✓

$\Delta t = 1,76$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$F_{net}\Delta t = \Delta p = m(v_f - v_i)$

$mg\Delta t = m(v_f - v_i)$

✓Any one/ *Enige een*

$\underline{9,8\Delta t = 17,26 - (0)}$ ✓

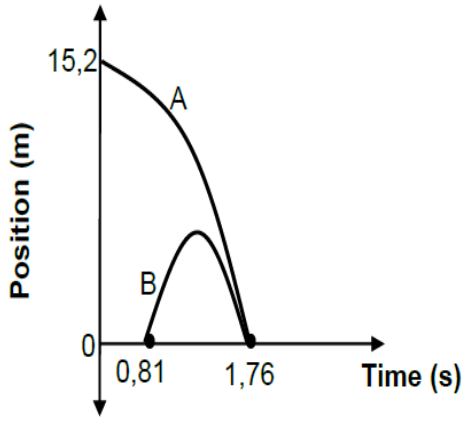
$\Delta t = 1,76$ s ✓

5.2.2

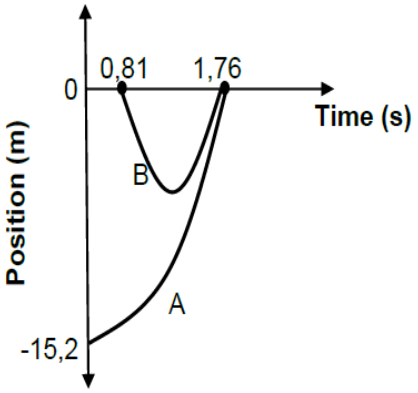
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF***	**UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $(0) = v_i(0,95) + \frac{1}{2}(-9,8)(0,95)^2$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-3,2 = (0) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $v_f = v_i + a\Delta t$ $-v_i = v_i + (-9,8)(0,95)$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓
DOWNWARDS AS POSITIVE/ ***AFWAARTS AS POSITIEF***	**DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $0 = -v_i(0,95) + \frac{1}{2}(9,8)(0,95)^2$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $3,2 = (0) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓ $\Delta t = 0,81$ s $\Delta t(B) = 1,76 - 0,81$ ✓ $\Delta t(B) = 0,95$ s $v_f = v_i + a\Delta t$ $v_i = -v_i + (9,8)(0,95)$ ✓ $v_i = 4,66\ m\cdot s^{-1}$ ✓

5.3

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF* (CHANGED GRAPH)



DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*



TOPIC 3: MOMENTUM AND IMPULSE

QUESTION 1

1.1 (Linear) momentum (of an object) is the product of mass and velocity. ✓✓

1.2 1.2.1

OPTION 1/*OPSIE 1*   **East as positive/*Oos as positief*** $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een* $(0,16)(10) + (0,2)(-15)$ ✓ $= (0,16)(-5) + (0,2)v_{Qf}$ ✓ $v_{Qf} = -3\ m{\cdot}s^{-1}$ $v_{Qf} = 3\ m{\cdot}s^{-1}$ ✓ west/*wes* ✓
OPTION 2/*OPSIE 2*   **West as positive/*Wes as positief*** $\sum p_i = \sum p_f$ $m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$ } ✓Any one/*Enige een* $(0,16)(-10) + (0,2)(15)$ ✓ $= (0,16)(5) + (0,2)Q_{Nf}$ ✓ $v_{Qf} = 3\ m{\cdot}s^{-1}$ ✓ west/*wes* ✓
OPTION 3/*OPSIE 3* $\Delta p_p = -\Delta p_Q$ ✓ $(0,16)(-5 - 10)$ ✓ $= -(0,2)(v - (-15))$ ✓ $v = -3\ m{\cdot}s^{-1}$ $= 3\ m{\cdot}s^{-1}$ ✓west/*wes* ✓

1.2.2

For ball/*Vir bal* P:	**POSITIVE MARKING FROM QUESTION 4.2.1 /*POSITIEWE NASIEN VANAF VRAAG 4.2.1***
West as negative/*Wes as negatief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $\Delta p = m(v_{Pf} - v_{Pi})$ } ✓Any one/ *Enige een* $= 0,16(-5 - 10)$ ✓ $= -2,4$ $\therefore 2,4$ N·s ✓ $(2,4\ kg{\cdot}m{\cdot}s^{-1})$ **OR/*OF*** West as positive /*Wes as positief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Pf} - v_{Pi})$ } ✓Any one/ *Enige een* $= 0,16(5 - (-10))$ ✓ $= 2,4$ N·s ✓	For ball/*Vir bal* Q: West as negative/*Wes as negatief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Qf} - v_{Qi})$ } ✓ Any one/ *Enige een* $= 0,2[-3 - (-15)]$ ✓ $= 2,4$ N·s ✓ $(2,4\ kg{\cdot}m{\cdot}s^{-1})$ **OR/*OF*** West as positive /*Wes as positief* Impulse = Δp $F_{net}\Delta t = \Delta p$ $= m(v_{Qf} - v_{Qi})$ } ✓Any one/ *Enige een* $= 0,16(3 - (15))$ ✓ $= -2,4$ N·s $\therefore 2,4$ N·s ✓ $(2,4\ kg{\cdot}m{\cdot}s^{-1})$

QUESTION 2

2.1 The total (linear) momentum in an isolated system is conserved/remains constant. ✓✓

2.2

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$0,8 = v_i(2)$ ✓
$v_i = 0,4\ m{\cdot}s^{-1}$

RIGHT AS +/*REGS AS +*	**LEFT AS +/*LINKS AS +***
OPTION 1/*OPSIE 1*	
$\sum p_i = \sum p_f$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ } ✓Any one/ *Enige een* $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $(2)v_{1i} + 0$ ✓ $= (2 + 1,5)(0,4)$ ✓ $v_{i1} = 0,7\ m{\cdot}s^{-1}$ ✓	$\sum p_i = \sum p_f$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ } ✓Any one/ *Enige een* $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $(2)(v_{1i}) + 0$ ✓ $= (2 + 1,5)(-0,4)$ ✓ $V_{1i} = -0,7$ $v_{1i} = 0,7\ m{\cdot}s^{-1}$ ✓
OPTION 2 /*OPSIE 2*	
$\Delta p_1 = -\Delta p_2$ $m(v_{1f} - v_{1i}) = -m(v_{2f} - v_{2i})$ } ✓Any one/ *Enige een* $2(0,4 - v_{1i})$ ✓ $= -1,5(0,4 - 0)$ ✓ $v_{1i} = 0,7\ m{\cdot}s^{-1}$ ✓	$-\Delta p_1 = \Delta p_2$ $-m(v_{1f} - v_{1i}) = m(v_{2f} - v_{2i})$ } ✓Any one/ *Enige een* $-2(0,4 - v_{1i})$ ✓ $= 1,5(-0,4 - 0)$ ✓ $v_{1i} = 0,7\ m{\cdot}s^{-1}$ ✓

2.3 Inelastic. ✓

2.4

DECREASES/*NEEM AF* ✓
$F_{net}\Delta t = \Delta p$ **OR/*OF*** $F_{net} = \frac{\Delta p}{\Delta t}$ **OR/*OF*** $F_{net}\Delta t = m\Delta v$ **OR/*OF*** $F_{net}\ \alpha\ \frac{1}{\Delta t}$ ✓

QUESTION 3

3.1 The total mechanical energy/sum of gravitational potential energy and kinetic energy, in an isolated system remains constant/is conserved. ✓✓

3.2

OPTION 1/*OPSIE 1*

Total $E_{mech(top/bo)}$ = Total $E_{mech(bottom/onder)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$
$(mgh + ½mv^2)_{top/bo} = (mgh + ½mv^2)_{bottom/onder}$ ✓Any one/*Enige een*

$(2)(9,8)(1,5) + 0$ ✓ $= 0 + ½(2)v^2$ ✓ **OR/*OF***

$(9,8)(1,5) + 0 = 0 + ½v^2$

$v = 5,42\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_k + \Delta E_p$
$W_{nc} = ½m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*

$0 = [0 - ½v_i^2] + [(9,8)(1,5 - 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta E_k$
$F_g\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$
$mg\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$ ✓Any one/*Enige een*

$(9,8)(1,5)\cos 180^\circ$ ✓ $= 0 - ½v_i^2$ ✓
$v_i = 5,42\ m\cdot s^{-1}$ ✓

OPTION 4/*OPSIE 4*

$\Delta E_k = -\Delta E_p$ ✓
$[0 - ½v_i^2]$✓ $= -[(9,8)(1,5 - 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

OR/*OF*

$-\Delta E_k = \Delta E_p$ ✓
$-[0 - ½v_i^2]$✓ $= [(9,8)(1,5 - 0)]$
$v_i = 5,42\ m\cdot s^{-1}$✓

OPTION 5/*OPSIE 5*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
0 ✓ $= v_i^2 + 2(9,8)(-1,5)$ ✓
$v_f = -5,42\ m\cdot s^{-1}$
speed $= 5,42\ m\cdot s^{-1}$ ✓

OR/*OF*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
0 ✓ $= v_i^2 + 2(-9,8)(1,5)$ ✓
speed $= v_f = 5,42\ m\cdot s^{-1}$ ✓

3.3 3.3.1

POSITIVE MARKING FROM QUESTION 4.2
POSITIEWE NASIEN VANAF VRAAG 4.2

$\Delta p = mv_f - mv_i$
$F_{net}\Delta t = \Delta p$ ✓ any one /enige een
$= 2(5,42 - 0)$ ✓ **OR/*OF*** $2(-5,42 - 0) = -10,84\ kg\cdot m\cdot s^{-1}$
$= 10,84\ kg\cdot m\cdot s^{-1}$ right/*regs* ✓

3.3.2 **POSITIVE MARKING FROM QUESTION 3.3.1**

10,84 kg·m·s-1 left/links/opposite direction. ✓

3.4 **POSITIVE MARKING FROM QUESTION 3.2 and 3.3.1**

$\Delta p_A = mv_f - mv_i$		$\Sigma p_i = \Sigma p_f$
$-10,84 = 1,5(v_f - 0)$ ✓	**OR/OF**	$0 = 1,5v_f + (2)(5,42)$ ✓
$v_f = -7,23\ m\cdot s^{-1}$		$v_f = -7,23\ m\cdot s^{-1}$
$v = 7,23\ m\cdot s^{-1}$ ✓		$v = 7,23\ m\cdot s^{-1}$ ✓
$10,84 = 1,5(v_f - 0)$ ✓	**OR/OF**	$0 = 1,5v_f + (2)(-5,42)$
$v = 7,23\ m\cdot s^{-1}$ ✓		$v = 7,23\ m\cdot s^{-1}$ ✓

QUESTION 4

4.1 The total (linear) momentum of an isolated/closed system remains constant (is conserved). ✓✓

Accept

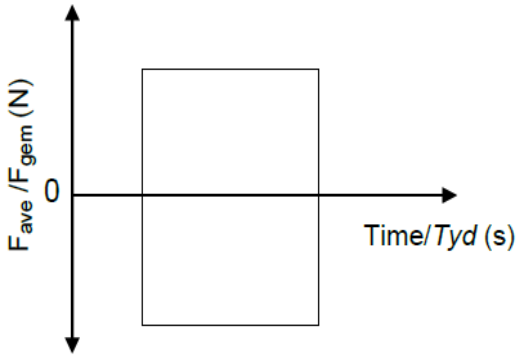
The total (linear) momentum before a collision is equal to the total linear momentum after collision in an isolated/closed system.

