HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 1- Physics memo

TRIALS 2023
TIME: 3 HRS

Total 150

SECTION A
QUESTION 1: MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only one correct answer. Write only the letter (A-D) next to the question number (1.1-1.10) in the answer book.

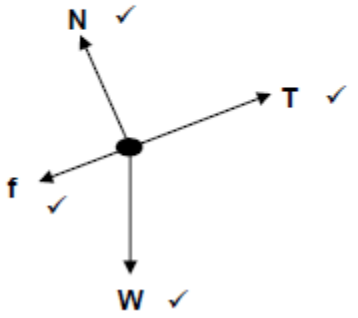
1.1 A
1.2 C
1.3 D
1.4 C
1.5 B
1.6 C
1.7 A
1.8 B
1.9 D
1.10 A
1.10 A

Section B

Question 2 – newton

2.1.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at <u>acceleration directly proportional to the force</u> and <u>inversely proportional to the mass</u> of the object. ✓✓ (2)

2.2



2.3 $f_k = \mu_k N$ ✓

$f_k = \mu_k . mg\cos\theta$

$f_k = (0,24) \times (8)(9,8)\cos 40^\circ$ ✓

$f_k = 14,41$ N ✓ (3)

2.4 Positive marking from question 2.3

For block P

$F_{net} = ma$ ✓

$T - f_k - W_{\parallel} = ma$

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

Positive marking from question 2.3

$T - \boxed{14,41} - (8)(9,8)\sin 40^\circ = 8a$ ✓

$T - 14,41 - 50,39 = 8a$

$T - 64,8 = 8a$

$T = 8a + 64,8$ .....(1)

For block Q

$F_{net} = ma$

$W - T = ma$

$mg - T = ma$

$(12)(9,8) - T = 12a$ ✓

$117,6 - T = 12a$

$117,6 - 12a = T$ .....(2)

$8a + 64,8 = 117,6 - 12a$ ✓

$20a = 52,8$

$a = 2,64$ m.s^{-2} ✓

Substitute back into (1)

$T = 8(2,64) + 64,8$ ✓

$T = 85,92$ N ✓

OR

Substitute back into (2)

$117,6 - 12(2,64) = T$ ✓

$T = 85,92$ N ✓

(7)

Question 3 – VPM

3.1 An object that has been given an initial velocity and then it moves under the influence of the gravitational force only. ✓✓ (2)

3.2

Upward is positive

Ball Y	**Ball X**
$\Delta y_1 = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $= 20t + \frac{1}{2}(-9.8) \Delta t^2$ $= 20t - 4.9 t^2$.....(1) ✓ Now, $20t - 4.9 t^2 = -4.9t^2 + 50$ ✓ $20t = 50$ $t = 2.5$ s✓	$\Delta y_2 = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $-(50 - \Delta y_1) = (0)(\Delta t) + \frac{1}{2}(-9.8) \Delta t^2$ $\Delta y_1 = -4.9t^2 + 50$.....(2) ✓

Remember that one object is moving up so +x and the other is moving downwards, so -x. **However** they don't meet after moving the same distance, thus we made ball x move -(50 – x)

Upward is negative

Ball Y	**Ball X**
$\Delta y_1 = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $-\Delta y_1 = -20t + \frac{1}{2}(9.8) \Delta t^2$ $\Delta y_1 = 20t - 4.9 t^2$.....(1) ✓ Solving (1) and (2): $20t = 50$ ✓ $t = 2.5$ s✓	$\Delta y_2 = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $(50 - \Delta y_1) = (0)(\Delta t) + \frac{1}{2}(9.8) \Delta t^2$ $\Delta y_1 = -4.9t^2 + 50$.....(2) ✓

OPTION 2

The balls are approaching each other (relative velocity increases)

$(v_x + v_y) = \frac{\Delta x}{\Delta t}$ ✓

$(0$✓ $+ 20$✓$) = \frac{50}{\Delta t}$ ✓

$\Delta t = 2.5$ s ✓

(5)

