SA-STUDENT

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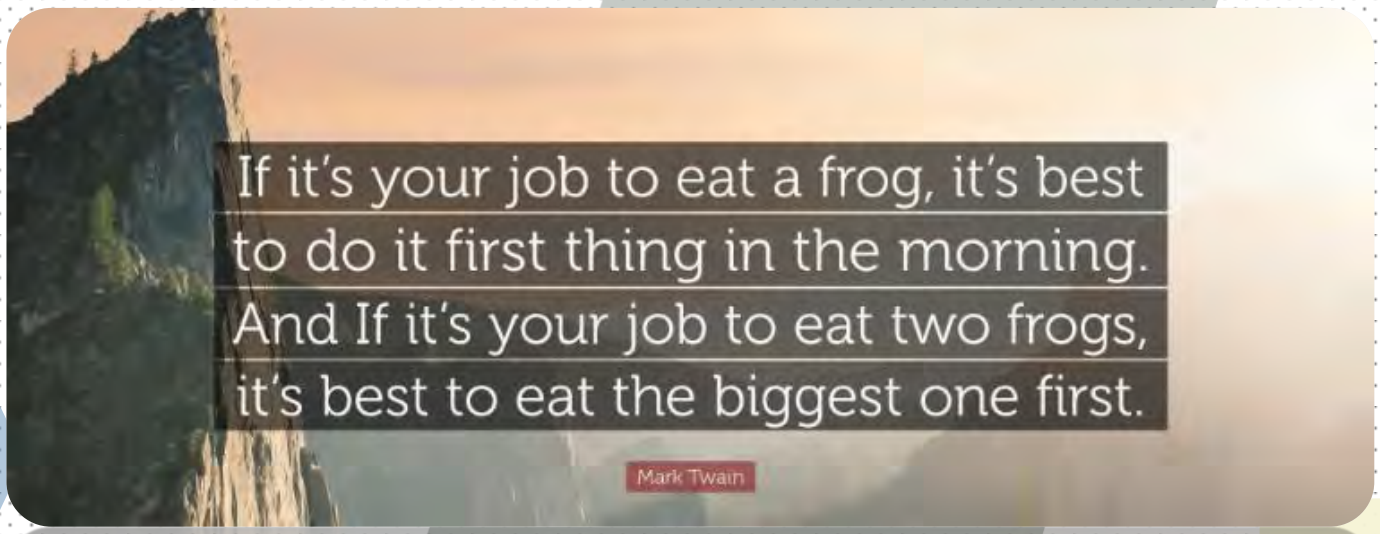


QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided all other physical conditions remain constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits alle ander fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided all other physical conditions remain constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits alle fisiese toestande konstant bly). (2)

8.2.1

OPTION 1/*OPSIE* 1

$R = \frac{V}{I}$ ✓

$7 = \frac{V}{1,5}$ ✓

V = 10,5 V ✓

OPTION 2/*OPSIE 2*

$R = \frac{V}{I}$ ✓

$2 = \frac{V}{1,5}$

V = 3 V

$5 = \frac{V}{1,5}$

V = 7,5 V

$V_T = V_1 + V_2$
= 3 + 7,5 ✓ (addition of calculated values/*optel van berekende waardes*)
= 10,5 V ✓

OPTION 3/*OPSIE 3*

Ratio of R:
3 : 7
Ratio of I:
7 : 3

$I = 1,5 \times \frac{7}{3} = 3,5$ A

$V = IR$ ✓
$= \underline{(3,5)(3)}$ ✓
$= 10,5$ V✓

(3)

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

OPTION 1/*OPSIE 1*

$R = \frac{V}{I_3}$ ✓

$3 = \frac{10,5}{I_3}$ ✓

$I_3 = 3,5$ A

✓

$I_T = 1,5 + 3,5$ (addition of calculated values/*optel van berekende waardes*)
$= 5$ A ✓

OPTION 2/*OPSIE 2*

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

OR/*OF*

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

$\frac{1}{R_p} = \frac{1}{7} + \frac{1}{3}$ ✓

$R_p = 2,1\ \Omega$

$R_p = \frac{(7)(3)}{7 + 3}$ ✓

$= 2,1\ \Omega$

$R = \frac{V}{I}$ ✓

$2,1 = \frac{10,5}{I}$ ✓

$I_T = 5$ A ✓

OPTION 3/*OPSIE 3*

$I_{3\Omega} = \frac{7}{3} \times 1,5$ ✓
$= 3,5$ A ✓

✓

$I_{total} = 3,5 + 1,5$

$= 5$ A✓

OPTION 4/*OPSIE 4*

$I_S = (\frac{3\Omega}{3\Omega + R_S}) \times I_{total}$ ✓

$1,5$ ✓$= \frac{3}{3+7}$ ✓$\times I_{total}$

$I_{total} = 5$ A ✓

(4)

8.2.3 **POSITIVE MARKING FROM QUESTION 8.2.1 AND/OR QUESTION 8.2.2.**
POSITIEWE NASIEN VANAF VRAAG 8.2.1 EN/OF VRAAG 8.2.2.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$P = \frac{V^2}{R}$ ✓ $= \frac{10,5^2}{3}$ ✓ = 36,75 W ✓	$P = I^2R$ ✓ $= \underline{(3,5)^2(3)}$ ✓ = 36,75 W ✓
OPTION 3/*OPSIE 3*	
P = VI ✓ = $\underline{(10,5)(3,5)}$ ✓ = 36,75 W ✓	

(3)

8.3 **POSITIVE MARKING IF <u>OPTION 2</u> IS USED IN QUESTION 8.2.2./**
POSITIEWE NASIEN INDIEN <u>OPSIE 2</u> GEBRUIK IS IN VRAAG 8.2.2.

<u>Marking criteria/*Nasienkriteria*</u>
- Correct equation for emf./*Korrekte vergelyking vir emk.* ✓
- Correct substitution for S_2 closed. /*Korrekte vervanging vir S_2* gesluit. ✓
- Correct substitution for S_2 open./*Korrekte vervanging vir S_2 oop.* ✓
- Equating emf or internal resistance equations. ✓
  Gelykstelling van emk of interne weerstand vergelykings.
- Correct final answer/*Korrekte finale antwoord:* 12,05 V ✓
  Range/*Gebied*: 12,04 V to/*tot* 12,05 *V*

$\frac{1}{p} = \frac{1}{1} + \frac{1}{2}$

$\frac{1}{p} = \frac{1}{7} + \frac{1}{3}$

$R_p = 2,1\ \Omega$

For S_1 and S_2 closed:
$\varepsilon = I(R + r)$
$\varepsilon = IR + Ir$
$\varepsilon = V_{int} + V_{ext}$
✓ Any one/ *Enige een*
$= \underline{5(2,1 + r)}$ ✓…(1)

For S_2 open:
$\varepsilon = I(R+r)$
$= \underline{3,64(3 + r)}$ ✓…(2)

(1) = (2)
$5(2,1 + r) = 3,64(3 + r)$ ✓
$r = 0,31\ \Omega$

$\varepsilon = 5(2,1 + 0,31)$
= 12,05 V ✓ (12,04)

OR/*OF*

$\varepsilon = 3,64(3 + 0,31)$
= 12,05 V ✓ (12,04)

(1) = (2):
$\frac{\varepsilon - 10,5}{5} = \frac{\varepsilon - 10,92}{3,64}$ ✓
ε = 12,05 V ✓ (12,04)

(5)

8.4 Increases/*Toeneem* ✓
(Total) resistance increases./(*Totale) weerstand neem toe.* ✓
Current decreases./*Stroom neem af.* ✓
$V_{internal}$ /Internal volts decreases./V_{intern}/*Interne volts neem af.* ✓ (4)

Note/*Aantekening:*
Award marks if learner proved the statement using calulated numerical values./ *Ken punte toe indien leerder die stelling bewys deur berekende waardes te gebruik.*

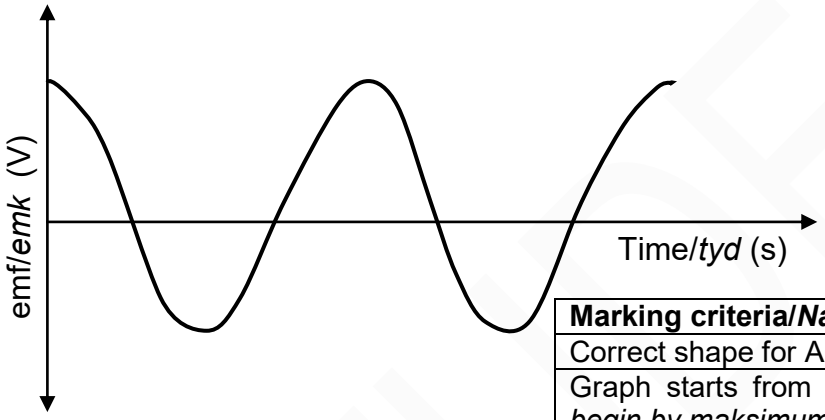
[21]

QUESTION 9/*VRAAG 9*

9.1.1 North pole/*Noord-pool* ✓ (1)

9.1.2 Y to X/*Y na X* ✓ (1)

9.1.3



Marking criteria/*Nasienkriteria*	
Correct shape for AC./*Korrekte vorm vir WS.*	✓
Graph starts from maximum value./*Grafiek begin by maksimum waarde.*	✓
Two complete waves/ *Twee volledige golwe*	✓
Note/*Aantekening:* Accept graph starting at negative max./*Aanvaar grafiek wat by negatiewe maks begin*.	

(3)

9.2.1

Marking criteria/*Nasienkriteria*:
- Formula to calculate V_{max} or I_{rms}./*Formule om V_{maks} of I_{wgk} te bereken.* ✓
- Correct substitution of V_{rms} or I_{max}./*Korrekte vervanging van V_{wgk} of I_{maks}.* ✓
- Correct substitution to calculate R./*Korrekte vervanging om R te bereken.* ✓
- Correct final answer/*Korrekte finale antwoord*: 47,14 Ω to/*tot* 47,2 Ω ✓

OPTION 1/*OPSIE 1*

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

$200 = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = 282,84$ V

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

$= \frac{282,84}{6}$ ✓

R = 47,14 Ω ✓

OPTION 2/*OPSIE 2*

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

$I_{rms} = \frac{6}{\sqrt{2}}$ ✓

$I_{rms} = 4,24$ A

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

$= \frac{200}{4,24}$ ✓

R = 47,17 Ω ✓

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature (provided temperature and all other physical conditions are constant). ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly).

OR/*OF*
The ratio of potential difference to current is constant at constant temperature.
Die verhouding van potensiaalverskil tot stroom is konstant by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature (provided temperature and all other physical conditions are constant).
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly). (2)

NOTE/*LET WEL*
Do not award the mark for addition of 4 if any other value is added to R_p/ *Moenie die punt vir bytel van 4 toeken indien enige ander waarde by R_p bygetel word nie.*

8.2.1

OPTION 1/*OPSIE 1*	**OPTION2/*OPSIE2***
$\frac{1}{p} = \frac{1}{1} + \frac{1}{2}$ ✓ $\frac{1}{p} = \frac{1}{1} + \frac{1}{5}$ ✓ $R_p = 0{,}83\ \Omega$ ↓ $R_T = 0{,}83 + 4$ ✓ $= 4{,}83\ \Omega$ ✓	$R_p = \frac{1 \quad 2}{1 + 2}$ ✓ $R_p = \frac{(1)(5)}{1+5}$ ✓ $R_p = 0{,}83\ \Omega$ ↓ $R_T = 0{,}83 + 4$ ✓ $= 4{,}83\ \Omega$ ✓

(4)

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

OPTION 1/*OPSIE 1*

$R = \frac{V}{I}$ ✓

$4{,}83 = \frac{\quad}{3{,}5}$ ✓

V = 16,91 V ✓ (16,92 V)

OPTION 2/*OPSIE 2*

$R_p = \frac{2}{\quad}$ ✓

$0{,}83 = \frac{\quad}{3{,}5}$

$V_2 = 2{,}91$ V

$R_{4\Omega} = \frac{4\Omega}{\quad}$ ✓ Any one/*Enige een*

$4 = \frac{4\Omega}{3{,}5}$

$V_{4\Omega} = 14$ V

$V_1 = V_2 + V_{4\Omega}$
$V_1 = 2{,}91 + 14$
= 16,91 V ✓ (16,92 V) (3)

8.2.3 Smaller than/*Kleiner as* ✓ (1)

8.3.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

Maximum work done by the battery per unit charge. ✓✓
Maksimum arbeid verrig deur die battery per eenheidslading.