4.2

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

4.3 Impulse. ✓

4.4



QUESTION 5

5.1 The product of the resultant/net force acting on an object and the time the (net) force acts on the object. ✓✓

OR

The product of the resultant/net force and the contact time.

5.2 5.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
Gradient/F_{net} $= \frac{\Delta p_f}{\Delta(\Delta t)}$ $= \frac{4,5 - 0}{0,03 - 0,01}$ ✓ ✓ $= 225$ N F_{net} = 225 N to the right / opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*	$F_{net}\Delta t = \Delta p$ $F_{net}(0,01) = 0 - p_i$ ✓ ..... eq (1) $F_{net}(0,03) = 4,5 - p_i$ ✓ ..... eq (2) $4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$ F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*

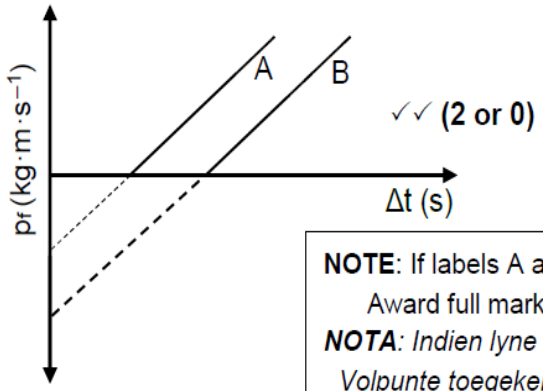
OPTION 3/*OPSIE 3*
$F_{net}\Delta t = \Delta p$ $F_{net}(0,01) = 0 - 0,15v_i$ ✓ ..... eq (1) $F_{net}(0,03) = 4,5 - 0,15v_i$ ✓ ..... eq (2) $4,5 - F_{net}(0,03) = 0 - (0,01)F_{net}$ F_{net} = 225 N to the right/ opposite to the original direction of the ball ✓ *Regs / teenoorgestelde rigting as die oorspronklike rigting van die bal*

4.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = p_f - p_i$ $F_{net}\Delta t = mv_f - mv_i$ ✓ Any one / *enige een* (225)(0,03) ✓ = 4,5 – (0,15)v_i ✓ $v_i = -15$ m·s^{-1} $v_i = 15$ m·s^{-1} ✓	$F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = p_f - p_i$ $F_{net}\Delta t = mv_f - mv_i$ ✓ Any one / *enige een* (225)(0,01) ✓ = 0 – (0,15)v_i ✓ $v_i = -15$ m·s^{-1} $v_i = 15$ m·s^{-1} ✓

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$p_f = F_{net}\Delta t + p_i$ $4,5 = 225(0,03) + p_i$ ✓ $p_i = -2,25$ $p_i = mv_i$ ✓ $-2,25 = 0,15v_i$ ✓ $v_i = -15\ m\cdot s^{-1}$ $v_i = 15\ m\cdot s^{-1}$ ✓	$F_{net} = ma$ $225 = 0,15a$ ✓ $a = 1500\ m\cdot s^{-2}$ $p_f = mv_f$ $4,5 = 0,15v_f$ $v_f = 30\ m\cdot s^{-1}$ $a = \frac{\Delta v}{\Delta t}$ ✓ $1500 = \frac{30 - v_i}{0,03 - 0}$ ✓ $v_i = 15\ m\cdot s^{-1}$ ✓

4.3



✓✓ **(2 or 0)**

NOTE: If labels A and B not indicated ($^0/_2$)
Award full marks for solid lines with labels.
***NOTA**: Indien lyne nie benoem A en B ($^0/_2$)*
Volpunte toegeken vir soliede benoemde lyne

TOPIC 4: WORK, ENERGY AND POWER

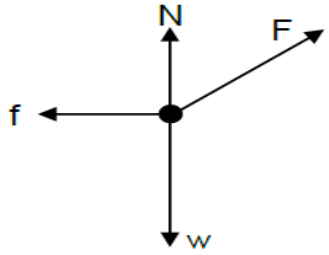
QUESTION 1

1.1 The work done on an object by a constant force **F** is F Δx cos θ, where **F** is the magnitude of the force, **Δx** the magnitude of the displacement and **θ** the angle between the force and the displacement. ✓✓

OR

The work done on an object is the product of the force and the displacement of the object in the direction of the displacement.

1.2



5.3

OPTION 1/*OPSIE 1*

$$W_{nc} = \Delta E_k + \Delta E_p$$
$$W_{nc} = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$$
$$W_F + W_f = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$$

✓ Any one/ *Enige een*

$$F(1,5)\cos30° + 10(1,5)\cos180° \checkmark = \tfrac{1}{2}(6)(2^2 - 0^2) \checkmark + 0$$
$$F = 20,78\ N \ \checkmark$$

OPTION 2/*OPSIE 2*

$$W_{net} = \Delta E_k$$
$$W_F + W_f = \Delta E_k$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

✓Any one/ *Enige een*

$$F(1,5)\cos30° + 10(1,5)\cos180° \checkmark = \tfrac{1}{2}(6)(2^2 \checkmark - 0^2)$$
$$F = 20,78\ N \ \checkmark$$

OPTION 3/*OPSIE 3*

$$W_{net} = \Delta E_K$$
$$(F\cos\theta - f)\Delta x\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

✓ Any one/ *Enige een*

$$(F\cos30° - 10)(1,5)\cos0° \checkmark = \tfrac{1}{2}(6)(2^2 - 0^2) \checkmark$$
$$F = 20,78\ N \ \checkmark$$

OPTION 4/*OPSIE 4*

$$W_{net} = \Delta E_K$$
$$(F_x - f)\Delta x\cos\theta = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$

✓ Any one/ *Enige een*

$$(F_x - 10)(1,5)\cos0° = \tfrac{1}{2}(6)(2^2 - 0^2) \checkmark$$
$$F_x = 18\ N$$
$$F_x = F\cos 30°$$
$$18 = F\cos 30° \checkmark$$
$$F = 20,78\ N \checkmark$$

1.4 REMAINS THE SAME. ✓✓

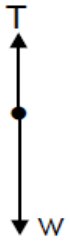
QUESTION 2

2.1 The net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓

OR

The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. ✓✓

2.2



2.3

$W_w = w\Delta x\cos\theta$ ✓ $= mg\Delta x\cos\theta$ $= (6)(9,8)(1,6)\cos0^o$ ✓ $\therefore W = 94,08$ J ✓	$W_w = -\Delta E_P$ ✓ $= -mg(h_f - h_i)$ $= -(6)(9,8)(0 - 1,6)$ ✓ $= 94,08$ J ✓

2.4

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_K / \Delta K$ ✓ $= \frac{1}{2}m(v_f^2 - v_i^2)$
$W_{net} = F_{net}\Delta x\cos\theta$
$W_{net} = W_f + W_g + W_N$
$= \mu_k N\Delta x\cos\theta + W_g + W_N$

$W_{net} = \underline{(0,4)(4)(9,8)(1,6)\cos180^o}$ ✓ $+ 94,08 + 0$
$= 68,992$ J
$W_{net} = \frac{1}{2}m(v_f^2 - v_i^2)$
$\underline{68,992}$ ✓ $= \underline{\frac{1}{2}(4)(v_f^2 - 0)} + \frac{1}{2}(6)(v_f^2 - 0)$ ✓
$v_f = 3,71$ m·s^{-1} ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$f\Delta x\cos\theta = (m_1gh_f - m_1gh_i) + (\frac{1}{2}m_1v_f^2 - \frac{1}{2}m_1v_i^2) + (\frac{1}{2}m_2v_f^2 - \frac{1}{2}m_2v_i^2)$
$\underline{(0,4)(4)(9,8)\ (1,6)\cos 180^o}$ ✓ $= [0 - (6)(9,8)(1,6)]$ ✓ $+ (\frac{1}{2}(6)v_f^2 + \frac{1}{2}(4)v_f^2 - 0)$ ✓
$68,992 = 5v_f^2$
$v_f = 3,71$ m·s^{-1} ✓

OPTION 3/*OPSIE 3*

$f_k = \mu_k N = (0,4)(4)(9,8) = 15,68$ N
$T - f_k = ma$
$w - T = ma$
$T - 15,68 = 4a$ … .(i)
$(6)(9,8) - T = 6a$ ……..(ii)
$\therefore a = 4,312$ m·s^{-2}
$\therefore T = 32,928$ N

$F_{net} = ma$
$= (6)(4,312)$
$= 25,872$

$W_{net} = F_{net}\Delta x\cos\theta$
$= (25,872)(1,6)\cos0^o$ ✓
$= 41,3952$ J

$W_{net} = \Delta E_k$ ✓
$41,3952 = \frac{1}{2}m(v_f^2 - v_i^2$
$\underline{41,3952 = \frac{1}{2}(6)(v_f^2 - 0)}$ ✓
$v_f = 3,7146$ m·s^{-1} ✓

Above calculations can be done with 4 kg or 10 kg / *Bostaande berekeninge kan met 4 kg of 10 kg gedoen word*

4 kg block	6 kg block
$W_{net} = \Delta E_K / \Delta K$✓ $W_f + W_T = ½m(v_f^2 - v_i^2)$ $f\Delta x\cos 180^o + T\Delta x\cos 0^o = ½(4)(v_f^2 - 0)$ $(15,68)(1,6)(-1)$✓ $+ (32,928)(1,6)(1)$✓ $= 2v_f^2$ $v_f = 3,72\ m\cdot s^{-1}$✓	$W_{net} = \Delta E_K / \Delta K$✓ $W_w + W_T = ½m(v_f^2 - v_i^2)$ $mg\Delta x\cos 0^o + T\Delta x\cos 180^o = ½(6)(v_f^2 - 0)$ $(6)(9,8)(1,6)(1)$✓$+ (32,928)(1,6)(-1)$✓$= 3v_f^2$ $v_f = 3,72\ m\cdot s^{-1}$✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_K / \Delta K$ ✓

For the 4 kg mass / *Vir die 4 kg massa*

$T(1,6)\cos 0^o + [(0,4)(9,8)(4)](1,6)\cos 180^o$✓ $= ½(4)v^2 - 0)$

For the 6 kg mass/*Vir die 6 kg massa*

$(6)(9,8)(1,6)]\cos 0^o + T(1,6)\cos 180^o$✓ $= ½(6)(v^2 - 0)$

Adding the two equations / *Optel van twee vergelykings*

$68,992 = ½(4)v^2 + ½(6)v^2$ ✓

$5v^2 = 68,992$

$v = 3,71\ m\cdot s^{-1}$✓

OPTION 5/*OPSIE 5*

$W_{net} = \Delta E_k$ ✓

$F_{net}\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$

$(F_g - f)\Delta x\cos\theta = ½m(v_f^2 - v_i^2)$

$[(6)(9,8) - (0,4)(4)(9,8)]$✓$(1,6)\cos 0^o$ ✓$= ½(10)(v_f^2 - 0)$✓

$v_f = 3,71 m.s^{-1}$ ✓

QUESTION 3

3.1 The net/total work done (on an object) is equal to the change in the object's kinetic energy. ✓✓

OR

The work done (on an object) by a resultant/net force is equal to the change in the object's kinetic energy.