3.3

OPTION 1

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= (20)(2.5)$ ✓ $+ \frac{1}{2}(-9.8)(2.5)^2$✓
$= 19.375$ m
$h = 19.375$ m✓

OPTION 2

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$✓
$= \underline{(0)(2.5) + \frac{1}{2}(-9.8)(2.5)^2}$✓
$= -30.625$
$h = 50 -$✓ 30.625
$= 19.375$ m✓

OPTION 3

Ball X

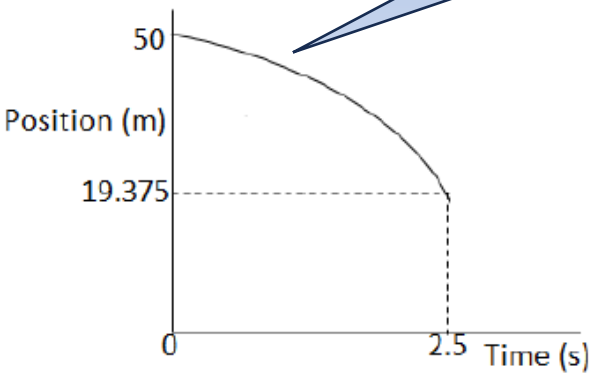
$v_f = v_i + a\Delta t$
$= 0 + (-9.8)(2.5)$ ✓
$v_f = -24.50$ m.s^{-1}

E_m at top = E_m at meeting point
$(mgh + \frac{1}{2}mv^2)_{\text{at top}} = mgh + \frac{1}{2}mv^2)_{\text{at meeting point}}$✓
$m(9.8)(50) + 0 = m(9.8)\Delta y + \frac{1}{2}m(-24.50)^2$✓
$\Delta y = 19.375$ m
$h = 19.375$ m✓

4)

3.4 **Mark positively from 3.2 and 3.3**

OPTION 1 (downward is positive)

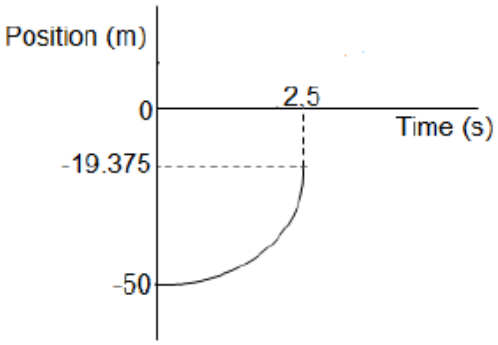


Careful here – they only want you to draw the graph until the objects **meet**

Criteria

- Shape✓
- Starts at 50 m✓
- Ends at 2.5 s✓
- Ends at 19.375m✓

OPTION 2 (downward is negative)



Criteria

- Shape✓
- Starts at -50 m✓
- Ends at 2.5 s✓
- Ends at -19.375m✓

(4)

Question 4 – momentum and impulse

QUESTION/*VRAAG* 4		
4.1	The <u>total linear momentum</u> of a <u>closed/isolated system remains constant</u> (is conserved). ✓✓ *Die <u>totale lineêre momentum</u> in 'n <u>geslote/geïsolleerde sisteem bly konstant</u> (is behou).* ✓✓	If any of the underlined key words/phrases in the correct context are omitted: -1 mark per word/phrase./ *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 punt per woord/frase.* (2)
4.2.1	$p = m \times v_f$ ✓ $-144 = 900 \times v_f$ ✓ $v_f = 0{,}160\ m.s^{-1}$ ✓ West/left/*Wes /links*✓	✓ Formula/*Formule* ✓ Substitution/*Vervanging* ✓ Answer with units/*Antwoord met eenhede* ✓ Direction – West/left/*Rigting – Wes/links* (4)