OR/*OF*
Maximum energy supplied by the battery per unit charge.
Maksimum energie verskaf deur die battery per eenheidslading.

OR/*OF*
The total amount of electric energy supplied by the battery per coulomb/per unit charge.
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheidslading. (2)

8.3.2 No/*Nee* ✓ (1)

8.3.3 The battery has internal resistance.✓
Die battery het interne weerstand.

OR/*OF*
Some energy per coulomb of charge/volts is used to overcome internal resistance.
'n Gedeelte van die energie per coulomb lading/volts word gebruik om interne weerstand te oorkom.

OR/*OF*
There is a potential drop/lost volts inside the battery.
Daar is 'n potensiaalval/verlore volts binne-in die battery.

OR/*OF*
$\varepsilon = V_{ext} + V_{int}$

OR/*OF*
$\varepsilon > V_{ext}$ (1)

8.4.1 Decreases/*Verlaag* ✓ (1)

8.4.2 Increases/*Verhoog* ✓ (1)

8.5 When the voltmeter is connected:
- No/very little current through the 1 Ω branch **OR** Branch with 1 Ω resistor is disabled/bypassed **OR** A voltmeter has a very high resistance **OR** The resistance of the parallel branch increases. ✓
- (Total) resistance of the circuit increases. ✓
- Current in circuit decreases. ✓
- $V_{internal}$/ Internal volts/ V_{lost} decreases. ✓

Therefore, external volts increase for a constant emf.

Wanneer die voltmeter geskakel word:
- *Geen/baie min stroom deur die 1 Ω-tak **OF** Ta m et 1 Ω-weerstand is uitgeskakel **OF** Voltmeter het baie hoë weerstand **OF** Die weerstand van die parallelle tak neem toe.*
- *(Totale) weerstand van die stroombaan neem toe.*
- *Stroom in stroombaan neem af.*
- *V_{intern}/ Interne volts/ $V_{verlore}$ neem af.*

Dus neem die eksterne volts toe vir konstante emf. (4)
[20]

7.2.3 Greater than / *Groter as* ✓

The gradient is equal to kQ./The gradient is proportional to Q. ✓
Graph of sphere B has a steeper gradient than graph of sphere A. ✓
Die gradiënt is gelyk aan kQ./Die gradiënt is proporsioneel aan Q.
Grafiek vir sfeer B het 'n steiler gradiënt as die grafiek vir sfeer A.

OR/*OF*

For the same $\frac{1}{r^2}$, E is greater for sphere B. ✓✓
Vir dieselfde $\frac{1}{r^2}$, is E groter vir sfeer B.

(3)
[20]

QUESTION 8/*VRAAG 8*

8.1 A conductor (resistor) which obeys Ohm's law./*'n Geleier wat Ohm se wet gehoorsaam*. ✓✓ **(2 or/*of* 0)**

OR/OF
V always directly proportional to I at constant temperature. ✓✓ **(2 or/*of* 0)**
V is altyd direk eweredig aan I by konstante temperatuur.

OR/OF
$\frac{V}{I}$ = constant / k / c*onstant at constant temperature.* ✓✓ **(2 or/*of* 0)**
$\frac{V}{I}$ = konstant / k / *konstant bly by 'n konstante temperatuur.*

OR/OF
A conductor for which the resistance remains constant at constant temperature when voltage or current change. ✓✓ **(2 or/*of* 0)**
'n Geleier waar die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander. (2)

8.2.1
$R = -$ ✓
$4 = \frac{3,2}{-}$ ✓
$I = 0,8$ A ✓ (3)

8.2.2

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

OPTION 1/*OPSIE 1*

$\varepsilon = (R+r)$ ✓ ✓

$= 0,8\ (4 + 8 + 0,5)$ ✓

$= 10$ V ✓

OR/*OF*

$\varepsilon = (R+r)$ ✓

$= 0,8(4 + 8) + 0,8 \times 0,5$ ✓

$= 10$ V ✓

OPTION 2/*OPSIE 2*

$V_8 = IR$
$= (0,8)(8)$
$= 6,4$ V

$V_{ext} = 3,2 + 6,4$
$= 9,6$ V

$V_{int} = Ir$
$= (0,8)(0,5)$ ✓
$= 0,4$ V

$\varepsilon = I(R + r)$
$= V_{ext} + V_{int}$ ✓Any one/*Enige een*
$= 9,6 + 0,4$ ✓
$= 10$ V ✓

(4)

8.3.1

POSITIVE MARKING FROM QUESTION 8.2.2./
POSITIEWE NASIEN VANAF VRAAG 8.2.2.

OPTION 1/*OPSIE 1*

$V_{int} = Ir$
$1,2 = I(0,5)$ ✓
$I = 2,4$ A

$R_{ext} = \frac{V}{I}$
$= \frac{8,8}{2,4}$ ✓✓
$= 3,67\ \Omega$ (3,667)

$R_P = \frac{12R}{12 + R}$

$3,67 = \frac{12R}{12 + R}$ ✓

$R = 5,29\ \Omega$ (5,28) ✓

OR/*OF*

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

$\frac{1}{3,67} = \frac{1}{R} + \frac{1}{12}$ ✓

$R = 5,29\ \Omega$ (5,28) ✓

OPTION 2 /*OPSIE 2*

$V_{int} = 10 - 8,8$
$= 1,2$ V

$V_{int} = Ir$
$1,2 = I(0,5)$ ✓
$I = 2,4$ A

$I_{series\ branch} = \frac{V}{R}$
$= \frac{8,8}{8+4}$ ✓
$= 0,73$ A (0,733)

$I_R = 2,4 - 0,73$ ✓
$= 1,67$ A (1,667)

$R = \frac{V}{I_R}$
$= \frac{8,8}{1,67}$ ✓
$= 5,27\ \Omega$ (5,28) ✓

(5)

8.3.2 There is a short circuit /*Daar is 'n kortsluiting*.

- The resistance of the connected wire is very low. / The total resistance decreases. ✓
  Die weerstand van die verbindingsdrade is baie klein. /Die totale weerstand neem af.
- $I \alpha \frac{1}{R}$, current delivered by the battery is very high. ✓
  $I \alpha \frac{1}{R}$, *stroom gelewer deur die battery is baie groot.*
- Higher current produces more heat. ✓
  Hoër stroom produseer meer hitte.

OR/*OF*
Any one of the following equations can be used to explain the effect of current on heat/*Enigeen van die volgende vergelykings kan gebruik word om die effek van stroom op hitte te verdudidelik:*

$W = I^2R\Delta t$ / $W = \frac{}{R}^2\Delta t$ / $W = \quad \Delta t$ / $P = {}^2R$ / $P = \frac{}{R}^2$ / $P = VI$ (3)

[17]

QUESTION 8/*VRAAG 8*

8.1.1 12 V ✓ (1)

8.1.2 0 (V) ✓ (1)

8.2

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The rate at which work is done or energy is expended/transferred.
Die tempo waarteen arbeid verrig word of energie oorgedra word. (2)

8.3

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$5,76 = (1,2^2)R$ ✓
$R = 4\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$P = VI$
$5,76 = V(1,2)$
$V = 4,8$ V

$P = \frac{V^2}{R}$ ✓
$5,76 = \frac{(4,8)^2}{R}$ ✓
$R = 4\ \Omega$ ✓

$V = IR$ ✓
$4,8 = (1,2)R$ ✓
$R = 4\ \Omega$ ✓

(3)

8.4 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

OPTION 1/*OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{8,4}$ ✓
$R_p = 3,5\ \Omega$
$R_T = 3,5 + 4$ ✓
$= 7,5\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$R_p = \frac{R_1R_2}{R_1 + R_2}$
$R_p = \frac{(6)(8,4)}{6 + 8,4}$ ✓
$R_p = 3,5\ \Omega$
$R_T = 3,5 + 4$ ✓
$= 7,5\ \Omega$ ✓

(3)

8.5 **POSITIVE MARKING FROM QUESTION 8.3**
POSITIEWE NASIEN VANAF VRAAG 8.3

CALCULATE V_P/*BEREKEN V_P*	**CALCULATE V_2/*BEREKEN V_2***
Marking criteria/*Nasienkriteria*	**Marking criteria/*Nasienkriteria***
• Formula/*Formule*: $V = IR$ ✓ • Substitution to calculate V_p / *Vervanging om V_p te bereken.*✓	• Substitution to calculate I_{branch} or ratio of R_{branch}/*Vervanging om I_{tak} of verhouding van R_{tak} te bereken.* ✓ • Substitution to calculate V_2 / *Vervanging om V_2 te bereken.*✓ • Final Answer/*Finale antwoord:* 3 V✓
OPTION 1/*OPSIE 1*	$I = \frac{V}{R}$
$V_p = IR$	$= \frac{4,2}{8,4}$ ✓
$= (1,2)(3,5)$ ✓	$= 0,5$ A
$= 4,2$ V	$V_2 = IR$ ✓
OPTION 2/*OPSIE 2*	$= (0,5)(6)$ ✓
$P_x = VI$	$= 3$ V ✓
$5,76 = V(1,2)$	
$V_x = 4,8$ V	**OR/*OF***
$I_{6\,\Omega} = \frac{8,4}{14,4} \times 1,2$	
$= 0,7$ A	
$V_{6\,\Omega} = IR$	
$= (0,7)(6)$ ✓	
$= 4,2$ V	
OPTION 3/*OPSIE 3*	$R_{2,4} : R_6 = 2,4 : 6$ ✓
$\varepsilon = I(R + r)$	$= 2 : 5$
$12 = 1,2(7,5 + r)$	$V_{2,4} : V_6 = 1,2 : 3$ ✓✓
$r = 2,5\ \Omega$	$V_2 = 3$ V ✓
$V_p = 12 - 1,2(2,5 + 4)$ ✓ $= 4,2$ V	

CALCULATION OF $I_{8,4\Omega}$ AND V_2/*BEREKENING VAN $I_{8,4\Omega}$ EN V_2*

OPTION 4/*OPSIE 4*

$I_{8,4\Omega} = \left(\frac{6}{14,4}\right)(1,2)$ **OR/*OF*** $\left(\frac{3,5}{8,4}\right)(1,2)$
$= 0,5$ A ✓✓
$V_2 = IR$ ✓
$= (0,5)(6)$ ✓
$= 3$ V ✓

OPTION 5/*OPSIE 5*

$V_x = IR$ $V_{ext} = IR_{ext}$
$= (1,2)(4)$ $= (1,2)(7,5)$
$= 4,8$ V $= 9$ V

$V_p = 9 - 4,8$✓ $= 4,2$ V

$V_{8,4\Omega} = IR$
$4,2 = I(8,4)$✓
$I = 0,5$ A

$V_2 = IR$ ✓
$= (0,5)(6)$ ✓
$= 3$ V ✓

(5)

8.6 Decreases/*Neem af* ✓
Total resistance decreases. / *Totale weerstand neem af*. ✓
Current increases. /*Stroom neem toe*. ✓
$V_{internal}$ /Internal voltage ("lost volts") increases. /*Interne potensiaalverskil neem toe.* ✓
$V_{external}$ /*external voltage decreases.* /*Eksterne potensiaalverskil neem af.*

NOTE/*LET WEL*
Do not penalise if "total" is omitted. / *Moenie penaliseer indien "totaal" uitgelaat is nie.* (4)
[19]

QUESTION 9/*VRAAG 9*

9. 1 Slip rings/*Sleepringe* ✓

ACCEPT/*AANVAAR*
Split ring/slip ring commutator /*splitring*/*sleepring kommutator* (1)

9. 2 Y to/*na* X ✓✓ (2)

9.3

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The AC potential difference which dissipates the same amount of energy as an equivalent DC potential difference.
Die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke GS-potensiaalverskil.