3.2 $W_{net} = \Delta E_k$

$W_{FA} = \Delta E_k$

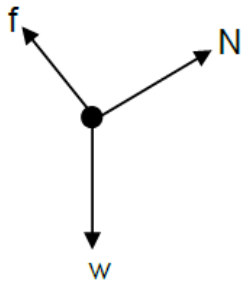
$F_A\Delta x\cos\theta = ½ mv_f^2 - ½ mv_i^2$ ✓

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

$(12)(7)\cos 0° = Ek_f - 0$

$E_{kf} = 84\ J$

3.3



3.4

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = E_{kf} - E_{ki}$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = E_{kf} - E_{ki}$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$(3)(9,8)\sin 20°\Delta x\cos 0°$ ✓ $+ 21\Delta x\cos 180°$ ✓ $= 0 - 84$ ✓
$\Delta x = 7,68$ m ✓

7,68 m > 6,8 m
The crate will pass point C. ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$
$W_{Fg} + W_{fk} = \Delta E_k$
$F_{g//}\Delta x\cos\theta + f_k\,\Delta x\cos\theta = \Delta E_k$
$mg\sin\theta\Delta x\cos\theta + f_k\Delta x\cos\theta = E_{kf} - E_{ki}$
$(3)(9,8)\sin 20°(6,8)\cos 0°$ ✓ $+ (21)(6,8)\cos 180°$ ✓ $= E_{kf} - 84$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52$ m·s^{-1}

9,58 J > 0 J **OR** 2,52 m·s^{-1} > 0 m·s^{-1}
The crate will pass point C. ✓

OPTION 3/*OPSIE 3*

$\sin 20° = \frac{h}{6,8}$
$h = 2,326$ m

$W_{nc} = \Delta E_k + \Delta E_p$
$f_k\,\Delta x\cos\theta = +\Delta E_k + \Delta E_p$
$(21)(6,8)\cos 180°$ ✓ $= (E_{kf} - 84)$ ✓ $- (3)(9,8)(2,326)$ ✓
$E_{kf} = 9,58$ J ✓ **OR** $v_f = 2,52$ m·s^{-1}

9,58 J > 0 J **OR** 2,52 m·s^{-1} > 0 m·s^{-1}
The crate will pass point C. ✓

QUESTION 4

4.1 The rate at which work is done/energy is expended. ✓✓

Accept

Work done per unit time / energy expended per unit time.

4.2

OPTION 1/*OPSIE 1*

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

$= \frac{\Delta mgh}{\Delta t}$ ✓Any one/*Enige een*

$= \frac{(1\ 250)(9,8)(5,8)}{60}$ ✓

$= 1\ 184,17$ W ✓ (1 184,167)

OPTION 2/*OPSIE 2*

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

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

$= \frac{mg\Delta x\cos 0^\circ}{\Delta t}$

$= \frac{(1250)(9,8)(5,8)\cos 0^\circ}{60}$ ✓

$= 1\ 184,17$ W ✓ (1 184,167)

OPTION 3/*OPSIE 3*

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

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

$= \frac{mg\Delta x\cos 180^\circ}{\Delta t}$ ✓

$= \frac{(1250)(9,8)(5,8)\cos 180^\circ}{60}$

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

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

OPTION 4/*OPSIE 4*

$P_{ave} = Fv_{ave}$ ✓

$= 1\ 250(9,8)\frac{5,8}{60}$ ✓

$= 1\ 184,17$ W ✓

4.3 A *conservative force* is a force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓

OR

A conservative force is a force for which the work done in moving an object in a closed path is zero.

4.4 Non-conservative. ✓

4.5 (Gravitational) potential to kinetic (energy).

4.6

OPTION 1/*OPSIE 1*

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

$\Delta U = mg(h_f - h_i)$

$= 1\,250(9,8)(0 - 5,8)$ ✓

$= -71\,050$ 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*

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

$F_{wall/muur}(0,25)\cos 180°$ ✓ $= 0 - 71\,050$ ✓

$F_{wall/muur} = 284\,089$ 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*

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

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

Into the wall / *In die muur in*:

$W_{net} = \Delta K$

$W_{wall/muur} = K_f - K_i$

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

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

$F_{wall/muur} = 284\,089$ 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*

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

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

Into the wall / *In die muur in*:

$W_{net} = \Delta K$

$W_{wall/muur} = K_f - K_i$ ✓Any one/*Enige een*

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

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

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

OPTION 4/*OPSIE 4*

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

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

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

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

$v_i = 10,66\ m\cdot s^{-1}$ (10,662) ✓Any one/*Enige een*

Into the wall / *In die muur in*:

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

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

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

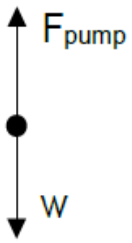
$F_{wall/muur}(0,25)\cos 180°$ ✓ $= \frac{1}{2}(1\,250)(0 - 10,66^2)$ ✓ $+ 0$

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

QUESTION 5

5.1 A non-conservative force is a force for which the work done (in moving an object between two points) is dependent on the path taken. ✓✓

5.2



5.3 5.3.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$W_{nc} = \Delta E_p + \Delta E_k$ ✓Any one/ *Enige een* $W_{pump} = mg\Delta h$ / mgh $= 200(9,8)(12,5)$ ✓ $= 24\ 500$ J✓	$F_{pump} = w = 1960$ N $W_{pump} = F_{pump}\Delta x\cos\theta$ ✓ $= (1960)(12,5)(1)$ ✓ $= 24\ 500$ J✓

OPTION 3/*OPSIE 3*	
$W_{net} = \Delta E_k$ ✓Any one/ *Enige een* $W_{pump} + W_{Fg} = 0$ $W_{pump} + 200(9,8)(12,5)\cos 180° = 0$ ✓ $W_{pump} = 24\ 500$ J ✓	

5.3.2

NOTE: Q5.3.3 can be done first for Q5.3.2. Credit the candidate
NOTA: *Q5.3.3 kan eerste gedoen word vir V5.3.2. Ken punte toe*

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\Delta t = \boxed{\frac{200}{2,5}}$ ✓ $= 80$ s $v = \frac{\Delta x}{\Delta t}$ $= \boxed{\frac{12,5}{80}}$ ✓ $= 0,16$ m·s^{-1} (0,156 m·s^{-1})✓	$\Delta t = \boxed{\frac{200}{2,5}}$ ✓ $= 80$ s $\Delta x = \frac{(v_i + v_f)}{2}\Delta t$ $\boxed{12,5 = \frac{2v}{2}(80)}$ ✓ $v = 0,16$ m·s^{-1} (0,156 m·s^{-1})✓

5.3.3

POSITIVE MARKING FROM Q5.3.1 and Q5.3.2 / ***POSITIEWE NASIEN VANAF V5.3.1 en V5.3.2***	
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$P = \frac{W}{\Delta t}$ ✓ $= \frac{24500}{80}$ ✓ $= 306,25$ W ✓	$P_{ave} = Fv_{ave}$ ✓ $= (200)(9,8)(0,16)$ ✓ $= 313,60$ W ✓ (Range/*Gebied*: 305,76 W - 313,60 W)

TOPIC 5: DOPPLER EFFECT

QUESTION 1

1.1 1.1.1 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. ✓✓

OR

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

1.1.2

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

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

$v = 343{,}04\ m{\cdot}s^{-1}$ ✓ Range/*Gebied:* $(332{,}14 - 343{,}04\ m{\cdot}s^{-1})$

1.1.3 (a) Remains the same. ✓

(b) Remains the same. ✓

(c) Decreases. ✓

1.2.1 AWAY FROM. ✓

1.2.2
- A lower frequency/longer wavelength is detected. ✓
- The spectral lines are shifted to the red end of the spectrum. ✓

QUESTION 2

2.1 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. ✓✓

OR

Is an (apparent) change in (observed/detected) frequency(pitch) as a result of the relative motion between a sound source and an observer.

2.2 2.2.1 Velocity/speed/vs of the ambulance/source. ✓

2.2.2 Frequency/wavelength of the sound produced by the ambulance siren / f_s / speed of sound/ density/temperature of air/detector/listener is stationary.

2.3 As the velocity of the ambulance increases, the detected frequency decreases. ✓

2.4

Ambulance approaching/*Ambulans beweeg nader*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V - V_S} f_S$ ✓ Either/ *Enige*

$1298 = \frac{v}{v - 25} f_S$ ✓

$v f_S = 1298(v - 25)$ ..... eq. (1)

Ambulance moving away/*Ambulans beweeg weg*:

$f_L = \frac{V \pm V_L}{V \pm V_S} f_S$ **OR/*OF*** $f_L = \frac{V}{V + V_S} f_S$ ✓ Either/ *Enige*

$1115 = \frac{v}{v + 25} f_S$ ✓

$v f_S = 1115(v + 25)$ ..... eq. (2)

(1) = (2) **OR/*OF*** (1) ÷ (2)

$1298(v - 25) = 1115(v + 25)$ ✓ **OR/*OF*** $1,164(v - 25) = v + 25$

$v = 329,64 \text{ m·s}^{-1}$ ✓

QUESTION 3

3.1 Doppler Effect. ✓

3.2 Away from. ✓

Wavelength of sound detected/observed by the listener is longer than wavelength of sound emitted by the source. ✓

OR

Frequency detected by the listener is lower than the frequency of the source.