	ANSWER/*ANTWOORD*	Marking Guidelines/*Nasienriglyne*
4.2.2	**OPTION/*OPSIE* 1:** $F\Delta t = \Delta p$ = -144 - (18 000) ✓ = - 18 144 kg.m.s^{-1} = 18 144 N.s ✓West/towards the car/*Wes/in die rigting van die motor*✓ **OR/*OF*** **OPTION/*OPSIE* 2:** $F\Delta t = \Delta p$ = 18144 - 0 = 18 144 kg.m.s^{-1}/ = 18 144 N.s West/towards the car/*Wes/in die rigting van die motor* **OR/*OF*** **OPTION/*OPSIE* 3:** $F\Delta t = \Delta p$ = (900 x (-0,16) - (900 x 20) ✓ = - 18 144 kg.m.s^{-1} = 18 144 N.s ✓West/towards the car/*Wes/in die rigting van die motor* ✓ **OR/*OF*** **OPTION/*OPSIE* 4:** $F\Delta t = \Delta p$ = (3 200 x (5,67) - 0 ✓ = - 18 144 kg.m.s^{-1} = 18 144 N.s ✓West/towards the car/*Wes/in die rigting van die motor* ✓	✓ Formula/*Formule* ✓ Substitution/*Vervanging* ✓ Answer must be positive/ *Antwoord moet positief wees* ✓ The direction of the impulse (West/towards the car)/*Die rigting van die impuls (Wes/in die rigting van die motor)* (4)

4.3

First calculate the vi of the car:

p = m.v

18 000 = 900.vi

vi = 20m.s^{-1}

$\sum E_{ki}$ = E_{ki} car + E_{ki} barrier/*versperring* = ½ mv_i^2 + ½ mv_i^2 ✓ any one/ *enige een* = ½ x 900 x 20^2 + 0 ✓ = 180 000 J $\sum E_{kf}$ = E_{kf} car/*motor* + E_{kf} barrier/ *versperring* = ½ mv_f^2 + ½ mv_f^2 = ½ x 900 x $0,16^2$ ✓ + ½ 3200 x $5,67^2$✓ = 11,52 + 51438,24 = 51449,76J ∴ $\sum E_{ki} \neq \sum E_{kf}$ inelastic collision/*onelastiese botsing*. ✓	✓ Formula/*Formule* ✓ Substitution - initial/ *Vervanging - aanvanklik* ✓✓ Substitution/*Vervanging* ✓ $\sum E_{ki} \neq \sum E_{kf}$ **NOTE**: Final mark can only be given if rest of the question was answered correctly./ *Finale punt kan net toegeken word as die res van die vraag korrek beantwoord is.* (5)
	[15]

Question 5 – W, P and E

5.1 The total mechanical energy in an isolated (closed) system ✓ remains constant (is conserved). ✓ (2)

NOTE
If any of the underlined key words in the **correct context** is omitted deduct 1 mark.