ACCEPT/*AANVAAR*
The DC potential difference which dissipates the same amount of energy as an equivalent AC potential difference.
Die GS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik as die ekwivalente/soortgelyke WS-potensiaalverskil. (2)

9.4

OPTION 1/*OPSIE 1*

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

$= \frac{100}{\sqrt{2}}$ ✓

$= 70,71$ V

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

$= \frac{70,71}{25}$ ✓

$= 2,83$ A ✓

ACCEPT/*AANVAAR*
If subscipts omitted in V = IR
Indien onderskrifte uitgelaat is in V = IR

OPTION 2/*OPSIE 2*

$I_{max/maks} = \frac{V_{max/maks}}{R}$

$= \frac{100}{25}$ ✓

$= 4$ A

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

$= \frac{4}{\sqrt{2}}$ ✓

$= 2,83$ A ✓

OPTION 3/*OPSIE 3*

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

$= \frac{\frac{100^2}{\sqrt{2}}}{25}$ ✓ $= 200$ W

$P_{ave} = V_{rms}I_{rms}$ ✓

$200 = \left(\frac{100}{\sqrt{2}}\right)I_{rms}$ ✓

$I_{rms} = 2,83$ A ✓

(4)

QUESTION 8/*VRAAG 8*

8.1 (a) (Electrical) energy/work (*Elektriese*) *energie/arbeid* ✓
(b) Unit charge/*eenheidslading* ✓ (Accept/ *Aanvaar* coulomb) (2)

8.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$R_s = R_1 + R_2$ $= 4 + 3$✓ $= 7\ \Omega$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{R_p} = \frac{1}{7} + \frac{1}{7}$ ✓ $R_p = 3,5\ \Omega$ ✓	$R_s = R_1 + R_2$ $= 4 + 3$ ✓ $= 7\ \Omega$ $R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓ $R_p = \frac{(7)(7)}{7+7}$ ✓ $= 3,5\ \Omega$ ✓

(4)

8.3.1 **POSITIVE MARKING FROM QUESTION 8.2/*POSITIEWE NASIEN VANAF VRAAG 8.2***

Marking criteria/*Nasienkriteria*

Calculation of current when switch is open and when closed/ *Berekening van stroom wanneer skakelaar S oop is en gesluit is:*

- Suitable formula for opem or closed switch /*Geskikte formule vir geslote of oop skakelaar*✓
- Correct substitution when switch is open /*Korrekte vervanging wanneer skakelaar oop is* ✓
- Correct substitution when switch is closed /*Korrekte vervanging wanneer skakelaar gesluit is* ✓

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

Vervanging in formule $\varepsilon = I(R + r)$ of $\varepsilon = V_{eks} + Ir$:

- Formula/*Formule* ✓
- Substitution in formula for open switch/ *Vervanging in formule vir oop skakelaar* ✓
- Substitution in formula for closed switch/ *Vervanging in formule vir geslote skakelaar* ✓

Calculating r / *Berekening van r*

- Equating the equations / *Stel twee vergelykings gelyk aan mekaar* ✓
- Final answer/*Finale antwoord*: 0,49 Ω ✓

When the switch is OPEN/*Wanneer die skakelaar OOP is*	When the switch is CLOSED/*Wanneer die skakelaar GESLUIT is*
$I = \frac{V}{R}$ ✓ ←(Any one / *Enige een*)→ $I = \frac{V}{R}$	
$I = \frac{2,8}{7}$ ✓	$I = \frac{2,63}{3,5}$ ✓
$= 0,4$ A	$= 0,75$ A
$\varepsilon = I(R + r)$ ✓ $= 0,4(7 + r)$ ✓	$\varepsilon = I(R + r)$ $= 0,75(3,5 + r)$ ✓
OR $\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,8 + (0,4)r$ ✓	**OR** $\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,63 + (0,75)r$ ✓
$0,4(7 + r) = 0,75(3,5 + r)$ $r = 0,49\ \Omega$ ✓	**OR/*OF*** $2,8 + (0,4)r = 2,63 + (0,75)r$ $r = 0,49\ \Omega$ ✓

(8)

8.3.2 **POSITIVE MARKING FROM QUESTION 8.3.1/**
POSITIEWE NASIEN VANAF VRAAG 8.3.1
Option depends on the equation in which r is substituted/
Opsie hang af van die vergelyking waarin r vervang is

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,8 + (0,4)r$ $= 2,8 + (0,4)(0,49)$ ✓ $= 3$ V ✓	$\varepsilon = V_{ext} + Ir$ $\varepsilon = 2,63 + (0,75)r$ $= 2,63 + (0,75)(0,49)$ ✓ $= 3$ V ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$\varepsilon = I(R + r)$ $= 0,4(7 + 0,49)$ ✓ $= 3$ V ✓	$\varepsilon = I(R + r)$ $= 0,75(3,5 + 0,49)$ ✓ $= 2,99$ V ✓

(2)
[16]

QUESTION 9/*VRAAG 9*

9.1 Slip rings/*sleepringe* ✓ (1)

9.2 Allows the slips rings to rotate while maintaining contact with the external circuit.
Laat die sleepringe toe om te roteer terwyl dit kontak met die eksterne stroombaan behou.
OR/*OF*
Transfer/conduct current to the external circuit. ✓
Dra stroom oor/Gelei stroom na eksterne stroombaan.
OR/*OF*
Connection between external circuit and coil/slip rings/internal circuit.
Verbinding tussen eksterne stroombaan en spoel/sleepringe/interne stroombaan. (1)

9.3 According to the principle of electromagnetic induction, an emf/current is induced as a result of the change in the magnetic flux linkage ✓✓ with the coil. **(2 or 0)**
Volgens die beginsel van elektromagnetiese induksie word 'n emk/stroom geïnduseer as gevolg van die verandering in magnetiese-vloedkoppeling met die spoel. ***(2 of 0)***

Accept/*Aanvaar*
When the coil rotates there is a change of magnetic flux linked/associated with the coil and according to the principle of electromagnetic induction, an emf/current is induced in the coil. **(2 or 0)**
Wanneer die spoel roteer is daar 'n verandering in magnetiese-vloedkoppeling met die spoel en volgens die beginsel van elektromagnetiese induksie word 'n stroom/emk in die spoel geïnduseer. ***(2 of 0)***
Accept/*Aanvaar*
There is relative motion between the conductor and the magnetic field.**(2 or 0)**
Daar is relatiewe beweging tussen die geleier en die magneetveld . ***(2 of 0)*** (2)

9.4 **P** to/*na* **Q** ✓✓ (2)

QUESTION 8/*VRAAG 8*

8.1

Marking criteria/*Nasienriglyne*
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

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓
(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/ eenheidslading wat daardeur beweeg.

Work done by the battery to move a unit coulomb of charge across the circuit./*Arbeid verrig deur die battery om 'n eenheidslading oor die stroombaan te beweeg*. (2)

8.2 Energy (per coulomb of charge) is converted to heat in the battery due to the internal resistance. ✓✓
Energie (per coulomb lading) word na hitte omskep binne-in die battery a.g.v. interne weerstand. (2)

8.3.1
$$I = \frac{V}{R} \checkmark$$
$$I = \frac{1,5}{0,5} \checkmark$$
$$= 3 \text{ A} \checkmark$$ (3)

8.3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓	$R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓
$\frac{1}{R_P} = \frac{1}{25} + \frac{1}{15}$ ✓	$R_p = \frac{(25)(15)}{25+15}$ ✓
$R_p = 9,375\ \Omega$	$R_p = 9,375\ \Omega$
$R_{ext} = 9,375 + 4$ ✓ $= 13,38\ \Omega$ ✓ (13,375 Ω)	$R_{ext} = 9,375 + 4$ ✓ $= 13,38\ \Omega$ ✓ (13,375 Ω)

(4)

8.3.3

POSITIVE MARKING FROM QUESTIONS 8.3.1 AND 8.3.2. ***POSITIEWE NASIEN VANAF VRAAG 8.3.1 EN 8.3.2.***
OPTION 1/*OPSIE 1* $\varepsilon = I(R + r)$ ✓ $= 3(13,38 + 0,5)$ ✓ $= 41,64$ V ✓ (Range/*Gebied:* 41,625 – 41,64)
OPTION 2/*OPSIE 2* $\varepsilon = V_{ext/eks} + V_{int}$ ✓ $= (3)(13,38) + 1,5$ ✓ $= 41,64$ V ✓ (Range/*Gebied:* 41,625 – 41,64)

(3)

8.4 Yes. ✓/*Ja*

For the same voltage/potential difference, ✓
a larger current will flow through a smaller resistor ($I = \frac{V}{R}$) ✓
Vir dieselfde spanning/ potensiaalverskil
sal 'n groter stroom deur die kleiner weerstand vloei ($I = \frac{V}{R}$).

OR/*OF*
$I \alpha \frac{1}{R}$ ✓, V = constant /*konstant*✓
I is inversely proportional to R and V is constant.
I is omgekeerd eweredig aan R en V is konstant.