OR

$\lambda_L > \lambda_S$

3.3 3.3.1 $v = f\lambda$

$343 = f(0,38)$ ✓

$f = 902,63$ Hz

3.3.2 $v = f\lambda$

$343 = f(0,4)$ ✓

$f_L = 857,5$ Hz

$f_L = \frac{(v \pm v_L)}{(v \pm v_S)} \times f_S$

$f_L = \frac{(v - v_L)}{(v + v_S)} \times f_S$ ✓

857.5 ✓ $= \frac{(343-0)}{(343+v_S)}$ ✓ x (902.63) ✓

$v_s = 18,05 \text{ m·s}^{-1}$ ✓ (Range: 18,05 m·s^{-1} to 18,45 m·s^{-1})

QUESTION 4

4.1 Doppler effect. ✓

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. ✓✓

OR

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

4.2

$v = f_L \lambda$

$340 = f_L \times 0{,}016$ ✓

$f_L = 21\,250$ Hz

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

$21\,250$ ✓ $= \left(\frac{340 + 0}{340 - v_B}\right) f_S$ ✓

$f_S = 21\,250 - 62{,}5 v_B$

4.3

$f_L = 21\,250 - 62{,}5 v_B + 850$

$f_L = 22\,100 - 62{,}5 V_b$ ✓

$f_L = \frac{(v \pm v_L)}{(v \pm v_S)} \times f_S$ **OR** $f_L = \frac{(v + v_L)}{(v - v_S)} \times f_S$

$(22\,100 - 62{,}5 V_b)$ ✓ $= \frac{(340 + v_B)}{(340 - 0)}$ ✓ $\times 21250$ ✓

$v_B = 6{,}8\ m \cdot s^{-1}$ ✓

QUESTION 5

5.1 It is the (apparent) 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. ✓✓

OR

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

5.2

$f_L = \frac{(v \pm v_L)}{(v \pm v_S)} \times f_S$ **OR** $f_L = \frac{(v+v_L)}{(v-v_S)} \times f_S$ ✓

$615 = \frac{(v+0)}{(v-26)} \times f_S$ ✓

$615 = \frac{(v)}{(v-26)} \times f_S$

$f_S = \frac{615(v-26)}{v}$ .....(1)

$f_L = \frac{(v \pm v_L)}{(v \pm v_S)} \times f_S$ **OR** $f_L = \frac{(v+v_L)}{(v-v_S)} \times f_S$

$526 = \frac{(v+0)}{(v-26)} \times f_S$ ✓

$526 = \frac{(v)}{(v-26)} \times f_S$

$f_S = \frac{526(v-26)}{v}$ .....(2)

$\frac{615(v-26)}{v} = \frac{526(v-26)}{v}$ ✓

$v = 333{,}33 \text{ m·s}^{-1}$ ✓

5.3

$f_S = \frac{615(333.33-26)}{333.33}$ ✓ $f_S = \frac{526(333.33-26)}{333.33}$

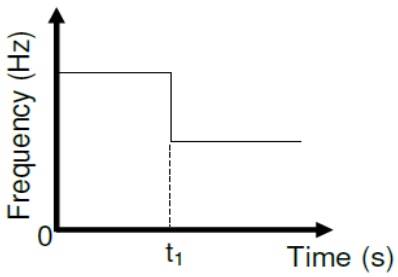
$f_S = 567.03$ Hz $f_S = 567.03$ Hz

$v = f\lambda$ ✓

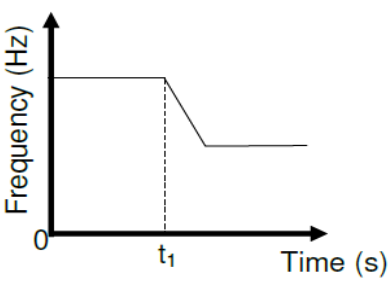
$333{,}33 = 567{,}03\lambda$ ✓

$\lambda = 0{,}59$ m ✓

5.4



OR/*OF*



Criteria for graph	
The lines before and after t1 are horisontal.	✓
The frequency after t1 is less than before t_1.	✓
Time t_1 correctly indicated.	✓

QUESTION 6

6.1 **For the source(ambulance)**

f_S = ?

v_S = 10 m.s^{-1}

v = ?

For the listener

f_L = ?

v_L = 0 m.s^{-1}

$$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_S \quad ✓$$

TOWARDS: $$f_L = \left(\frac{v + v_L}{v - v_S}\right) f_S$$

$$\frac{f_L}{f_S} = \frac{v + v_L}{v - v_S}$$

$$1.03 = \frac{v + 0}{v - 10} \quad ✓$$

$$v = 343.33 \text{ m.s}^{-1} \quad ✓$$

6.2 $$f_L = \left(\frac{v + v_L}{v - v_S}\right) f_S$$

$$f_L = \left(\frac{343.33 + 0}{343.33 - 10}\right) ✓(620) ✓$$

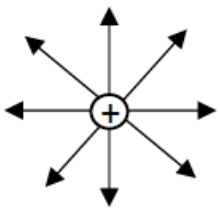
f_L = 638.6 Hz ✓

TOPIC 6: ELECTROSTATICS

QUESTION 1

1.1 A region of space in which an electric charge experiences a force. ✓✓

1.2



Marking criteria	
Direction;	✓
Field lines radially outward;	✓
Two or more lines inside sphere/not touching sphere/cross each other: deduct 1 mark.	

1.3 $$E = \frac{kQ}{r^2} \quad ✓$$

1.08×10^6 ✓ $= \frac{(9 \times 10^9)(3 \times 10^{-7})}{r^2}$ ✓

r = 0,05 m

1.4

OPTION 1/*OPSIE 1*

$F_{XY} = \frac{kQ_XQ_Y}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓

$= 0,54$ N

$F_{XZ} = \frac{kQ_XQ_Z}{r^2}$

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,68$ N

$F_{net}(E) = F_{XZ} + F_{XY}$

$= \underline{0,68 - 0,54}$ ✓

$= 0,14$ N

No/*Nee* ✓

$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 2/*OPSIE 2*

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

$= \frac{(9 \times 10^9)(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(4 \times 10^{-7})}{(0,04)^2}$ ✓

$E_{net} = 450\ 000$ N·C^{-1}

$F_{net} = qE$ ✓

$F_{net} = \underline{(3 \times 10^{-7})(450\ 000)}$ ✓

$F_{net} = 0,14$ N

No/*Nee* ✓

$F_{net}(E) >/\neq F_{net}$ ✓

OPTION 3/*OPSIE 3*

$F_{net}(E) = \frac{kQ_XQ_Y}{r^2} - \frac{kQ_XQ_Z}{r^2}$ ✓

$= \frac{(9 \times 10^9)(3 \times 10^{-7})(5 \times 10^{-7})}{(0,05)^2}$ ✓ $- \frac{(9 \times 10^9)(3 \times 10^{-7})(4 \times 10^{-7})}{(0,04)^2}$ ✓

$= 0,14$ N

$0,0427 = 0,14 - f$ ✓

$f = 0,0923$ N ✓

No/*Nee* ✓

1.5 Decrease. ✓

QUESTION 2

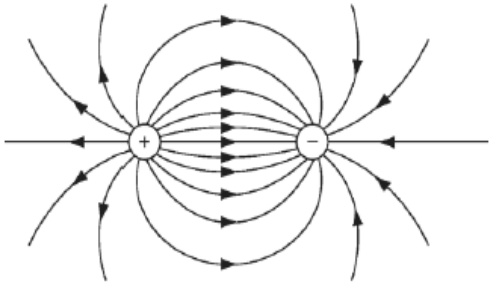
2.1

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

$$= \frac{(9 \times 10^9)(2 \times 10^{-9})}{(0,06)^2} \checkmark$$

$$= 5 \times 10^3 \text{ N·C}^{-1} \checkmark (5\,000 \text{ N·C}^{-1})$$

2.2



2.3 2.3.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the magnitudes of their charges and inversely proportional to square of the distance between them. ✓✓

2.3.2 POSITIVE. ✓

2.3.3

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

✓Both/*Beide*

$$F_{ST} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2} \qquad F_{PT} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$$

$$F_{net} = F_{ST} - F_{PT}$$

$$2,5 \times 10^{-4} \checkmark = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2} \checkmark - \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$$

$$Q_T = 6,25 \times 10^{-9} \text{ C} \checkmark$$

OR/*OF*

$$-F_{net} = F_{PT} - F_{ST}$$

$$-2,5 \times 10^{-4} \checkmark = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2} \checkmark - \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$$

$$Q_T = 6,25 \times 10^{-9} \text{ C} \checkmark$$

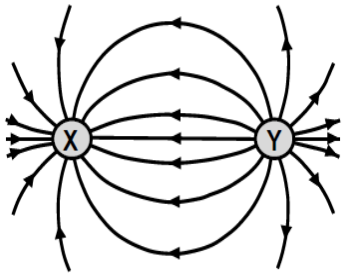
OPTION 2

RIGHT AS POSITIVE/*REGS AS POSITIEF*	LEFT AS POSITIVE/*LINKS AS POSITIEF*
$E = \frac{kQ}{r^2}$	$E = \frac{kQ}{r^2}$
$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓	$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓
$= 45\,000\ N \cdot C^{-1}$	$= 45\,000\ N \cdot C^{-1}$
$E_{net} = E_P - E_S$	$E_{net} = E_S - E_P$
$E_{net} = 5 \times 10^3 - \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓	$= \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓ $- 5 \times 10^3$
$= -4 \times 10^4\ N \cdot C^{-1}$ (40 000)	$= 4 \times 10^4\ N \cdot C^{-1}$
$F = Eq$ ✓	$F = Eq$ ✓
$-2,5 \times 10^{-4} = (-4 \times 10^4)Q_T$ ✓	$2,5 \times 10^{-4} = (4 \times 10^4)Q_T$ ✓
$Q_T = 6,25 \times 10^{-9}$ C ✓	$Q_T = 6,25 \times 10^{-9}$ C ✓

QUESTION 3

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

3.2



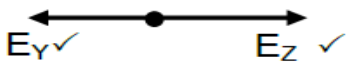
Criteria for graph	
Correct shape.	✓
Correct direction from **Y** to **X**.	✓
Lines must not cross and must touch charges.	✓

3.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\ x\ 10^9)(7.2\ x\ 10^{-9})(7.2\ x\ 10^{-9})}{(0.03)^2}$ ✓

$F = 5,18 \times 10^{-4}$ N ✓ (0,000518 N)

3.4



3.5

OPTION 1/*OPSIE 1*

$E_{net} = E_Z + E_Y$

$= E_Z - E_Y$

$E_{net} = \frac{kQ_z}{r^2} + \frac{kQ_y}{r^2}$ ✓

$4,91 \times 10^5 = \left(\frac{(9 \times 10^9)(Q_z)}{0,01^2}\right) - \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})}{0,03^2}\right)$ ✓ ✓

$Q_Z = 6,25 \times 10^{-9}$ C ✓

3.6

$E = \frac{F}{Q}$ ✓

$4,91 \times 10^5 = \frac{F}{7,2 \times 10^{-9}}$

$F_{net} = 3,54 \times 10^{-3}$ N

$F_{net} = F_{Z\ on\ X} + F_{Y\ on\ X}$

$F_{net} = \left(\frac{kQ_zQ_x}{r^2}\right) + \left(\frac{kQ_YQ_x}{r^2}\right)$

$(3,54 \times 10^{-3})$ ✓ $= \left(\frac{(9 \times 10^9)(7,2 \times 10^{-9})Q_Z}{(0,01)^2}\right)$ ✓ ✓ $- (5,18 \times 10^{-4})$