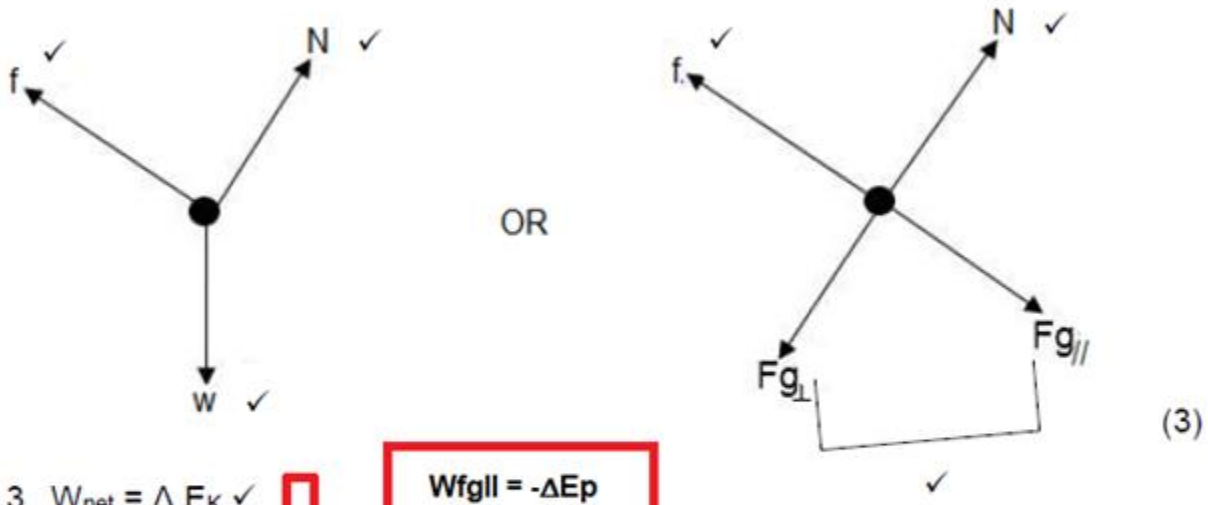
5.2

OPTION 1
E_{mech} at P = E_{mech} at Q ✓
$(mgh + \frac{1}{2}mv^2)P = (mgh + \frac{1}{2}mv^2)Q$
$4[(9,8)(3) + \frac{1}{2}(0)^2]$ ✓ = $4[(9,8)(1,25) + \frac{1}{2}v^2]$ ✓
$v = 5,86\ m \cdot s^{-1}$ ✓
(4)

OPTION 2
E_{mech} at P = E_{mech} at Q ✓
$(mgh + \frac{1}{2}mv^2)P = (mgh + \frac{1}{2}mv^2)Q$
$4[(9,8)(1,75) + \frac{1}{2}(0)^2]$ ✓ = $4[(9,8)(0) + \frac{1}{2}v^2]$ ✓
$v = 5,86\ m \bullet s^{-1}$ ✓ (4)

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

5.3.2



(3)

5.3.3 $W_{net} = \Delta E_K$ ✓
$W_{net} = 0$
$W_f + W_g = 0$
$f\Delta x \cos\Theta + -\Delta Ep = 0$

Wfgll = -ΔEp

$(15)(X)\cos 180°$ ✓ $+ (4)(9,8)(1,25)\cos 0°$ ✓ $= 0$ ✓
$X = 3,267\ m$ ✓ (5)

$W_{net} = \Delta E_{lc}$ ✓

$W_f + W_{Fg_{//}} = \Delta E_{lc}$

$[F_f . \Delta x . \cos\theta] + [-\Delta E_p] = \Delta E_{lc}$

$[15(\Delta x).\cos 180^\circ] - [mgh_f - mgh_i] = 0$

$[15\,\Delta x\,(\cos 180^\circ)] - [0 - 4(9,8)(1,25)] = 0$ ✓

$\Delta x = 3,27\ m$ ✓ (5)

(a)

$W_{nc} = \Delta E_{lc} + \Delta E_p$ ✓

$mgh + \frac{1}{2}mv^2 + F_f . \Delta x . \cos\theta = mgh + \frac{1}{2}mv^2$

$4(9,8)(1,25) + \frac{1}{2}(4)(5,86)^2 + [15.\Delta x.(\cos 180^\circ)] = 0 + \frac{1}{2}(4)(5,86)^2$

$\Delta x = 3,27\ m$ ✓ cA

(a)

$W_{nc} = \Delta E_{lc} + \Delta E_p$ ✓

$W_f = \Delta E_k + \Delta E_p$

$F_f . \Delta x . \cos\theta = (\frac{1}{2}mv_f^2 - \frac{1}{2}mv^2) + (mgh_f - mgh_i)$

$15 . \Delta x . (\cos 180^\circ) = (\frac{1}{2}(4)(5,86^2) - \frac{1}{2}(4)(5,86)^2) + [0 - 4(9,8)(1,25)]$

$\Delta x = 3,27\ m$ (5)