OR/*OF*
$V_{||} = IR$
$= (3)(9,38)$
$= 28,14$ V

$I_{R2} = \frac{V}{R} = \frac{28,14}{25} = 1,13$ A ✓
$I_{R3} = \frac{V}{R} = \frac{28,14}{15} = 1,88$ A ✓

OR/*OF*
V is the same / *V is dieselfde* ✓
$I_{15\Omega} = \frac{25}{40}I$
$I_{25\Omega} = \frac{15}{40}I$ ✓

(3)

8.5 Remains the same/*Bly dieselfde*✓ (1)
[18]

QUESTION 8/*VRAAG 8*

8.1 (Maximum) energy provided (work done) ✓ by a battery per coulomb / unit charge passing through it. ✓
(*Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidlading wat daardeur beweeg.*

ACCEPT/*AANVAAR*:
The reading on a voltmeter connected across a battery when there is no current/ in an open circuit.✓✓
Lesing op 'n voltmeter oor 'n battery as daar geen stroom is nie (2)

8.2 13 V ✓ (1)

8.3.1

$R = \frac{V}{I}$ ✓ $5,6 = \frac{10,5}{I}$ ✓ I = 1,88 A ✓ (1,875 A)	**Marking criteria/*Nasienriglyne:*** • Appropriate formula/*Toepaslike formule* ✓ • Whole substitution/*Hele vervanging* ✓ • Final answer/*Finale antwoord*: 1,88 A ✓

(3)

8.3.2

POSITIVE MARKING FROM QUESTION 8.3.1.
POSITIEWE NASIEN VANAF VRAAG 8.3.1

OPTION 1	**OPTION 2**
P = VI ✓ = (10,5)(1,88) ✓ = 19,74 W ✓ (19,688 W)	$P = I^2R$ ✓ $= (1,88)^2(5,6)$ ✓ = 19,79 W ✓ (19,688 W)

OPTION 3
$P = \frac{V^2}{R}$ ✓
$= \frac{10,5^2}{5,6}$ ✓
= 19,69 W ✓ (19,688 W)

(3)

8.3.3

POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.1.
POSITIEWE NASIEN VANAF VRAE 8.2 EN 8.3.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
ε = I(R + r) ✓ 13 = 1,88 (5,6 + r) ✓ r = 1,31 Ω ✓ (1,31 – 1,33 Ω)	$r = \frac{V_{internal}}{I}$ ✓ $= \frac{2,5}{1,88}$ ✓ = 1,33 Ω ✓ (1,31 – 1,33 Ω)

OPTION 3/*OPSIE 3*
$\varepsilon = V_{ext} + V_{int}$
$13 = 10,5 + V_{int}$
$V_{int} = 2,5$ V
$V_{int} = Ir$ ✓
$2,5 = (1,88)r$✓
r = 1,31 Ω ✓ (1,31 – 1,33 Ω)

(3)

8.4.1 Decreases/*Neem af* ✓
$V_{internal\ resistance}$/Internal volts increase ✓
$V_{interne\ weerstand}$/*Interne volts neem toe* (2)

8.4.2

Marking criteria/*Nasienriglyne*
- Formula/*Formule* $\varepsilon = I(R + r)$ ✓
- Correct substitution into/ *Korrekte vervanging in* $\varepsilon = I(R + r)$ ✓
- Substitution of values into R_p formula/*Vervanging van waarde van R_p in formule*✓
- Halving value of R_{2X}/*Halvering van waarde van R_{2X}* ✓
- Final answer/*Finale antwoord*: 1,49 Ω ✓ Range/*Gebied*: 1,46 Ω – 1,49 Ω

POSITIVE MARKING FROM QUESTIONS 8.2 AND 8.3.3
POSITIEWE NASIEN VANAF VRAE 8.2 EN 8.3.3

OPTION 1/*OPSIE 1*

$\varepsilon = I(R + r)$ ✓
$13 = 4\ (R_{ext} + 1{,}31)$ ✓
$R_{ext} = 1{,}94\ \Omega\ (1{,}92\ \Omega)$

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

$$\frac{1}{1{,}94} = \frac{1}{5{,}6} + \frac{1}{R_2}$$ ✓

$R_2 = 2{,}97\ \Omega\ (2{,}92\ \Omega)$

$$X = \frac{1}{2}(2{,}97)$$ ✓
$= 1{,}49\ \Omega$ ✓ (1,46 – 1,49 Ω)

OPTION 2/*OPSIE 2*

$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1{,}31)$ ✓
$R_{ext} = 1{,}94\ \Omega\ (1{,}92\ \Omega)$

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

$$1{,}94 = \frac{5{,}6\ R_2}{5{,}6 + R_2}$$ ✓

$R_2 = 2{,}97\ \Omega\ (2{,}92\ \Omega)$

$$X = \frac{1}{2}(2{,}97)$$ ✓
$= 1{,}49\ \Omega$ ✓ (1,46 – 1,49 Ω)

OPTION 3/*OPSIE 3*

$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1{,}31)$ ✓
$R_{ext} = 1{,}94\ \Omega\ (1{,}92\ \Omega)$

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

$$\left[\frac{1}{1{,}94} = \frac{1}{5{,}6} + \frac{1}{2X}\checkmark\right]$$ ✓

$X = 1{,}49\ \Omega$ ✓ (1,46 – 1,49 Ω)

OPTION 4/*OPSIE 4*

$\varepsilon = I(R + r)$ ✓
$13 = 4(R_{ext} + 1{,}31)$ ✓
$R_{ext} = 1{,}94\ \Omega\ (1{,}92\ \Omega)$

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

$$\left[1{,}94 = \frac{(5{,}6)(2X)}{5{,}6 + 2X}\checkmark\right]$$ ✓

$X = 1{,}49\ \Omega$ ✓

OPTION 5/*OPSIE 5*

$\varepsilon = I(R + r)$ ✓
$V_{ext} = \underline{13 - (4)(1{,}31)}$ ✓
$= 7{,}76$ V
$V_p = IR_{5,6}$
$7{,}76 = I(5{,}6)$
$I_{5,6\Omega} = 1{,}37$ A

$I_T = I_{2X} + I_{5,6}$
$4 = I_{2x} + 1{,}37$
$I_{2X} = 2{,}63$ A

$V = IR_{2X}$
$[7{,}76 = (2{,}63)\underline{2X}\checkmark]\checkmark$
$X = 1{,}46\ \Omega\checkmark$

OPTION 6/*OPSIE 6*

$\varepsilon = I(R + r)$ ✓
$V_{ext} = \underline{13 - (4)(1{,}31)}$ ✓
$V_{ext} = 7{,}76$ V

$$I_{5,6\Omega} = \frac{7{,}76}{5{,}6} = 1{,}39\ A$$

$I_{2x} = 4 - 1{,}39 = 2{,}61$ A

$V_{2x} = I_{2X}R_{2X}$
$[7{,}76 = (2{,}61)\underline{2X}\checkmark]\checkmark$
$2X = 2{,}97\ \Omega$
$X = 1{,}49\ \Omega\checkmark$

$V_X = I_X R_X$
$3{,}88\checkmark = (2{,}61)R_X\checkmark$
$R_X = 1{,}49\ \Omega\checkmark$

OPTION 7/*OPSIE 7*

$\mathcal{E} = I(R + r)$ ✓

$V_{ext} = \underline{13 - (4)(1,31)}$ ✓

$= 7,76$ V

$V_{ext} = IR_{ext}$

$7,76 = (4)\left(\frac{1}{2X} + \frac{1}{5,6}\right)^{-1}$ ✓

$X = 1,48\ \Omega$ ✓ (5)

[19]

QUESTION 9/*VRAAG 9*

9.1

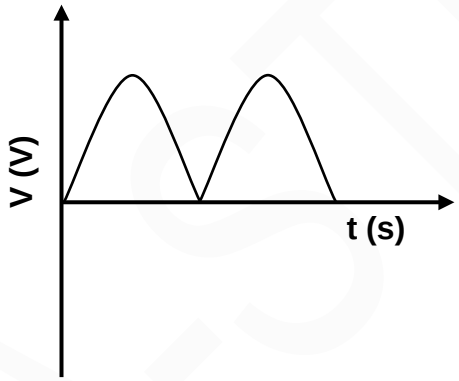
9.1.1 DC/*GS* ✓ (1)

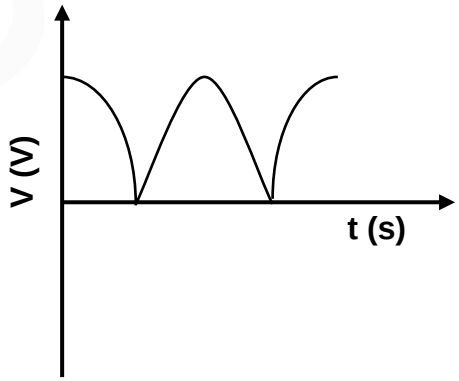
9.1.2 **NOTE:** -1 mark for each key word/phrase omitted in correct context.
LET WEL: *-1 punt vir elke sleutel woord/frase weggelaat in die korrekte konteks.*

Emf is induced as a result of change of magnetic flux (linked) with the coil. ✓✓

Emk word geïnduseer as gevolg van verandering van die magnetiese vloedkoppeling. (2)

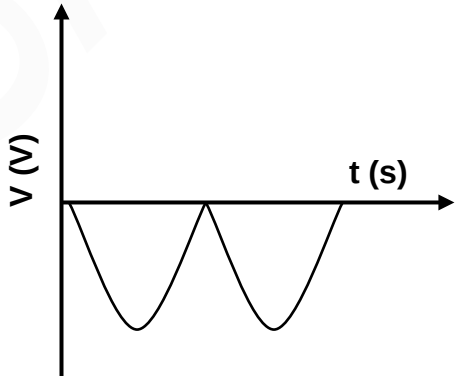
9.1.3 **POSITIVE MARKING FROM QUESTION 9.1.1**
POSITIEWE NASIEN VANAF VRAAG 9.1.1

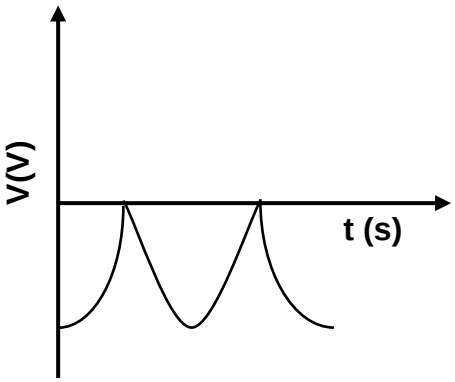




OR/*OF*

Marking criteria for graph:	
Correct shape *Korrekte vorm*	✓
One complete cycle/*Een volledige siklus*	✓





(2)

QUESTION 8/*VRAAG 8*

8.1.1 The rate at which (electrical) energy is converted (to other forms) (in a circuit)
The rate at which energy is used/Energy used per second
The rate at which work is done ✓✓
(2 or zero)
Die tempo waarteen elektriese energie omgesit word (in ander vorms) in 'n stroombaan.
Die tempo waarteen energie verbruik word.
Die tempo waarteen arbeid verrig word.
(2 of nul) (2)

8.1.2

$P = \frac{V^2}{R}$ ✓ $6 = \frac{(12)^2}{R}$ ✓ $R = 24\ \Omega$✓	$W = \frac{V^2\Delta t}{R}$ ✓ $6 = \frac{(12)^2(1)}{R}$ ✓ $R = 24\ \Omega$✓	$P = VI$ $6 = (12)(I)$ $\therefore I = 0,5$ A $P = I^2R$✓ $6 = (0,5)^2 R$✓ $R = 24\ \Omega$✓	$P = VI$✓ $6 = (12)(I)$ $\therefore I = 0,5$ A $V = IR$ $12 = (0,5)R$✓ $R = 24\ \Omega$✓

(3)

8.1.3 **POSITIVE MARKING FROM 8.1.2/*POSITIEWE NASIEN VANAF 8.1.2***
OPTION 1/*OPSIE 1*

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$
$= \frac{1}{24} + \frac{1}{24}$ ✓
$R_{//} = 12\ \Omega$

$R_{tot} = (R_s + \frac{R_1R_2}{R_1 + R_2})$
$R_{tot} = \{24 + \frac{(24)(24)}{48}$ ✓$\}$ ✓
$= 36\ \Omega$

$R_{ext} = (R_s + R_{//})$
$R_{ext} = (24 + 12)$ ✓
$= 36\ \Omega$
$V = IR$
OR
$\varepsilon = I(R + r)$
$12 = I(36 + 2)$ ✓
$I = 0,32$ A✓(0,316 A)

✓ any one
Enige 1

POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2
OPTION 2/OPSIE 2

Rext = (Rs + R//)

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{24} + \frac{1}{24}$ ✓

R// = 12 Ω

Rext = (24 + 12)✓

= 36 Ω

$R_{ext} = R_s + \frac{R_1R_2}{R_1 + R_2}$

$R_{ext} = \left\{24 + \frac{(24)(24)}{48}\checkmark\right\}\checkmark$

$= 36\,\Omega$

$P = I^2R = \frac{V^2}{R}$ ✓

$I^2(36 + 2) = \frac{(12)^2}{38}$ ✓

I = 0,32 A✓(0,316) ✓

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

$I^2R^2 = V^2$

V = IR

12 = I(38) ✓

I = 0,316 A✓

(5)