$Q_Z = 6,26 \times 10^{-9}$ C ✓

QUESTION 4

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

OR

The force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. ✓✓

4.2

OPTION 1/ *OPSIE 1*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

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

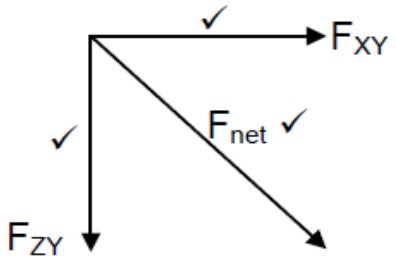
$= 10,8$ N✓

OPTION 2/ *OPSIE 2*

$E = \frac{kQ}{r^2} = \frac{(9 \times 10^9)(8 \times 10^{-6})}{(0,2)^2}$ ✓ $= 1,8 \times 10^4$ N·C^{-1}

$F = Eq = (1,8 \times 10^4)(6 \times 10^{-6})$ ✓ $= 10,8$ N✓

4.3



4.4

OPTION 1 /*OPSIE 1*

$F_{net}^2 = F_{XY}^2 + F_{ZY}^2$

$15,20^2 = 10,8^2 + F_{ZY}^2$

F_{ZY} = 10,696 N

$F_{ZY} = k\frac{Q_Z Q_Y}{r^2}$

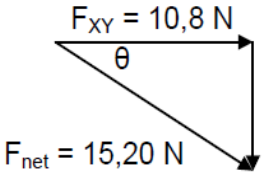
$10,696\checkmark = 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0,30)^2}\checkmark$

Q_Z = 1,34 x 10^{-5} C✓

OPTION 2 /*OPSIE 2*

$\cos\theta = \frac{10,8}{15,2}$

$\theta = 44,72^o$



$\sin 44,72 = \frac{F_{ZY}}{15,2}\checkmark$ **OR/*OF*** $\tan 44,72 = \frac{F_{ZY}}{F_{XY}}$

F_{ZY} = 10,696 N

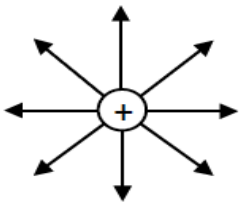
$F_{ZY} = k\frac{Q_Z Q_Y}{r^2}$

$10,696\checkmark = 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0,30)^2}\checkmark$

Q_Z = 1,34 x 10^{-5} C✓

QUESTION 5

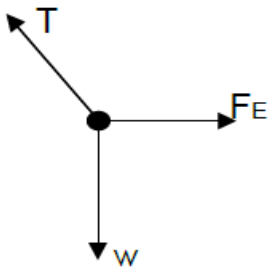
5.1



Criteria for sketch	
Correct shape (straight field lines).	✓
Correct direction away from the charge.	✓✓

5.2 5.2.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes) of the charges and inversely proportional to the square of the distance (r) between them. ✓✓

5.2.2



5.2.3

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

$$= \frac{(9 \times 10^9)(6 \times 10^{-9})(3 \times 10^{-9})}{0{,}03^2} \checkmark$$

$$= 1{,}8 \times 10^{-4}\ N$$

$$w = mg$$

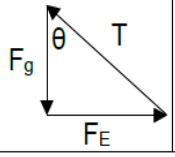
$$= (1{,}5 \times 10^{-4})(9{,}8) \checkmark$$

$$= 1{,}47 \times 10^{-3}\ N$$

$$\tan\theta = \frac{F_E}{mg}$$

$$= \frac{1{,}8 \times 10^{-4}}{1{,}47 \times 10^{-3}} \checkmark$$

$\theta = 6{,}98° \checkmark$



OR/OF

$$T^2 = (F_E)^2 + (F_g)^2$$

$$= (1{,}47 \times 10^{-3})^2 + (1{,}8 \times 10^{-4})^2$$

$$T = 1{,}481 \times 10^{-3}\ N$$

$$\cos\theta = \frac{1{,}47 \times 10^{-3}}{1{,}481 \times 10^{-3}} \checkmark \textbf{ OR/OF } \sin\theta = \frac{1{,}8 \times 10^{-4}}{1{,}481 \times 10^{-3}}$$

$\theta = 6{,}98° \checkmark$

TOPIC 7: ELECTRIC CIRCUITS

QUESTION 1

1.1 Maximum/ Total energy provided / work done by a battery/ cell per unit/ coulomb of charge passing through it. ✓✓

1.2 $R = \frac{V}{I}$ ✓

$0.1 = \frac{V}{120}$ ✓

$V = 12\ V$ ✓

1.3 1.3.1

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*	OPTION 3/*OPSIE 3*
$P = I^2R$ ✓ $15 = I^2(12)$ ✓ $I = 1,12$ A ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13,42$ V $P = VI$ ✓ $15 = (13,42)I$ ✓ $I = 1,12$ A ✓	$P = \frac{V^2}{R}$ $15 = \frac{V^2}{12}$ $V = 13,42$ V $V = IR$ ✓ $13,42 = I(12)$ ✓ $I = 1,12$ A ✓

1.3.2 **POSITIVE MARKING FROM 1.3.1**

$A_1 = (1,12)(2)$
$= 2,24$ A ✓

1.4

OPTION 1/*OPSIE 1*

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

$\boxed{\frac{1}{R_p} = \frac{1}{12} + \frac{1}{12}}$ ✓

$R_p = 6\ \Omega$

$R_p = \frac{R_1R_2}{R_1 + R_2}$

$\boxed{R_p = \frac{(12)(12)}{12 + 12}}$ ✓

$R_p = 6\ \Omega$

When S_1 closed and S_2 open/*Wanneer S_1 gesluit en S_2 oop is*:

$\varepsilon_1 = I(R + r)$ ✓
$= 2,24(6 + r)$ ✓

When S_1 open and S_2 closed/*Wanneer S_1 oop en S_2 gesluit is*:

$\varepsilon_2 = I(R + r)$
$= 120(0,1 + r)$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)
$2,24(6 + r) = 120(0,1 + r)$ ✓
$r = 0,012\ \Omega$

$\varepsilon = I(R + r)$
$= 2,24(6 + 0,012)$
$= 13,46$ V ✓

OR/*OF*

$\varepsilon = IR + Ir$
$= 120(0,1 + 0,012)$
$= 13,47$ V ✓

OPTION 2/*OPSIE 2*

$\varepsilon_1 = IR + Ir$ ✓
$= 12 + 120r$ ✓

$P = \frac{V^2}{R}$
$15 = \frac{V^2}{12}$ ✓
$V = 13{,}42$ V

OR/*OF* $V_p = IR$
$= 2{,}24(6)$ ✓
$= 13{,}44$ V

OR/*OF* $V_P = IR$
$= 1{,}12(12)$ ✓
$= 13{,}44$ V

$\varepsilon_2 = V_{ext} + Ir$
$= 13{,}42 + 2{,}24r$ ✓

$\varepsilon_1 = \varepsilon_2$ (equating)
$12 + 120r = 13{,}42 + 2{,}24r$ ✓
$r = 0{,}012\ \Omega$

$\varepsilon_1 = IR + Ir$
$= 12 + (120)(0{,}012)$
$= 13{,}47$ V ✓

$\varepsilon_2 = IR + Ir$
$= 13{,}42 + (2{,}24)(0{,}012)$
$= 13{,}45$ V ✓

1.5 Decrease. ✓
- Total/External resistance decreases; ✓
- Total current increases; ✓
- $V_{internal}$ increases; ✓
- Voltage across the light bulbs decreases / Vexternal decreases. ✓

QUESTION 2

2.1 The rate at which work is done/dissipated **OR** energy transferred **OR** Work done per unit time ✓

2.2 2.2.1

OPTION 1/*OPSIE 1*

$P = VI$ ✓
$48 = 32\ I$ ✓
$I = 1{,}5$ A ✓

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$
$48 = \frac{32^2}{R}$
$R = 21{,}33\ \Omega$

$P = I^2R$ ✓
$48 = I^2(21{,}33)$ ✓
$I = 1{,}5$ A ✓

$V = IR$ ✓
$32 = I(21{,}33)$ ✓
$I = 1{,}5$ A ✓

2.2.2

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

OPTION 1/*OPSIE 1*

For L_1 / *Vir* L_1
$P = VI$
$36 = 20I$ ✓
$I = 1,8$ A

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$
$36 = \frac{20^2}{R}$
$R = 11,11\ \Omega$

$P = I^2R$
$36 = I^2(11,11)$ ✓
$I = 1,8$ A

$V = IR$
$20 = I(11,11)$ ✓
$I = 1,8$ A

$I_{TOT} = 1,5 + 1,8$ ✓
$= 3,3$ A ✓

2.2.3

OPTION 1/*OPSIE 1*

$V_{R1} + V_{L1} = V_{//}$
$V_{R1} + 20 = 32$
$V_{R1} = 12$ V

$V = IR$ ✓
12 ✓ $= 1,8\ R_1$ ✓
$R_1 = 6,67\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$V = IR$ ✓
$32 = 1,8R$ ✓
$R = 17,77\ \Omega$

$P = \frac{V^2}{R}$
$36 = \frac{20^2}{R}$
$R = 11,11\ \Omega$

$R_1 = 17,77 - 11,11 = 6,67\ \Omega$ ✓

2.2.4

OPTION 1/ *OPSIE 1*

$V_2 = I_{TOT} R_2$
$= 3,3(4)$
$= 13,2$ V

$\varepsilon = V_{ext} + Ir$ ✓
$= (13,2 + 32)$ ✓ $+ 3,3(0,6)$ ✓
$= 47,18$ V ✓
Range/*Gebied*: 47,16 – 47,19 V

OPTION 2/*OPSIE 2*

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

$$\frac{1}{R_p} = \frac{1}{21,33} + \frac{1}{11,11 + 6,67}$$

OR/OF

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

$$= \frac{21,33(11,11 + 6,67)}{21,33 + 11,11 + 6,67}$$

$R_p = 9,69\ \Omega$

$R_{ext} = R_p + Rs$

$R_{ext} = 9,69 + 4$

$= 13,69\ \Omega$

OPTION 3/*OPSIE 3*

$V = IR$

$32 = 3,3R$

$R_p = 9,7\ \Omega$

$R_{ext} = R_p + Rs$

$R_{ext} = 9,69 + 4$

$= 13,69\ \Omega$

$\varepsilon = I(R + r)$ ✓

$= \underline{3,3(13,69)}$ ✓ $+ \underline{3,3(0,6)}$ ✓

$= 47,18$ V ✓

Range/*Gebied*:
47,16 – 47,19 V

2.5

POSITIVE MARKING FROM QUESTION 8.2.1. AND 8.2.4
POSITIEWE NASIEN VANAF VRAAG 8.2.1. EN 8.2.4

NO / NEE ✓ Accept Not glow / Aanvaar Nie gloei nie

$$P = \frac{V^2}{R}$$

$$48 = \frac{32^2}{R}$$ ✓

$R_{L2} = 21,33\ \Omega$

$$R_{L2} = \frac{V}{I}$$

$$= \frac{32}{1,5}$$ ✓

$= 21,33\ \Omega$

$\varepsilon = I(R + r)$ ✓

$\underline{47,18 = I(21,33 + 4 + 0,6)}$ ✓

$I = 1,82$ A ✓

NOTE: If 21,33 Ω already calculated previously award mark
NOTA: *Indien 21,33 Ω alreeds bereken in vorige vraag, ken punt toe*