(a)

5.2.3) $W_{net} = \Delta E_{lc}$ ✓

$W_{Fg_{//}} + W_f = \Delta E_{lc}$

$[mg.\sin\theta.\Delta x.\cos\theta] + [F_f . \Delta x . (\cos\theta)] = 0$

$4(9,8).\sin^{-1}\left(\frac{1,25}{x}\right).\Delta x.(\cos 0) + [15\,\Delta x.(\cos 180)] = 0$

Δx Δx

$\Delta x = 3,27\ m$

(a)

$\left[4(9,8)\left(\frac{1,25}{x}\right)\Delta x.\cos\theta\right] + [15\,\Delta x.(\cos 180)] = 0$

$4(9,8)(1,25).\cos\theta + [15\,\Delta x.(\cos 180)] = 0$

5.4 REMAIN THE SAME. ✓ (1)

[17]

Question 6

6.1 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. (2)

6.2

OPTION1/*OPSIE1*

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

$(5100) = \frac{340}{340 - 240} f_s$ ✓✓✓

$f_s = 1\,500$ Hz

$v = f\lambda$ ✓

$340 = (1\,500)\lambda$ ✓

$\lambda = 0{,}23$ m ✓

(7)

OPTION 2/*OPSIE 2*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v - v_s}\left(\frac{v}{\lambda_s}\right)$

$(5100) = \left(\frac{340}{340 - 240}\right)\left(\frac{340}{\lambda_s}\right)$ ✓✓✓✓

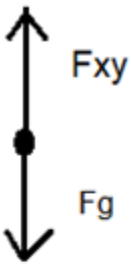
$\lambda = 0{,}23$ m ✓

(7)

Question 7 – electrostatics

7.1 State Coulomb's law: 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: (2)

7.2



Fxy - electrostatic force between sphere x and y

Fg- gravitational force on sphere y

(2)

7.3 **Fg = m.g**
= 0,01(9,8)
= 0,098
= 0,1 N (2)

Remember that once the spheres touch their charges are the same, thus Q.Q is Q^2 (not 2 Q)

7.4

Positive marking from Q 8.4

Fg = Fxy ✓

$w = F_E = \frac{kq_1q_2}{r^2}$ ✓

$0,1 = \frac{(9 \times 10^9)q^2}{(0,03)^2}$ ✓

$q = 1 \times 10^{-7}C$ ✓

$Q_{new} = \frac{Qx + Qy}{2}$

$1 \times 10^{-7}C = \frac{Qx + 0}{2}$ ✓

$Qx = 2 \times 10^{-7}C$

(5)

7.5.

$$\text{new charge} = \frac{2 \times 10^{-7} + (-1 \times 10^{-7})}{2 \checkmark} = \frac{1}{2} \times 10^{-7}\,C \checkmark \text{ or } 5,0 \times 10^{-8}\,C$$ (2)

Question 8 – circuits

8.1 The current in a resistor is directly proportional to the potential difference across the resistor if the temperature of the resistor remains constant. (2)

8.2

$$\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{10} + \frac{1}{15}$$
$$R_{parellel} = 6\,\Omega$$

$$R_{parallel} = \frac{R(product)}{R(sum)}$$
$$= \frac{(10 \times 15)}{(10+15)}$$
$$R_{parellel} = 6\,\Omega$$

(3)