8.1.4

POSITIVE MARKING FROM 8.1.3
POSITIEWE NASIEN VANAF 8.1.3
OPTION 1/*OPSIE 1*
V = IR
V = I(R_A+r)
= 0,316(26) ✓
= 8,216 V (8,32 V)
 	
$V_{//}$ = (12 – 8,216) ✓
= 3,784 V(3,68 V)
∴V_C = 3,78 V (3,68 V) ✓
	POSITIVE MARKING FROM 8.1.3
	POSITIEWE NASIEN VANAF 8.1.3
	OPTION 2/*OPSIE 2*
	V = IR
	For the parallel portion (or from 8.1.3):
	Vir die parallel gedeelte (of vanaf 8..1.3)
	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ OR $R = \frac{R_1R_2}{(R_1 + R_2)}$
	$R = \frac{(24)(24)}{48}$
	= 12 Ω
	$V_{//} = V_C$ ✓
	V = I$R_{//}$
	= (0,316)(12) ✓
	= 3.79 V (3,84 V)✓
		(3)

POSITIVE MARKING FROM 8.1.3 ***POSITIEWE NASIEN VANAF 8.1.3*** **OPTION 3/*OPSIE 3*** $I_A = I_B + I_C$ = 2 I_B 0,316 = 2I_B✓ I_B = 0,158 A V = 0,158 (24) ✓ = 3,79 V✓		(3)

8.1.5 **OPTION 1/*OPSIE 1***

The power rating (output voltage) of the bulb is 6 W, 12 V. /*Die gloeilamp is gemerk 6W ; 12 V*

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

[For a given resistance, power is directly proportional to V^2] ✓
[of *Vir 'n gegewe resistor is drywing direk eweredig aan* V^2]
Since the potential difference across light bulb C is less than the operating voltage,✓ the output/power will be less, ✓/ Omdat d*ie potensiaalverskil oor gloeilamp C minder is as die benodigde spanning sal die uitset/drywing minder wees*.

OPTION 2/*OPSIE 2*

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

The potential difference across light bulb C is less than the operating voltage. ✓ Thus for the same resistance, ✓ brightness decreases.
Die potensiaalverskil oor gloeilamp C is minder as die benodigde potensiaalverskil. Dus vir dieselfde weerstand, sal die helderheid afneem.

OPTION 3/*OPSIE 3*

$P = I^2 R$
For a given resistance✓, power is directly proportional to I^2 Since current decreases✓, brightness decreases.]
[*vir 'n gegewe resistor is drywing direk eweredig aan* I^2 *Omdat stroom afneem sal die helderheid afneem]*

OPTION 4/*OPSIE 4*

$P = I^2 R$
In the circuit, the total current in light bulb C is less than the optimum current required (0,5 A). ✓ Thus for the same resistance, ✓ the power will be less✓ hence brightness will decrease.
In die stroombaan is die totale stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Dus vir dieselfde weerstand, is die drywing minder en die helderheid sal afneem.

OPTION 5/*OPSIE 5*

$P = IV$✓ [Power is directly proportional/equal to product of V and I. ✓
Since current decreases✓, brightnes decreases/
drywing is direk eweredig/gelyk aan produk van V en I. Omdat stroom afneem sal die helderheid afneem]]
OR/OF
The voltage across light bulb C, as well as the current in the bulb are all less✓ than the optimum values✓ hence power is less✓ and brightness is less.
Die potensiaalverskil oor gloeilamp C sowel as die stroom in die gloeilamp is almal minder as die optimum waardes, dus is die drywing minder en die helderheid minder. (3)
NOTE: No mark if only equation is given.

8.2.1 The total current passes through resistor A. ✓ For the parallel portion, the current branches, therefore only a portion of the total current passes through resistor C. ✓
Die totale stroom vloei deur resistor A. Vir die parallelle gedeelte verdeel die stroom, dus vloei slegs 'n gedeelte van die stroom deur resistor C. (2)
ACCEPT for 1 mark: Resistor C is connected parallel to resistors B and D together. Current is dividing ✓at the junction.
AANVAAR vir 1 punt: Resistor C is in parallel geskakel met B en D saam. Die stroom breek op ✓ by die koppeling.

8.2.2 The current in B is equal✓ to the current in A. The circuit becomes a series circuit. ✓
Die stroom in B is gelyk aan die stroom in A. Die stroombaan word 'n serie stroombaan. (2)
[21]

QUESTION 8/*VRAAG 8*

8.1 The battery supplies 12 J per coulomb/12 J per unit charge. ✓✓
Die battery verskaf 12 J per coulomb lading

OR /*OF*
The potential difference of the battery in an open circuit is 12 V. ✓✓
Die potensiaal verskil van die battery in 'n oop stroombaan is 12 V

OR/*OF*
The battery does 12 J of work per coulomb of charge.✓✓
Die battery verrig 12 J arbeid per coulomb lading

OR/*OF*
Maximum work done by the battery per unit charge is 12 J
Maksimum arbeid verrig deur die battery per eenheidslading is 12 J

OR/*OF*
Maximum energy supplied by the battery per unit charge is 12 J
Maksimum energie verskaf deur die battery per eenheidslading is 12 J

OR/*OF*
The battery supplies 12 J of energy per coulomb/ 12 J of energy per unit charge
Die battery verskaf 12 J energie per coulomb/12 J energie per eenheidslading

OR/*OF*
The greatest potential difference that can be generated by a battery is 12V
Die grootste potensiaalveskil wat deur 'n battery gelewer word, is 12 V

OR/*OF*
The total energy transferred by a battery to a unit electric charge is 12 J
Die totale energie oorgedra deur die battery aan 'n eenheid elektriese lading is 12 J

OR/*OF*
The total amount of electric energy supplied by the battery per coulomb/per unit charge is 12 J
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheid lading is 12 J (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af*

8.2.1 **OPTION 1/*OPSIE 1***

$V_{lost/verlore}$ = I r ✓
= (2) (0,5)
= 1 V

$V_{ext/eks}$ = Emf/*emk* – $V_{lost/verlore}$
= (12 - 1) ✓
= 11 V✓

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 ✓

(3)

8.2.2 **POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1***

OPTION 1/*OPSIE 1*
$R = \frac{V}{I}$
$= \frac{11}{2}$ ✓
$= 5,5\ \Omega$✓

OPTION 2/*OPSIE 2*
0,5:R
1:11 } ✓
$R = 5,5\ \Omega$✓

OPTION 3/*OPSIE 3*
$\frac{1}{0,5} = \frac{11}{R}$ ✓
$R = 5,5\ \Omega$✓

OPTION 4/*OPSIE 4*
$V_{total} = IR_{total}$
$12 = (2)R_{total}$
$R_{total} = 6\ \Omega$
$R = 6 - 0,5$ ✓
$= 5,5\ \Omega$ ✓

OPTION 5/*OPSIE 5*
$\varepsilon = I(R + r)$
$12 = 2(R + 0,5)$ ✓
$R = 5,5\ \Omega$ ✓

(2)

8.3 Decreases /*Neem af* ✓
Total resistance decreases /*Totale weerstand neem af*✓
Current increases/*Stroom neem toe* ✓
"Lost volts" increases, ✓(emf the same)/*"Verlore volts" neem toe, (emk dieselfde)*
External potential difference decreases/*eksterne potensiaal verskil neem af*

OR/*OF*
Decreases /*Neem af* ✓
Total resistance decreases /*Totale weerstand neem af* ✓
Current increases/*Stroom neem toe* ✓
$\varepsilon = V_{ext/eks} + Ir$
Ir increases/*Ir neem toe* ✓
ε is constant/*is konstant*
$\therefore V_{ext/eks}$ decreases/*neem af* (4)
[11]

QUESTION 9/*VRAAG 9*

9.1 Temperature/*Temperatuur* ✓ (1)

9.2.1 *r* = 3 Ω or/*of* 1,5 Ω ✓✓

Accept *for one mark only*: /*Aanvaar vir slegs een punt*
r = -3 Ω ✓ or/of -1,5 Ω (2)

9.2.2 ε = slope (gradient) of the graph/*helling(gradiënt)van die grafiek* ✓

$\varepsilon = \frac{7,5-(-3)}{1,5-0}$ ✓
= 7 V✓

Accept any correct values from the graph
Aanvaar enige korrekte waardes vanaf die grafiek

OR/*OF*
POSITIVE MARKING FROM 9.2.1 / *POSITIEWE NASIEN VANAF 9.2.1*

$R = \frac{\varepsilon}{I} - r$ ✓
$7,5 = 1,5\varepsilon - 3$ ✓
ε = 7 V ✓

Accept any correct values on the line from the graph
Aanvaar enige korrekte waardes op die lyn vanaf die grafiek

OR/OF
ε = I(R + r) ✓
= 0,5(11 + 3) ✓
ε = 7 V ✓ (3)
[6]

QUESTION 9/*VRAAG 9*

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.✓✓.
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.

OR/*OF*
The current in a conductor is directly proportional to the potential difference across the conductor at constant temperature. ✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor die geleier by konstante temperatuur (2)

9.1.2 Graph X./*Grafiek X*✓
Graph X is a straight line (passing through the origin) therefore potential difference is directly proportional to current. ✓
/*Grafiek X is lineêr*
(2)

9.2.1

$$\frac{1}{R_{//}} = \frac{1}{R_{10}} + \frac{1}{R_{15}}$$

$$\frac{1}{R_{//}} = \frac{1}{10} + \frac{1}{15}\checkmark$$

$R_{//} = 6\ \Omega$

$$R_{//} = \frac{R_{10} \times R_{15}}{R_{10} + R_{15}}$$

$$R_{//} = \frac{10 \times 15}{25}\checkmark$$

$= 6\ \Omega$

$\therefore R = (10 + 6 + 2)\checkmark$(for the addition/*vir optelling*)
$= 18\ \Omega$

$R_{ext} = (10 + 6) = 16\ \Omega$

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

$6 = I(16 + 2)\checkmark$

$I = 0{,}33\ A\checkmark$

✓

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

$$I = \frac{6}{18}\checkmark$$

$= 0{,}33\ A\checkmark$ (5)

9.2.2 Decrease. ✓
The total resistance of the circuit increases✓.
Afneem
Die totale weerstand van die stroombaan neem toe. (2)

9.2.3 Increase/*Neem toe* ✓ (1)

9.2.4 The total resistance in the external circuit increases./*Die totale weerstand in die eksterne stroombaan neem toe*✓
Current decreases/*Stroom neem af*✓
"Lost" volts decreases/*"Verlore" volts neem af*✓

OR/*OF*

The total resistance in the external circuit increases./*Die totale weerstand in die eksterne stroombaan neem toe* ✓
V α R✓ for constant/*vir konstante* I✓
Therefore V increases./*Dus neem V toe* (3)
[15]

QUESTION 10/*VRAAG10*

10.1 **ANY THREE/*ENIGE DRIE***
I. Permanent magnets/*Permanente magnete*
II. coils (armature)/*spoel*
III. commutator/*kommutator*
IV. brushes/*borsels*
V. power supply/battery/*kragbron* (3)

10.2.1 The rms voltage of AC is the potential difference which dissipates the same amount of energy as the equivalent DC potential difference. ✓✓
Die wgk spanning/potensiaalverskil van WS is die potensiaalverskil wat dieselfde aantal energie verkwis as GS.
Accept formula for V_{rms} as 1 mark. (2)