QUESTION 3

3.1 The potential difference (voltage) across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓

OR

The current in a conductor is directly proportional to the potential difference (voltage) across the conductor if the temperature is constant. ✓✓

OR

The ratio of potential difference to current for a conductor is constant provided the temperature is constant. ✓✓

3.2 3.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
V = IR V = 0,8(13) ✓ = 10,4 V V = IR 10,4 = I_L(9,5) ✓ I_L = 1,09 A ✓	$V_{13} = V_L$ 0,8(13) ✓= I_L(9,5) ✓ I_L = 1,09 A ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$I_{R_L} = I_{R_{13}}\left(\frac{R_{13}}{R_L}\right)$ $I_{R_L} = (0,8)\left(\frac{13}{9,5}\right)$ ✓ ✓ = 1,09 A ✓	$\frac{I_{R13}}{22,5}(9,5) = 0,8$ ✓ I_{R13} = 1,89 A I_L = 1,89 – 0,8 ✓ = 1,09 A ✓

3.2.2

OPTION /*OPSIE 1*

$V_p = V_{9\Omega}$
10,4✓= $I_{9\Omega}$(9) ✓
$I_{9\Omega}$ = 1,16 A

OR/*OF*

$V_p = V_{9\Omega}$
$I_1 R_{13} = I_{9\Omega}R_{9\Omega}$
(0,8)(13) ✓= $I_{9\Omega}$(9) ✓
$I_{9\Omega}$ = 1,16 A

OPTION 2/*OPSIE 2*

$I_{R_{9\Omega}} = I_{R_{13}}\left(\frac{R_{13}}{R_9}\right)$ ✓
$I_{R_{9\Omega}} = (0,8)\left(\frac{13}{9}\right)$ ✓
= 1,16 A

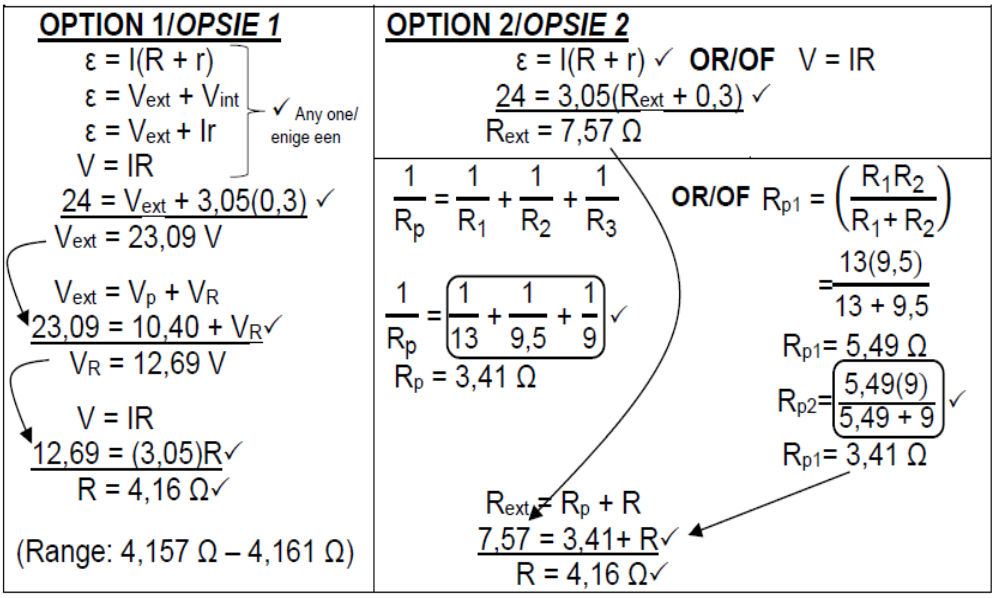
$I_{total} = I_{13\Omega} + I_L + I_{9\Omega\,I}$
= 0,8 + 1,09 +1,16 ✓
= 3,05 A ✓

OPTION 3/*OPSIE 3*

V = IR
V = 0,8(13) ✓
= 10,4 V
$V_p = V_9$
10,4 = I(9) ✓
I = 1,156 A

$R_{p1} = \left(\frac{R_1R_2}{R_1+R_2}\right) = \frac{13(9,5)}{13+9,5}$
R_{p1}= 5,49 Ω
V = IR
10,4 = I(5,49)
I = 1,89 A
I_{total} = 1,156 + 1,89 ✓ = 3,05 A ✓

3.2.3



3.3 Decreases. ✓

The total/external resistance increases. ✓

3.4 Increases. ✓

- V_R / IR decreases ✓ thus
- V_{Lost} / Ir decreases AND V_L increases ✓ (and emf stays constant);
- R_L constant AND P α V^2 / P = $\frac{V^2}{R}$ ✓ therefore L is brighter;

OR

- R_L constant AND I_L increases AND P α I^2 / P = I^2R therefore L is brighter;

3.5 C ✓ D ✓ and F✓ **OR** A_1, A_2 and $V_{9\Omega}$.

QUESTION 4

4.1 The battery supplies 12 J per coulomb/12 J per unit charge. ✓✓

OR

The potential difference of the battery in an open circuit is 12 V. ✓✓

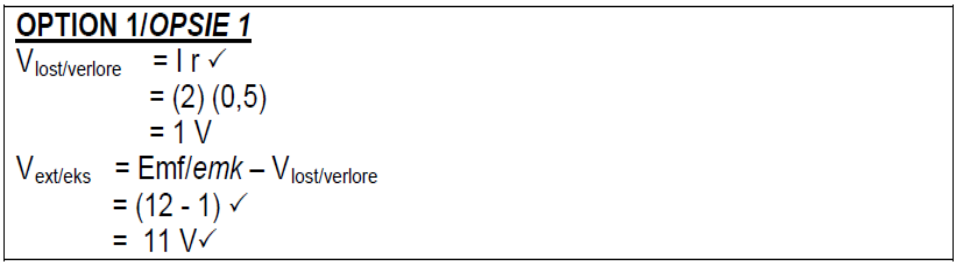
OR

The battery does 12 J of work per coulomb of charge. ✓✓

OR

Maximum work done by the battery per unit charge is 12 J. ✓✓

4.2 4.2 1



OPTION 2/*OPSIE 2*

$\varepsilon = I(R + r)$ ✓

$12 = V_{ext/eks} + (2)(0,5)$ ✓

$V_{ext/eks} = 11$ V✓

OPTION 3/*OPSIE 3*

$\varepsilon = I(R + r)$ ✓

$12 = 2(R + 0,5)$

$R = 5,5\ \Omega$

$V = IR$

$= 2(5,5)$✓

$= 11$ V ✓

4.2.2 **OPTION 1**

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

$R = \frac{11}{2}$ ✓

$R = 5.5\ \Omega$ ✓

OPTION 2

$\mathcal{E} = I(R + r)$

$12 = 2(R + 0,5)$ ✓

$R = 5,5\ \Omega$ ✓

4.3 Decreases. ✓

Total resistance decreases; ✓

Current increases; ✓

"Lost volts" increases, ✓ (emf the same)

External potential difference decreases.

OR

Decreases; ✓

Total resistance decreases; ✓

Current increases; ✓

$\mathcal{E} = V_{ext} + Ir$;

Ir increases; ✓

$\mathcal{E}$ is constant;

$\therefore V_{ext}$ decreases.

QUESTION 5

5.1 5.1.1 From graph: $\frac{R}{V}$ ✓

From equation: $\frac{r}{\mathcal{E}}$ ✓

5.1.2 $\frac{1}{\mathcal{E}} = 0.65$ ✓

$\therefore \mathcal{E} = 1,54$ V ✓

5.1.3 $\frac{r}{\mathcal{E}} = \frac{2-1}{4-1}$ ✓✓

$\therefore r = 0,51\ \Omega$ ✓

5.2 5.2.1 Emf = I(R + r) ✓

6 = I(9 + 1) ✓

∴I = 0,6 A ✓

5.2.2 $P = I^2R$ ✓

$1,8 = (0,6)^2R_1$ ✓

$R_1 = 5\ \Omega$ ✓

$R_p = 9 - 5 = 4\ \Omega$ ✓

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

$$\frac{1}{4} = \frac{1}{R_2} + \frac{1}{4R_2}$$ ✓

$\therefore R_2 = 5\ \Omega$ ✓

5.3 $W = VI\Delta t$ ✓

$W = (240)(9,5)(12)(60)$ ✓

$W = 1,64 \times 10^6$ J ✓

$$\text{Cost} = \frac{1.64 \times 10^6}{3.6 \times 10^6} \times 1.47$$ ✓

Cost = R0.67 ✓

TOPIC 8: ELECTRODYNAMICS

QUESTION 1

1.1 The AC potential difference /voltage that produces/dissipates the same amount of energy as an equivalent DC potential difference/voltage. ✓✓

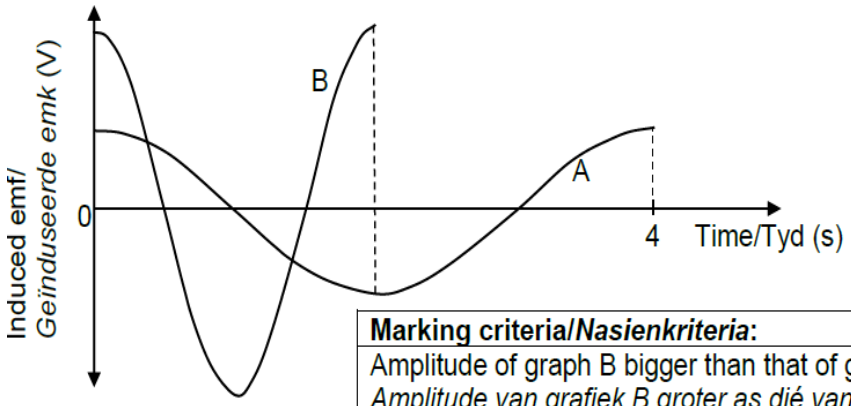
1.2 N/North. ✓

1.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW cost = PΔt × tariff $= \underline{0,80659(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{219,99^2}{60}$ ✓ $= 806,59$ W $= 0,80659$ kW $E = P\Delta t$ $= \underline{0,80659(1,5)}$ $= 1,21$ kWh cost = E × tariff $= \underline{1,21(3,33)}$ = R4,03 ✓ ✓ for both/*beide*