8.3

$$W = \frac{V^2 t}{R}$$
$$576 = \frac{V^2 (60)}{15}$$
$$V = 12\,V$$

$$P = \frac{W}{t}$$
$$= \frac{576}{60}$$
$$= 9{,}6\ Watt$$
$$P = \frac{V^2}{R}$$
$$9{,}6 = \frac{V^2}{15}$$
$$V = 12\,V$$

$$I = \frac{V}{R} = \frac{12}{6} = 2\ A$$

$$P = \frac{W}{t}$$
$$= \frac{576}{60}$$
$$= 9{,}6\ Watt$$
$$P = I^2R = I^2.15$$
$$I_{15\Omega} = 0{,}8\ A$$
$$I_{10\Omega} = \frac{12}{10} = 1{,}2\ A$$
$$I_A = 0{,}8 + 1{,}2 = 2\ A$$

$$W = I^2Rt$$
$$576 = I^2.15.60$$
$$I_{15\Omega} = 0{,}8\ A$$
$$I_{10\Omega} = \frac{12}{10} = 1{,}2\ A$$
$$I_A = 0{,}8 + 1{,}2 = 2\ A$$

(6)

8.3

8.4

$\text{Emf} = IR + Ir$ ✓

24 ✓ $= 2(R + 6) + (2 \times 1{,}5)$ ✓ ✓

$24 = 2R + 12 + 3$

$2R = 9$

$R = 4{,}5\ \Omega$ ✓

$V_{\text{external /ekstern}} = \text{Emf} - (2 \times 1{,}5)$ ✓

$= 24 - 3$ ✓

$= 21\ \text{V}$

$R_{\text{external / ekstern}} = \frac{21}{2} = 10{,}5\ \Omega$ ✓

$R = R_{\text{external/ekstern}} - 6 = 10{,}5 - 6 = 4{,}5\ \Omega$ ✓

(5)

8.5

R increase ✓, I decreases ✓, less "lost volts" ✓,
V_1 increases ✓

(4)