10.2.2 **OPTION 1/*OPSIE 1***

$V_{rms} = I_{rms}R$ ✓

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

$I_{rms} = \frac{240}{11}$ ✓

$= 21,82\ A$

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

$I_{max} = (21,82)\sqrt{2}$ ✓

$I_{max} = 30,86\ A$✓

OPTION 2/*OPSIE 2*

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

$V_{max} = (240)\sqrt{2}$ ✓

$= 339,41$

$V_{max} = I_{max}R$

$I_{max} = \frac{339,41}{11}$ ✓

$I_{max} = 30,86\ A$✓

OPTION 3/*OPSIE 3*

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$P_{ave} = \frac{(240)^2}{11}$ ✓

$P_{ave} = 5236,36\ W$

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

$5236,36 = I_{rms}240$

$I_{rms} = 21,82\ A$

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

$21,82 = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max} = 30,86\ A$ ✓

$P_{ave} = \frac{I_{max}V_{max}}{2}$

$P_{ave} = \frac{I_{max}V_{rms}\sqrt{2}}{2}$

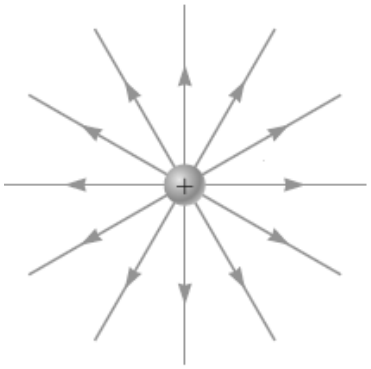
$5236,36 = \frac{I_{max}(240)\sqrt{2}}{2}$ ✓

$I_{max} = 30,86\ A$ ✓

(4)
[9]

QUESTION 8/*VRAAG 8*

8.1 (2)



Criteria for sketch/*Kriteria vir skets*	Marks/ *Punte*
Lines are directed away from the charge / *Lyne is weg vanaf die lading*	✓
Lines are radial, start on sphere and do not cross./*Lyne is radiaal, begin op die sfeer en kruis nie*	✓

8.2

Q = ne✓
= (8 x 10^{13})(-1,6 x10^{-19}) ✓ or/*of* (8 x 10^{13})(1,6 x 10^{-19})
= -12,8 x 10^{-6}
Net charge on the sphere = (+ 6 x 10^{-6}) + (-12,8 x 10^{-6}) ✓
Q_{net} = - 6,8 x 10^{-6} C

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

$$E=\frac{(9\times10^{9})(6{,}8\times10^{-6})}{(0{,}5)^2}\ \checkmark$$

= 2,45 x 10^{5} N·C^{-1}✓ towards sphere ✓/*na die sfeer* (7)

[9]

QUESTION 9/*VRAAG 9*

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstate temperatuur.

OR/*OF*
The ratio of potential difference across a conductor to the current in the conductor is constant, provided the temperature remains constant.
Die verhouding van potensiaalverskil oor die geleier tot stroom in die geleier is konstant indien die temperatuur konstant bly. (2)

NOTE:/LET WEL
If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte woorde in die **korrekte konteks** uitgelaat is trek 1 punt af.*

9.1.2

V_1 = IR ✓
= (0,6)(4) ✓
= 2,4 V ✓ (3)

9.1.3

POSITIVE MARKING FROM 9.1.2/ *POSITIEWE NASIEN VANAF 9.1.2*	**OR/*OF***	**OR/*OF***
$I_{6\Omega} = \frac{V}{R}$ $= \frac{2,4}{6}$ ✓ $= 0,4$ A✓	$\frac{6}{10}(I) = 0,6$ ✓ $I = 1$ A $I_{6\Omega} = 0,4$ A✓	$V_{4\Omega} = V_{6\Omega}$ $I_{4\Omega}R_1 = I_{6\Omega}R_2$ $(0,6)(4) = I_{6\Omega}(6)$ ✓ $I_{6\Omega} = 0,4$ A ✓

(2)

9.1.4

POSITIVE MARKING FROM 9.1.3 /*POSITIEWE NASIEN VANAF 9.1.3*

$V_2 = IR$
$= (0,4 + 0,6)(5,8)$ ✓
$= 5,8$ V ✓

(2)

9.1.5

POSITIVE MARKING FROM 9.1.4 AND 9.1.2/*POSITIEWE NASIEN VANAF 9.1.4 EN 9.1.2*

OPTION 1/ *OPSIE 1*

$V_{ext} = (5,8 + 2,4)$ ✓
$= 8,2$ V
$V_{int} = Ir$
$= (1)(0,8)$ ✓
$= 0,8$ V
Emf $= 0,8 + 8,2 = 9$ V✓

OPTION 2/*OPSIE 2*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$
$= \frac{1}{6} + \frac{1}{4}$
$= \frac{5}{12}$
$R_p = 2,4\ \Omega$
$R_{ext} = (2,4 + 5,8)$ ✓
$= 8,2\ \Omega$
Emf $= I(R + r)$
$= 1\ (8,2 + 0,8)$ ✓
$= 9$ V ✓

$R_{//} = \frac{R_1R_2}{R_1+R_2}$
$= \frac{(6)(4)}{(6+4)}$
$= 2,4\ \Omega$

(3)

9.1.6

POSITIVE MARKING FROM 9.1.5 AND 9.1.3/ *POSITIEWE NASIEN VANAF 9.1.5 EN 9.1.3*

$W = V I \Delta t$ ✓ $= (0,8)(1)\ (15)$ ✓ $= 12$ J ✓	$W = I^2R \Delta t$ ✓ $= (1)^2\ (0,8)(15)$ ✓ $= 12$ J✓	$W = \frac{V^2 \Delta t}{R}$ ✓ $= \frac{0,8^2\,(15)}{0,8}$ ✓ $= 12$ J ✓

(3)

9.2.1
$$R = \frac{V}{I}$$
$$= \frac{2,8}{0,7} \checkmark$$
$$= 4\ \Omega \checkmark$$
(2)

9.2.2 Increases ✓/*Neem toe*
Total resistance decreases, ✓ current/power increases✓, motor turns faster/
Totale weerstand neem af, stroom/drywing neem toe, motor draai vinniger (3)
[20]

QUESTION 10/*VRAAG 10*

10.1
10.1.1 Split ring / commutator ✓/*Spleetring/ kommutator* (1)

10.1.2 Anticlockwise ✓✓/*Antikloksgewys* (2)

10.1.3 Electrical energy ✓to mechanical(kinetic) energy ✓
Elektriese energie na meganiese (kinetiese) energie (2)

10.2
10.2.1 DC generator: split ring/commutator and AC generator has slip rings✓
GS-generator spleetringe/kommutator en WS-generator sleepringe

OR/*OF*
AC generator: slip ring and DC generator has split rings✓
WS-generator sleepringe en GS-generator spleetringe (1)

10.2.2
$$V_{rms} = \frac{V_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{320}{\sqrt{2}} \checkmark$$
$$= 226,27\ V \checkmark$$
(3)

10.2.3
<u>OPTION 2/*OPSIE 12*</u>
$$I_{max} = \frac{V_{max}}{R}$$
$$= \frac{320}{35} \checkmark$$
$$= 9,14\ A$$
$$I_{rms} = \frac{I_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{9,14}{\sqrt{2}} \checkmark$$
$$= 6,46\ A \checkmark$$

7.4

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

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

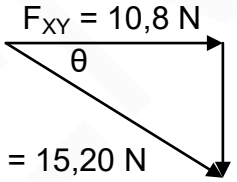
$10{,}696\checkmark = 9\times10^9 \times \frac{8\times10^{-6}\times Q_Z}{(0{,}30)^2}\checkmark$

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✓

(4)
[13]

QUESTION 8 / *VRAAG 8*

8.1 Electric field at a point is the force per <u>unit</u> <u>positive</u> charge placed at that point. ✓✓
Elektriese veld by 'n punt is die krag per <u>eenheids</u> <u>positiewe</u> lading geplaas by daardie punt. (2)

8.2

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

$E_{net} = (E_A + E_B)$

$= 9\times10^9 \frac{(1{,}5\times10^{-6})\checkmark}{(0{,}4)^2} + 9\times10^9 \frac{(2{,}0\times10^{-6})}{(0{,}3)^2}\checkmark$

= 2,84 x 10^5 N·C^{-1} ✓ (4)

8.3

OPTION 1/*OPSIE 1*

$F_E = qE$ ✓

= (3,0 x 10^{-9})(2,84 x 10^5) ✓

= 8,52 x 10^{-4} N ✓

OPTION 2/*OPSIE 2*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{net} = (F_A + F_B)$

$= \left(\frac{(9\times10^9)(3\times10^{-6})(1{,}5\times10^{-6})}{(0{,}4)^2} + \frac{(9\times10^9)(3\times10^{-6})(2{,}0\times10^{-6})}{(0{,}3)^2} \right)$ ✓

$= 8{,}53 \times 10^{-4}$ N ✓ (3)

[9]

QUESTION 9 / *VRAAG 9*

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

9.1.2 (Equivalent) resistance/ (*Ekwivalente) weerstand*✓ (1)

9.1.3 Gradient/*Helling* = $\frac{\Delta V}{\Delta I}$

$= \frac{2-0}{0{,}5-0}$ ✓ = 4 (Ω)✓ (2)

9.1.4 **OPTION 1/*OPSIE 1***

In series $R_1 + R_2 = 4\ \Omega$ ✓.....(1)

In parallel $\frac{R_1R_2}{R_1+R_2} = 1\ \Omega$ ✓✓.....(2)

$R_1R_2 = 4\ \Omega$

$\therefore R_1 = R_2 = 2\ \Omega$ ✓

OPTION 2/*OPSIE 2*

For graph X/*Vir grafiek X*:

$R_1 + R_2 = 4$……(1) ✓

For graph Y/*Vir grafiek Y*

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\left\{ \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = \left(\frac{1}{1} \right) \right\}$ ✓✓.....(2)

$R_1^2 - 4R_1 + 4 = 0$

$R_1 = 2\ \Omega$✓ (4)

9.2.1

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

$$= \frac{5}{(R_M + R_N)}$$

$$= \frac{5}{(6)} \checkmark$$

$$= 0{,}83 \text{ A} \checkmark$$

(3)

9.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\mathcal{E} = I(R + r)$ ✓ $= 0{,}83[(6 + 1{,}5)$ ✓$+ 0{,}9$✓$]$ $= 6{,}997$ V $= 7(,00)$ V✓ (6,972 – 7,00 V)	$\mathcal{E} = (V_s + V_{//} + V_r)$✓ / $V_{ext/eks} + V_{int}$ $= [5 + (0{,}833 \times 1{,}5)$ ✓$+ (0{,}9 \times 0{,}833)]$ ✓ $= 6{,}999$ V $= 7(,00)$ V✓ (6,972 – 7,00 V)

9.2.3 The resistance R_N will be 3 Ω ✓
The voltage divides (proportionately) in a series circuit. Since the voltage across **M** is half the total voltage, it means the resistances of **M** and **N** are equal.✓

Die weerstand R_N sal 3 Ω wees.
*Die potensiaalverskil verdeel (eweredig) in 'n serie stroombaan. Aangesien die potensiaalverskil oor **M** die helfte is van die totale potensiaalverskil, beteken dit dat die weerstande van **M** en **N** gelyk is.* (2)

[18]

QUESTION 8/*VRAAG 8*

NEGATIVE MARKING FOR 8.1.1,8.1.2 AND 8.1.3/NEGATIEWE *NASIEN VIR VRAAG 8.1.1, 8.1.2 EN 8.1.3*

8.1.1 **P** and **Q** burn with the same brightness ✓ same potential difference/same current✓
***P** en **Q** brand met dieselfde helderheid ✓dieselfde potensiaalverskil / dieselfde stroom*✓ (2)