OPTION 3/*OPSIE 3*	OPTION 4/*OPSIE 4*
$P_{ave} = V_{rms}I_{rms}$ ✓ $= \left(\frac{311,11}{\sqrt{2}}\right)$ ✓ $\left(\frac{220}{60}\right)$ ✓ $= 806,67$ W $= 0,8067$ kW cost = PΔt x tariff $= \underline{0,8067(1,5)(3,33)}$ ✓ = R4,03 ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ $= \frac{311,11}{\sqrt{2}}$ ✓ $= 219,99$ V $W = \frac{V^2}{R}\Delta t$ ✓ $= \frac{(219,99)^2}{60}(1,5)(10^{-3})$ ✓ = 1,21 kWh Cost = E x tariff $= \underline{(1,21)(3,33)}$ ✓ = R4,03 ✓

1.4



Marking criteria/*Nasienkriteria*:	
Amplitude of graph B bigger than that of graph A *Amplitude van grafiek B groter as dié van A*	✓
Period of B is half of A/*Periode van B helfte van A*	✓
Correct shape and one cycle(Cosine graph)/ *Vorm en een siklus(cos-grafiek)*	✓

1.5 By replacing slip rings with split ring commutator / split ring / commutator. ✓

QUESTION 2

2.1 2.1.1 Split ring/commutator. ✓

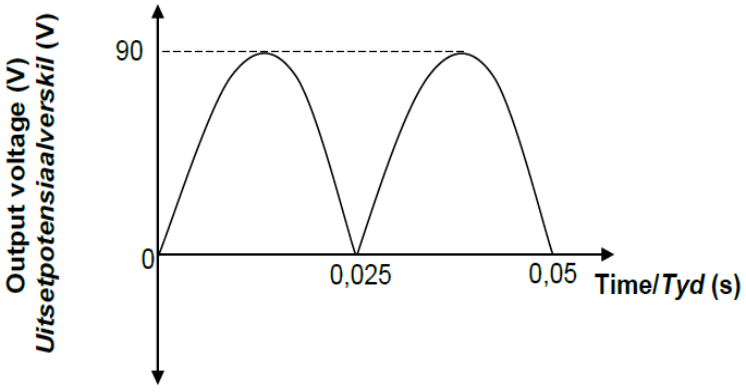
2.1.2 Y to X. ✓

2.1.3 $T = \frac{1}{f}$

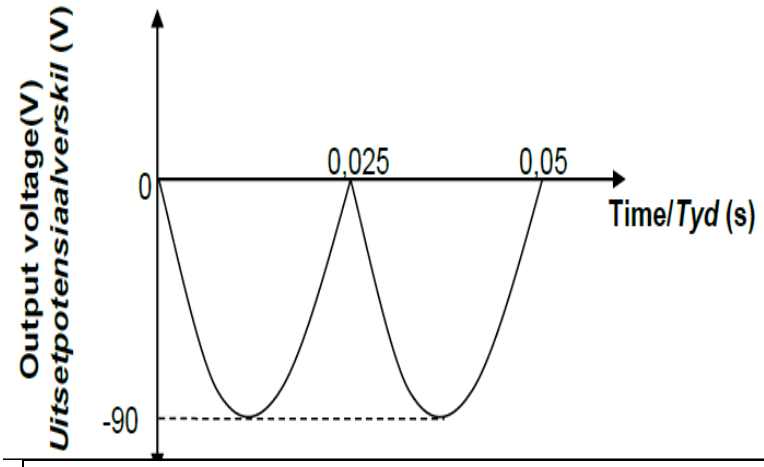
$T = \frac{1}{20}$

$T = 0.05$ s ✓

2.1.4



OR



Criteria for graph	
Correct shape with one full cycle.	✓
Curve starts at zero to first peak.	✓
Any one of the correct time values at the correct position.	✓
Maximum voltage of 90 V OR -90 V	✓

OPTION 1/*OPSIE 1*

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

$$= \frac{220^2 (120)}{32} \checkmark \checkmark$$

$$= 181\ 500\ J \checkmark$$

OPTION 2/*OPSIE 2*

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

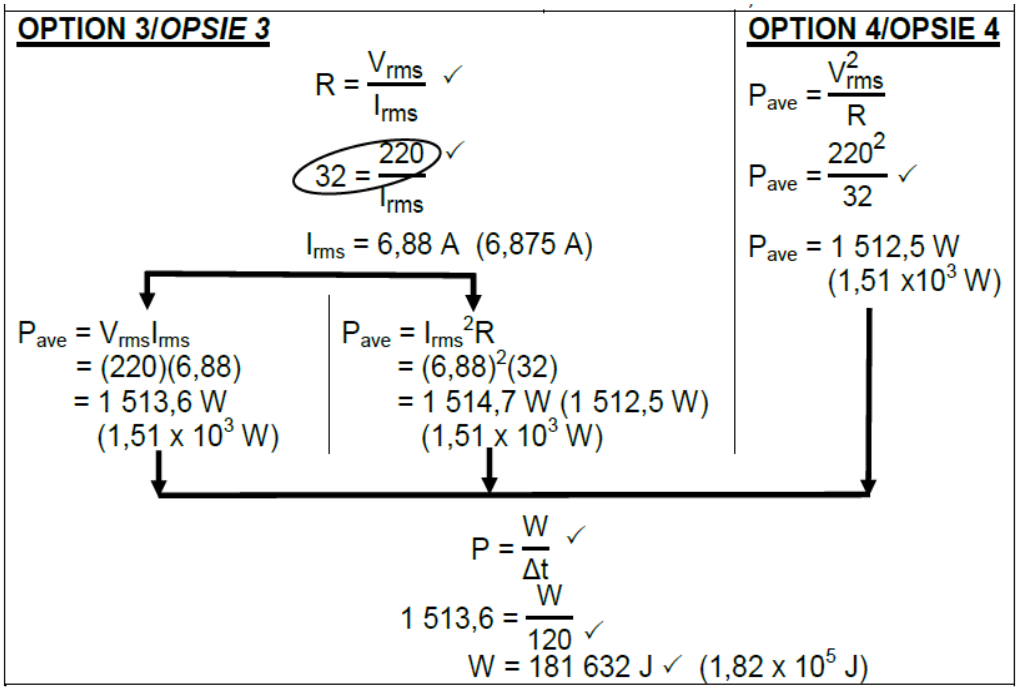
$$32 = \frac{220}{I_{rms}}$$

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

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

OR/*OF*

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



QUESTION 3

3.1 DC (generator). ✓

3.2 Mechanical/Kinetic to Electrical. ✓

3.3 Power / Energy / Voltage loss cannot be reduced / will be too large. ✓

OR

I (current) cannot be made smaller.

Accept:

Transformers do not use DC / Cannot be stepped-up or down.

3.4 $T = \frac{1}{f} = \frac{1}{0.02}$ ✓ = 50 Hz ✓

3.5 Root-mean-square current is the alternating current that dissipates the same amount of energy as an equivalent DC current.

3.6 $I_{rms} = \frac{I_{rms}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{1.2}{\sqrt{2}}$ ✓

I_{rms} = 0.85 A ✓

3.7 Speed of rotation halved; ✓✓

Accept: Frequency was halved / Period was doubled;

QUESTION 4

4.1 4.1.1 (DC) motor. ✓

4.1.2 Electrical to mechanical /kinetic (energy). ✓✓

4.1.3 Split ring/commutator. ✓

4.1.4 Anticlockwise. ✓

4.2 4.2.1 (The rms voltage/value of AC is) the AC voltage/potential difference which dissipates the same amount of energy/ heat/power as an equivalent DC voltage/potential difference. ✓✓

ACCEPT
The rms voltage/value of AC is the DC potential difference which dissipates the same amount of energy/heat/power as AC.

4.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $200 = \frac{220^2}{R}$ ✓ $R = 242\ \Omega$ ✓	$P_{ave} = V_{rms}I_{rms}$ ✓ $200 = I_{rms}(220)$ $I_{rms} = 0,909\ A\ (0,91)$ $R = \frac{V_{rms}}{I_{rms}}$ or/*of* $R = \frac{V}{I}$ $R = \frac{220}{0,909}$ ✓ $R = 242\ \Omega$ ✓ (241,76 Ω)	$P_{ave} = V_{rms}I_{rms}$ ✓ $200 = I_{rms}(220)$ $I_{rms} = 0,909\ A(0,91)$ $P_{ave} = I_{rms}^2R$ $200 = (0,909)^2R$ ✓ $R = 242\ \Omega$ ✓ (241,52 Ω)

4.2.3

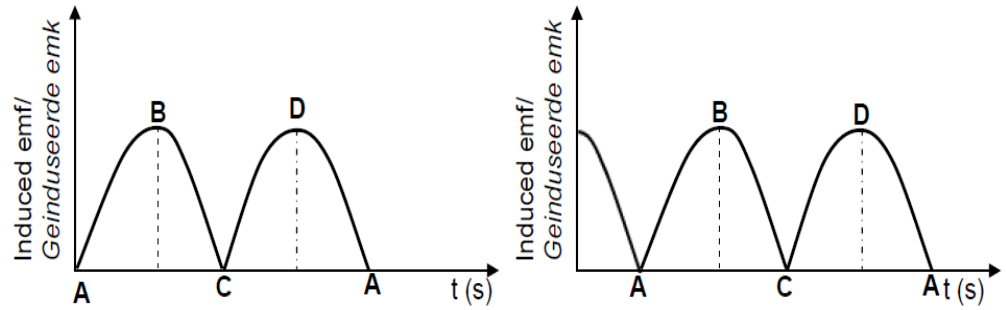
OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***	**OPTION 4/*OPSIE 4***
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{150^2}{242}$ ✓ $P_{av} = 92,975\ W$ $P = \frac{W}{\Delta t}$ ✓ $92,975 = \frac{W}{(10)(60)}$ ✓ $W = 55\ 785,12\ J$ ✓ (55785,12 – 55896 J)	$R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$ $242 = \frac{150}{I_{rms}}$ ✓ $I_{rms} = 0,620\ A$ $P_{ave} = I_{rms}V_{rms}$ $= (0,62)(150)$ $= 92,97\ W\ (93\ W)$ $P = \frac{W}{\Delta t}$ ✓ $92,975 = \frac{W}{(10)(60)}$ ✓ $W = 55\ 785,12\ J$ ✓ (55785,12 – 55896 J)	$R = \frac{V_{rms}}{I_{rms}}$ ✓/ $R = \frac{V}{I}$ $242 = \frac{150}{I_{rms}}$ ✓ $I_{rms} = 0,620\ A$ $W = I^2R\Delta t$ ✓ $= (0,62)^2(242)(10)(60)$ ✓ $= 55\ 814,88\ J$ ✓ (55785,12 – 55896 J) **OR/*OF*** $W = VI\Delta t$ $= (150)(0,62)(600)$ $= 55\ 800\ J$

OPTION 5/*OPSIE 5*
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{150^2}{242}$ ✓ $= 92,975\ W$ $P_{ave} = I_{rms}^2R$ $92,975 = I_{rms}^2(242)$ $I_{rms} = 0,6198\ A$ $W = I^2R\Delta t$ ✓ $= (0,6198)^2(242)(10)(60)$ ✓ $= 55\ 778,88\ J$ ✓