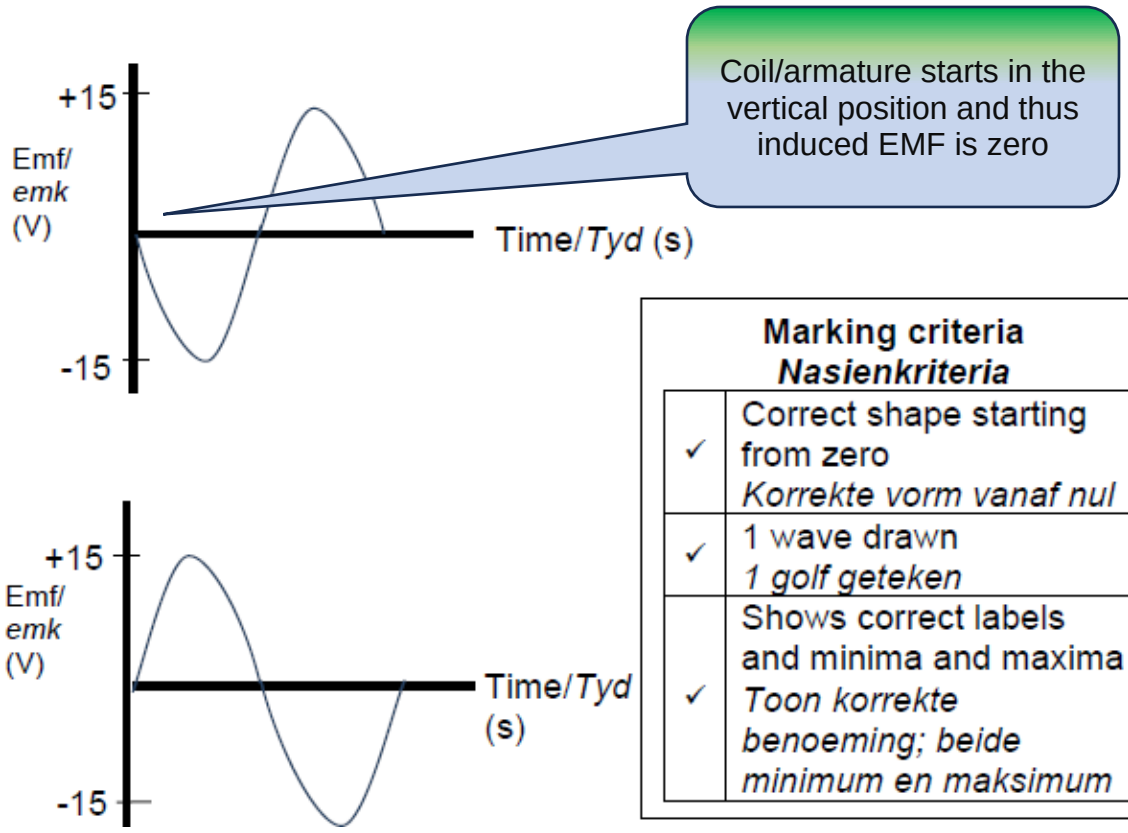
Question 9 – electrodynamics

9.1 AC Generators/*WS-Generator* ✓ (1)

9.2 Electromagnetic induction/ *Elektromagnetiese induksie* ✓ (1)

9.3 Mechanical energy to electrical energy./*Meganiese energie na elektriese energie.*✓✓ (2)

9.4



Marking criteria *Nasienkriteria*	
✓	Correct shape starting from zero *Korrekte vorm vanaf nul*
✓	1 wave drawn *1 golf geteken*
✓	Shows correct labels and minima and maxima *Toon korrekte benoeming; beide minimum en maksimum*

9.5.1 The rms value of AC is the **DC** potential difference which dissipates the same amount of energy as **AC** potential difference. ✓✓

(2)

9.5.2 240 V ✓ (1)

9.5.3

$P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$

$2100 = 240 \times I_{rms/wgk}$ ✓

$I_{rms/wgk} = 8{,}75\ A$

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

$2100 = \frac{(240)^2}{R}$ ✓

$R = 27{,}43\ \Omega$

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

$240 = \frac{V_{max}}{\sqrt{2}}$

$V_{max} = 339{,}41\ V$

OPTION 1

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$8{,}75 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 12{,}37\ A$

OPTION/*OPSIE* 2

$R = \frac{V}{I}$ ✓

$27{,}43 = \frac{399{,}41}{I}$ ✓

$I_{max} = 12{,}37\ A$ ✓

OPTION/*OPSIE* 3

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

$27{,}43 = \frac{240}{I_{rms}}$ ✓

$I_{rms} = 8{,}75\ A$

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$8{,}75 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 12{,}37\ A$ ✓

(4)

QUESTION/*VRAAG* 10

10.1 The work function of a metal is the minimum energy ✓ that an electron (in the metal) needs to be emitted/ejected from the(metal)surface. ✓

Die werkfunksie/arbeidsfunskie van 'n metaal is die minimum energie benodig om 'n elektron vanaf 'n (metaal) oppervlak vry te stel. (2)

10.2 The frequency of light is less than threshold/cut-off frequency of 50×10^{14} Hz.✓✓

Die frekwensie van lig is minder as die drumpel/afsnyfrekwensie van 50×10^{14} Hz. (2)

10.3 h / Planck's constant / *h/ Planck se kon* (1)

Careful: On the x-axis the value needs to be multiplied by x 10^{14}

10.4 $x = w_o = hf_o$ ✓
$= 6,63 \times 10^{-34} (50 \times 10^{14})$ ✓
$= 3,315 \times 10^{-18}$J ✓ (1)

10.5.1

$$E = W_0 + K_{max}$$
$$hf = hf_0 + \frac{1}{2}mv_{max}^2$$

Any/*Enige* ✓

$$6,6,3 \times 10^{-34}(110 \times 10^{14}) = 6,63 \times 10^{-34}(50 \times 10^{14}) + \frac{1}{2}(9,11 \times 10^{-31})v_{max}^2$$ ✓

$$v_{max} = 2,955 \times 10^6 \, m \cdot s^{-1}$$ ✓

(4)

10.5.2 Stays the same ✓
Intensity only increases the number of photons per unit time/photo-electrons emitted per unit time. ✓
OR
The energy of a photon/emitted photo-electron is not influenced by the intensity of the light.