8.1.2 **P is dimmer (less bright) than R/*P is minder helder as P***
OR/OF
R is brighter than P/*R is helderder as* P✓
R is connected across the battery alone therefore the voltage (terminal pd) is the same as the emf source (energy delivered by the source). ✓
***R** is alleen aan die battery gekoppel* ✓ *dus is die potensiaalverskil (terminale potensiaalverskil)dieselfde as die emk bron (energie gelewer deur die bron).*✓

OR/*OF*
The potential difference across **R** is twice (larger/greater than) that of **P**./The current through **R** is twice (larger/greater than) that of **P.**
*Die potensiaalverskil oor **R** is twee maal dié van **P**./Die stroom deur **R** is twee maal dié van **P**.*

OR/*OF*

P and **Q** are in series and are both connected across the same battery, ✓ hence the voltage (terminal pd) is shared equally ✓(P and Q are potential dividers) Therefore R is brighter.
***P** en **Q** is in serie en beide is oor dieselfde battery gekoppel, ✓ dus word die potensiaalverskil gelyk verdeel ✓(P en Q is potensiaal verdelers) Dus is R helderder.*

OR/*OF*

Potential difference across **P** is half that across **R***/Die potensiaalverskil oor **P** is die helfte die oor **R*** (2)

8.1.3 **T** does not light up at all✓
***T** brand glad nie*

ACCEPT/*AANVAAR*
T is dimmer (less bright) than R/T *is minder helder as R*✓

R is brighter than **T**✓
R** is helderder as **T

Reason/*Rede*
The wire acts as a short circuit. ✓
Die draad dien as 'n kortsluiting

OR/*OF*
The potential difference across T / current in T is zero.✓
Die potensiaalverskil oor T/stroom in T is nul. (2)

8.2.1

OPTION 1/*OPSIE 1*

$\frac{1}{R_{//}} = \frac{1}{R_5} + \frac{1}{R_{10}}$ ✓

$\frac{1}{R_{//}} = \frac{1}{5} + \frac{1}{10}$ ✓

$\therefore R_{//} = 3{,}33\ \Omega\ (3{,}333\ \Omega)$

$R_{//} = \frac{R_5 R_{10}}{R_5 + R_{10}}$ ✓

$= \frac{(5)(10)}{(5+10)}$ ✓ = 3,33 (3,333)Ω

$R_{tot} = R_8 + R_{//} + r$
$= (8 + 3{,}33 + 1)$✓
$= 12{,}33\ \Omega$

$I = \frac{V}{R}$ ✓

$I_{tot} = \frac{20}{12{,}33}$ ✓ = 1,62 A

$\therefore I_8 = 1{,}62$ A✓

$\varepsilon = I(R + r)$✓
$20 = I[(\ 11{,}33 + 1)$✓$]$ ✓
$I = 1{,}62$ A✓

OPTION 2/*OPSIE 2*

$$\frac{1}{R_{//}} = \frac{1}{R_5} + \frac{1}{R_{10}} \checkmark$$

$$\frac{1}{R_{//}} = \frac{1}{5} + \frac{1}{10} \quad \checkmark$$

$\therefore R_{//} = 3{,}33\ \Omega\ (3{,}333\ \Omega)$

$$R_{//} = \frac{R_5 R_{10}}{R_5 + R_{10}} \checkmark$$

$$= \frac{(5)(10)}{(5+10)} \checkmark = 3{,}33\ (3{,}333\ )\Omega$$

$R_{tot} = R_8 + R_{//} + r$

$= (8 + 3{,}33 + 1) \checkmark$

$= 12{,}33\ \Omega$

$$V_8 = \frac{8}{12{,}33} \times 20 = 12{,}973\,V$$

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

$$\therefore I_{tot} = I_8 = \frac{12{,}973}{8} \checkmark$$

$= 1{,}62\ A \checkmark$

(6)

8.2.2

OPTION 1/*OPSIE 1*

$V = IR$

$V_5 = \mathcal{E} - (V_8 + V_1)$

Any one/*Enige een*✓

$= 20 \checkmark - [\ 1{,}62(8 + 1)] \checkmark$

$= 5{,}42\ V \checkmark$

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$$R_{//} = \frac{(5)(10)}{(5+10)} = 3{,}33\Omega$$

$$V_{R//} = \frac{R_{//}}{R_{tot}} \times V_{tot} \checkmark$$

$$V_{R//} = \frac{(3{,}33)}{(12{,}33)}(20) \checkmark\checkmark$$

$= 5{,}41\ V \checkmark$

$V_{||} = IR_{||}$ ✓

$= (1{,}62)(3.33)$ ✓✓

$= 5{,}39\ V$ ✓

OPTION 3/*OPSIE 3*

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*

$I_5\ R_5 = I_{10} R_{10}$ ✓

$5I_5 = 10(1{,}62 - I_5)$ ✓

$I_5 = 1{,}08\ A$

$V_5 = (1{,}08\ )(5)$ ✓

$= 5{,}4\ V \checkmark$

(4)

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 4/*OPSIE 4*

$I_5 = \frac{10}{15} \times I_{tot}$ ✓

$= \frac{2}{3}(1{,}62)$

= 1,08 A

$\underline{V_5 = I_5 R_5}$ ✓

$V_5 = (1{,}08)(5)$ ✓

= 5,4 V✓ (4)

8.2.3

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 1/*OPSIE 1*

$P = \mathcal{I}V = I\mathcal{E}$ ✓

= (1,62)(20)✓

= 32,4 W✓

POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1*
OPTION 2/*OPSIE 2*

$P = \mathcal{I}V$✓

$P_{tot} = P_{8\Omega} + P_{//} + P_{1\Omega}$

$= \mathcal{I}V_8 + \mathcal{I}V_{//} + \mathcal{I}V_1$

$= I^2(R_8 + R_{//} + R_1)$

$= (1{,}62)^2[8 + 3{,}33 + 1)]$ ✓

= 32,36 W✓

POSITIVE MARKING FROM 8.2.1 AND 8.2.2/*POSITIEWE NASIEN VANAF*
OPTION 3/*OPSIE 3*
8.2.1 EN 8.2.2

$P = I^2R$✓

$I_5 = \frac{V_5}{R_5} = \frac{5{,}4}{5} = 1{,}08$ A

$\therefore I_{10} = 0{,}54$ A

$P_{tot} = I_8^2R_8 + I_1^2R_1 + I_5^2R_5 + I_{10}^2R_{10}$

$= (1{,}62)^2[8 + 1] + (1{,}08)^2(5) + (0{,}54)^2(10)$ ✓ = 32,37 W✓

OPTION 4/*OPSIE 4*

$P = \frac{V^2}{R}$ ✓ $P = \frac{20^2}{(8+1+3{,}33)}$ ✓ = 32,44 W✓	$P = I^2R_{tot}$ ✓ $= (1{,}62)^2(12{,}33)$ ✓ = 32,36 W✓

(3)

NOTE/*LET WEL*: Range/*Gebied* 32,35- 32,45

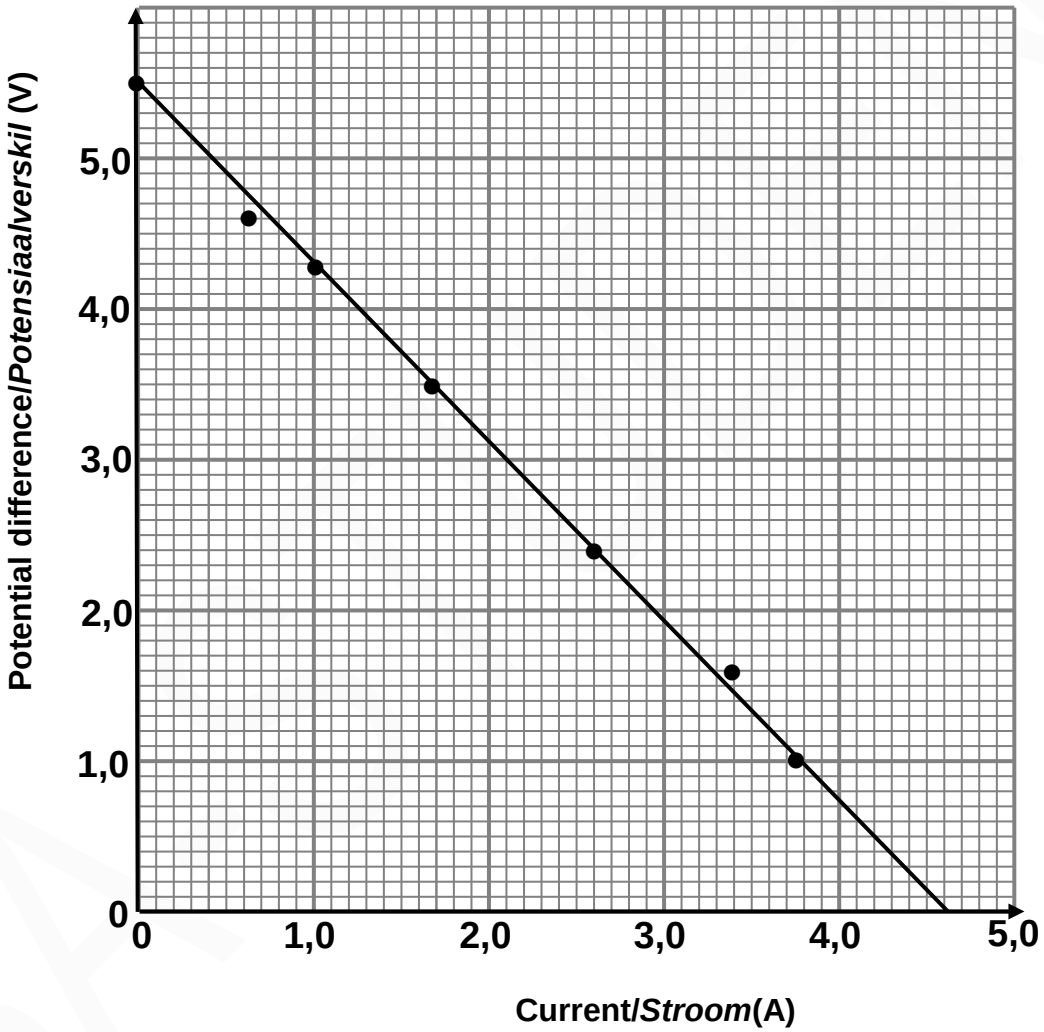
[19]

QUESTION/*VRAAG 9*

9.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom deur die geleier by konstante temperatuur.