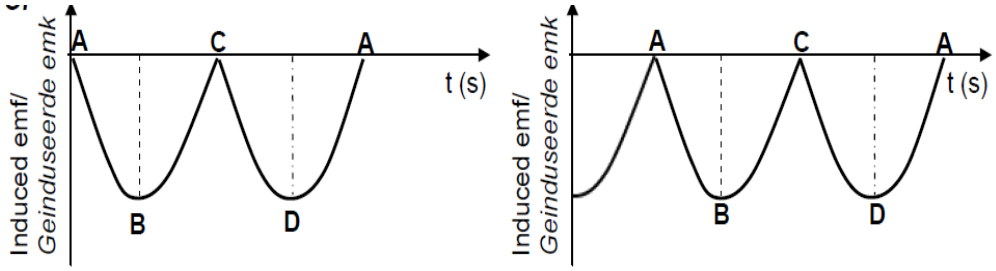
QUESTION 5

5.1 5.1.1 Mechanical to electrical. ✓

5.1.2



OR



Criteria for graph	
Correct DC shape, starting from zero.	✓
Positions ABCDA correctly indicated on the graph.	✓

5.2 5.2.1 20,5 Ω. ✓

5.2.2

OPTION 1/*OPSIE 1*

$I_{rms} = \frac{V_{rms}}{R} \checkmark = \frac{25}{20,5} \checkmark$

$= 1,22\ (1,2195)\ A$

$P_{ave} = I_{rms}^2 R$ $=(1,22)^2(0,5)$ $= 0,74\ W$ $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $P_{ave} = \frac{(25)^2}{20,5}$ ✓ $P_{ave} = 30,49\ W$ Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)* $= (30,49 - 0,74)$ $= 29,75\ W$✓	$P_{ave} = I_{rms}^2 R$✓ $= (1,22)^2(20)$ ✓ $= 29,77\ W$✓ **OR/OF** $V_{rms/wgk\ device/toestel} = \frac{20}{20,5}$ ✓ $\times 25 = 24,39\ V$ $P_{ave} = V_{rms} I_{rms}$ ✓ $= (24,39)(1,22)$ $= 29,76\ W$ ✓	$W = I^2_{rms}\ R\Delta t$ $= (1,22)^2\ (0,5)(1)$ $= 0,74\ J$ $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $P_{ave} = \frac{(25)^2}{20,5}$ ✓ $P_{ave} = 30,49\ W$ Actual energy delivered per second(power) / *Energie aan toestel gelewer per sekonde (drywing)* $= (30,49 - 0,74)$ $= 29,75\ W$✓

OPTION 2/*OPSIE 2*

$V_{rms/wgk\ device/toestel} = \frac{20}{20,5} \checkmark \times 25 = 24,39\ V$

$P_{ave} = \frac{V_{rms}^2 \checkmark}{R} = \frac{(24,39)^2 \checkmark}{20 \checkmark} = 29,74\ W \checkmark$

TOPIC 9: PHOTOELECTRIC EFFECT

QUESTION 1

1.1 1.1.1 Minimum energy needed for the electrons to be emitted from the metal surface. ✓✓

1.1.2 $1,045 \times 10^{15}$ Hz. ✓

1.1.3 Greater than. ✓

- The maximum kinetic energy of electrons from sodium is smaller. ✓
- E is constant / same frequency used / same light used ($E_{K(max)}$ is smaller; W_0 is larger). ✓

1.1.4 No. ✓

- The intensity of light does not have any effect on the ejection of electrons for metal **M**. ✓

OR

- The frequency of light has not changed / Energy of a photon has not changed.

1.2 1.2.1

OPTION 1/*OPSIE 1*

$E = hf$ ✓

$5,7 \times 10^{-19} - 1,3 \times 10^{-19}$ ✓ $= (6,63 \times 10^{-34})f$ ✓

$f = 6,64 \times 10^{14}$ Hz ✓

Accept $E_3 - E_1$ OR $E_1 - E_3$ in all options
***Aanvaar*: $E_3 - E_1$ OF $E_1 - E_3$ in alle opsies**

OPTION 2/*OPSIE 2*

$\Delta E = E_1 - E_3$

$= 1,3 \times 10^{-19} - 5,7 \times 10^{-19}$ ✓

$= -4,4 \times 10^{-19}$

$E = hf$ ✓

$4,4 \times 10^{-19} = (6,63 \times 10^{-34})f$ ✓

$f = 6,64 \times 10^{14}$ Hz ✓

f must be positive/ *f moet positief wees*

(4)

1.2.2 No. ✓

The energy does not correspond to any transition in this atom. ✓

QUESTION 2

2.1 The process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident/shining on that surface. ✓✓

2.2 2.2.1 Green. ✓

2.2.2 Only green and blue light eject electrons / red light does not eject electrons. ✓ Green has a lower frequency than blue / Green has longer wavelength than blue / Photons of blue light has more energy than photons of green light ✓ and therefore ejects electrons with the lower kinetic energy. ✓

2.2.3

OPTION 1/*OPSIE 1*

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

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $= W_0 + 2,65 \times 10^{-20}$ ✓
$W_0 = 3,61 \times 10^{-19}$ J

$hf = W_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = 3,61 \times 10^{-19} + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓

OPTION 2/*OPSIE 2*

$E = W_0 + E_{k(max)}$
$hf_1 - E_{k(max)1} = hf_2 - E_{k(max)2}$ } ✓ Any one/ *Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $- 2,65 \times 10^{-20}$ ✓ $= (6,63 \times 10^{-34})f_2 - 6,96 \times 10^{-20}$ ✓
$f_2 = 6,5 \times 10^{14}$ Hz ✓

OPTION 3/*OPSIE 3*

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$ ✓ $= 6,63 \times 10^{-34} f_0 + 2,65 \times 10^{-20}$ ✓
$f_0 = 5,45 \times 10^{14}$ Hz

$hf = hf_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = (6,63 \times 10^{-34})(5,45 \times 10^{14}) + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓

2.2.4 Remains the same.

2.3 2.3.1 (Line) emission spectrum.

2.3.2 Coloured lines represent (associated) frequencies/wavelengths/energy of the emitted (photons) ✓ when atoms / electrons move to a lower energy level. ✓

QUESTION 3

3.1 3.1.1 The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓

3.1.2

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*

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

✓ both/*beide*

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

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

3.1.3

OPTION 1/*OPSIE 1*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

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

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

OPTION 2/*OPSIE 2*

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

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

$E = 4\,860\,000$ N·C^{-1} $(4{,}86 \times 10^{6})$

$E = \frac{F}{q}$ ✓

$4860000 = \frac{0{,}027}{q}$ ✓

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

OPTION 3/*OPSIE 3*

$E = \frac{F}{q}$

$= \frac{0{,}027}{5{,}4 \times 10^{-6}}$ ✓

$= 5\,000$ N·C^{-1} (5×10^{3})

$E = \frac{kQ}{r^2}$ ✓

$5000 = \frac{(9 \times 10^{9})Q_B}{0{,}1^2}$ ✓

$Q_B = 5{,}56 \times 10^{-9}$ 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* = $n = 3{,}47 \times 10^{10}$ ✓ $(3{,}475 \times 10^{10})$

3.2 3.2.1 (Line) Absorption. ✓

3.2.2 Continuous spectrum of white light/rainbow of colours ✓ with dark/black lines ✓ (replacing specific frequencies).

3.2.3 Diagram **B**. ✓

QUESTION 4

4.1 The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓

4.2 1. ✓✓

4.3 4.3.1

$$E_{k(max)} = \frac{1}{2}mv_{max}^2 \checkmark$$

$$2,99 \times 10^{-19} = \tfrac{1}{2}(9,11 \times 10^{-31})v_{max}^2 \checkmark$$

$$v_{max} = 8,10 \times 10^{5}\ m{\cdot}s^{-1} \checkmark$$

4.3.2

OPTION 1/*OPSIE 1*

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

$= 3,68 \times 10^{-19}$ ✓ $+ 2,99 \times 10^{-19}$ ✓

$E = 6,67 \times 10^{-19}$ (J) ✓

OPTION 2/*OPSIE 2*

$\text{gradient} = \frac{\Delta E_{k(max)}}{\Delta E}$ ✓

$1 = \frac{2,99 \times 10^{-19} - 0}{Y - 3,68 \times 10^{-19}}$ ✓ ✓

$Y = 6,67 \times 10^{-19}$ ✓

4.4 Remains the same. ✓

The energy of the incident photons is not changing. ✓

OR

(Kinetic energy is affected by/depends on the frequency of the photons and) the frequency remains the same.

QUESTION 5

5.1 The process whereby electrons are ejected from a metal / surface when light (of suitable frequency) is incident on that surface. ✓✓

5.2 $7,48 \times 10^{-19}$ (J). ✓

$E = W_o + E_{k(max)}$ $(= W_o + \frac{1}{2}mv_{max}^2)$ ✓

When $E_{k(max)} = 0$ / $v = 0$ / $v^2 = 0$ / $E = W_o$ / W_o is the y-intercept / is y. ✓

5.3 Mass (of photo-electron)/ m. ✓

ACCEPT:

½m

5.4

OPTION 1/*OPSIE 1*

Gradient = ½m

$$\frac{11{,}98 \times 10^{-19} \checkmark - 7{,}48 \times 10^{-19} \checkmark}{X - 0 \checkmark} = \tfrac{1}{2}(9{,}11 \times 10^{-31}) \checkmark$$

$X = 0{,}9879$ ✓ (0,99 or 0,988)

ACCEPT/*AANVAAR*

$X = 0{,}9879 \times 10^{12}\ (m^2 \cdot s^{-2})$

OPTION 2/ *OPSIE 2*

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

$11{,}98 \times 10^{-19}$ ✓ $= 7{,}48 \times 10^{-19}$✓ $+ \tfrac{1}{2}(9{,}11 \times 10^{-31})\ v^2$✓ [or/*of* $\tfrac{1}{2}(9{,}11 \times 10^{-31})X$]

$4{,}5 \times 10^{-19} = 4{,}56 \times 10^{-31}v^2$

$v^2 = 0{,}9868 \times 10^{12}$

$X/v^2 = 0{,}9868$ ✓ (0,99)

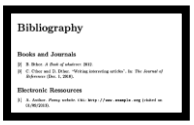
Range/*gebied* $(0{,}9868 - 0{,}9879 / 9{,}87 \times 10^{11} - 9{,}88 \times 10^{11})$

ACCEPT/*AANVAAR:*

$X = 0{,}9868 \times 10^{12}\ (m^2 \cdot s^{-2}) / 9{,}868 \times 10^{11}\ (m^2 \cdot s^{-2})$

5.5 5.5.1 Remains the same. ✓

5.5.2 Increases. ✓


Bibliography

Books and Journals

Electronic Resources

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3	November 2024;
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5	November 2022;
6	November 2020;
7	November 2019;
8	November 2018;
9	November 2017;
10	November 2015;
11	Exemplar 2014;
12	June 2025;
13	June 2024;
14	June 2023;
15	June 2021;
16	FS. September 2023.