NOTE/LET WEL
If constant temperature is omitted -1 mark
Indien konstante temperatuur weggelaat word -1 punt (2)

9.1.2 **Graph of potential difference versus current**
Grafiek van potensiaalverskil teenoor stroom



Straight line passing through 4 or five points✓.
Straight line with intercepts on both axes✓.
Reguitlyn deur 4 of 5 punte
Reguitlyn met afsnitte op beide asse (2)

9.1.3 5,5 V (accept any value from /*aanvaar enige waarde vanaf* 5,4 V to/*tot* 5,6 V based on graph drawn/*op die grafiek gebaseer*.)
NOTE */LET WEL* :
The value must be the y-intercept./ *Die waarde moet die y-afsnit wees.* (1)

9.1.4

Slope/*helling* $= \frac{\Delta V}{\Delta I}$ or/*of* $\frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{5{,}5 - 0}{0 - 4{,}6}$ ✓✓ $= -1{,}2$

Internal resistance/*Interne weerstand* (r) = 1,2 Ω✓

NOTE/*LET WEL*:
Any correct pair of coordinates chosen from the line drawn
Enige korrekte paar koördinate vanaf die getekende lyne gekies
For the equation $\varepsilon = I(R + r)$ or $\varepsilon = V_{ext} + Ir$ marks are awarded only if the correct I and V values are used from the graph
Vir die vergelyking $\varepsilon = I(R + r)$ of $\varepsilon = V_{ext} + Ir$ sal punte slegs toegeken word indien die korrekte waardes van I and V vanaf die grafiek gebruik is. (3)

9.2.1

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

✓any of these/*enige van hierdie*

$21{,}84 = I_{tot}\ (8)$ ✓
$I_{tot} = 2{,}73$ A✓ (3)

9.2.2

OPTION 1/*OPSIE 1*

$\frac{1}{R_{//}} = \frac{1}{R_{30}} + \frac{1}{R_{20}}$

$\frac{1}{R_{||}} = \frac{1}{30} + \frac{1}{20}$ ✓

$R_{||} = 12\ \Omega$✓

$R_{||} = \frac{R_{30} \times R_{20}}{R_{30} + R_{20}}$

$R_{||} = \frac{30 \times 20}{50}$ ✓
$= 12\ \Omega$✓

(2)

9.2.3

POSITIVE MARKING FROM QUESTION 9.2.1 AND 9.2.2
POSITIEWE NASIEN VANAF VRAAG 9.2.1 EN 9.2.2

OPTION 1/*OPSIE 1*
$R_{tot} = (8 + 12 + r)$ (for the addition/*vir optelling*)
$= (20 + r)$
$\varepsilon = I(R + r)$ ✓
60 ✓$= (2{,}73)(20 + r)$ ✓
$\therefore r = 1{,}98\ \Omega$✓

POSITIVE MARKING FROM QUESTION 9.2.1
POSITIEWE NASIEN VANAF VRAAG 9.2.1
OPTION 2/*OPSIE 2*

$V_{||} = I_{tot}R_{||}$
$= (2,73)(12)$ ✓
$= 32,76$ V

$\therefore V_{terminal} = (32,76 + 21,84)$ ✓ for addition/*vir optelling*
$= 54,6$ V

"V_{lost}" $= 60 - 54,6 = 5,4$ V

$\mathcal{E} = V_{lost} + V_{||} + V_8$
$60 = (V_{"lost"} + 32,76 + 21,84)$ ✓
$V_{"lost"} = 5,4$ V

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

✓any of these/*enige van hierdie*

$5,4 = 2,73\ r$
$r = 1,98\ \Omega$✓

NOTE/*LET WEL:*
No penalisation for omitted subscripts
Geen penalisering vir weggelate onderskrifte nie

(4)

9.2.4

POSITIVE MARKING FROM 9.2 1 AND 9.2.2
POSITIEWE NASIEN VANAF VRAAG 9.2.1 EN 9.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$W = \frac{V^2}{R}\Delta t$ ✓ $W = \frac{(54,6)^2}{20}(0,2)$ ✓ $= 29,81$ J✓	$W = I^2R\Delta t$✓ $= (2,73)^2\ (20)(0,2)$ ✓ $= 29,81$ J✓	$W = VI\Delta t$✓ $= (54,6)(2,73)(0,2)$ ✓ $= 29,81$ J ✓

(3)
[20]

QUESTION 8/*VRAAG 8*

8.1.1 (Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it ✓✓ / *Energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheid lading wat daardeur vloei.* (2)

8.1.2 12 (V)✓ (1)

8.1.3 0 (V) / Zero/*nul* ✓ (1)

8.1.4 $\varepsilon = I(R + r)$
$\varepsilon = V_{ext} + V_{int}$ } ✓
$12 = 11,7 + Ir$
$\underline{0,3 = I_{tot}(0,2)}$ ✓
$I_{tot} = 1,5$ A ✓

OR/*OF*
$V = IR$ ✓ (Accept/Aanvaar: $V_{"lost"} = Ir$)
$\underline{0,3 = I_{tot}(0,2)}$ ✓
$I_{tot} = 1,5$ A✓ (3)

8.1.5

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 2*</u>**
$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$ } ✓Any one *Enigeen* $\frac{1}{R} = \frac{1}{10} + \frac{1}{15}$ $R = 6\ \Omega$ ✓	$R_{\|\|} = \frac{R_1 R_2}{R_1 + R_2}$ } ✓Any one *Enigeen* $= \frac{(10)(15)}{10 + 15}$ $= 6\ \Omega$ ✓

(2)

8.1.6

POSITIVE MARKING FROM QUESTIONS 8.1.4 AND 8.1.5/*POSITIEWE NASIEN VANAF VRAE 8.1.4 EN 8.1.5*

<u>OPTION 1/*OPSIE 1*</u>

	OR/OF
$V = IR$ ✓ $11,7$✓ $= \underline{1,5(6 + R)}$ ✓ $R = 1,8\ \Omega$ ✓	$V = IR$ ✓ $\underline{11,7 = 1,5R}$ ✓ $R = 7,8\ \Omega$ ↘ $R_R = 7,8 - 6$ ✓ $= 1,8\ \Omega$ ✓

OPTION 2/*OPSIE 2*

$\varepsilon = I(R + r)$ ✓
$12 = 1,5(R + 0,2)$ ✓
$R = 7,8\ \Omega$

$R_R = 7,8 - 6$ ✓
$= 1,8\ \Omega$ ✓

OPTION 3/*OPSIE 3*

$V_{||} = IR_{||}$
$= (6)(1,5)$ ✓
$= 9$ V

$V_R = IR$ ✓
$(11,7 - 9) = (1,5)R$✓
$R = 1,8\ \Omega$✓ (4)

8.2.1

$P_{ave/gemid} = Fv_{ave/gemid}$ ✓$= mg(v_{ave/gemid})$
$= (0,35)(9,8)(0,4)$✓
$= 1,37$ W✓

OR/*OF*

$P = \frac{W_{nc}}{\Delta t}$ ✓$= \frac{\Delta E_k + \Delta E_p}{\Delta t} = \frac{0 + (0,35)(9,8)(0,4 - 0)}{1}$ ✓$= 1,37$ W ✓

OR/*OF*

$P = \frac{W}{\Delta t}$ ✓$= \frac{E_p}{\Delta t} = \frac{(0,35)(9,8)(0,4)}{1}$ ✓$= 1,37$ W ✓ (3)

8.2.2

POSITIVE MARKING FROM QUESTION 8.2.1/*POSITIEWE NASIEN VANAF VRAAG 8.2.1*

OPTION 1/*OPSIE 1*

$P = VI$
$1,37 = (3)I$ ✓
$I = 0,46$ A

$\varepsilon = V_{ext} + V_{int}$
$= V_T + V_X + V_{int}$
$12 = V_T + 3 + (0,2)(0,46)$ ✓
$V_T = 8,91$ V

$V_T = IR_T$
$8,91 = (0,46)R_T$ ✓
$R_T = 19,37\ \Omega$✓

✓Any one
Enigeen

OPTION 2/*OPSIE 2*

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

$1,37 = \frac{3^2}{R}$ ✓
$R = 6,57\ \Omega$

$P = VI$
$1,37 = (3)I$ ✓
$I = 0,46$ A

$\varepsilon = I(R + r)$
$12 = 0,46(6,57 + R_T + 0,2)$ ✓
$R_T = 19,38\ \Omega$ ✓

✓Any one
Enigeen

OPTION 3/*OPSIE 3*

$P = VI$ ✓
$1,37 = (3)I$ ✓
$I = 0,46$ A

$P_{tot} = P_r + P_{motor} + P_T$
$(12)(0,46)$✓ $= (0,46)^2(0,2) + 1,37 + (0,46)^2R_T$ ✓
$R_T = 19,41\ \Omega$ ✓

OR/*OF*

$P = VI$ ✓
$1,37 = (3)I$ ✓
$I = 0,46$ A

$P_{tot} = P_r + P_{motor} + P_T$
$(12)(0,46) = (0,46)^2(0,2) + 1,37 + P_T$ ✓
$P_T = 4,07$ W

$P=I^2R$
$4,07 = (0,46)^2R_T$ ✓
$R_T = 19,49\ \Omega$ ✓

OPTION 4/*OPSIE 4*

$P = VI$
$1,37 = (3)I$ ✓
$I = 0,46$ A

$\varepsilon = I(R + r)$
$12 = (0,46)(R + 0,2)$ ✓
$R = 25,87\ \Omega$

✓Any one
Enigeen

$V = IR$ $3 = (0,46)R$✓ $R = 6,52\ \Omega$ $R_T = 25,87 - 6,52$ $= 19,35\ \Omega$ ✓	$P = I^2R$ $1,37 = (0,46)^2R$✓ $R = 6,47\ \Omega$ $R_T = 25,87 - 6,47$ $= 19,4\ \Omega$ ✓	$P_{motor} = \frac{V^2}{R}$ $1,37 = \frac{3^2}{R}$ ✓ $R = 6,56\ \Omega$ $R_T = 25,87 - 6,56$ $= 19,31\ \Omega$ ✓

(5)
[21]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 $V = IR$✓
$= (0,2)(\underline{4+8})$✓
$= 2,4\ V$✓ (3)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1/*POSITIEWE NASIEN VANAF VRAAG 9.1.1***

$V = IR$	OR
$2,4 = I_2(2)$ ✓	$I_2 = 6 \times 0,2$ ✓
$I_{2\Omega} = 1,2\ A$✓	$I_2 = 1,2\ A$✓
$I_T = I_2 + 0,2\ A$✓	$I_T = I_2 + 0,2$ ✓
$= 1,4\ A$✓	$= 1,4\ A$✓

(4)

9.1.3 **POSITIVE MARKING FROM QUESTION 9.1.2/*POSITIEWE NASIEN VANAF VRAAG 9.1.2***

OPTION 2/*OPSIE* 2	**OR/*OF***
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓	$R_P = \frac{R_1 R_2}{R_1 + R_2}$ ✓
$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{2}$	$R_P = \frac{(12)(2)}{12+2}$
$R_P = 1,72\ \Omega$✓	$= 1,71\ \Omega$✓
$\varepsilon = I(R+r)$ ✓	$\varepsilon = I(R+r)$ ✓
$= 1,4(1,72+0,5)$ ✓	$= 1,4(1,71+0,5)$ ✓
$= 3,11\ V$✓	$= 3,09\ V$✓

OPTION 2/*OPSIE* 2
$V_{int} = Ir$✓
$=(1,4)(0,5)$
$= 0,7\ V$✓
$\varepsilon = V_{ext/eks} + V_{int}$✓
$= 2,4 + 0,7$✓
$= 3,1\ V$✓

(5)

9.2 Removing the 2 Ω resistor increases the total resistance of the circuit. ✓ Thus the <u>total current decreases, decreasing the V_{int} (V_{lost}).</u> ✓ Therefore the voltmeter reading increases. V✓/*Wanneer die 2 Ω-resistor verwyder word, verhoog dit die totale weerstand van die kring.* ✓ *Dus <u>verklein die totale stroom, wat die V_{int} ($V_{verloor}$) verlaag.</u>* ✓ *Dus verhoog die voltmeterlesing V.* ✓ (3)

[15]

QUESTION/*VRAAG 9*

9.1.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P = \frac{V^2}{R}$ ✓ $4 = \frac{V^2}{R} = \frac{(12)^2}{R}$ ✓ R = 36 Ω✓	P = VI 4 = I(12) I = 0,33...A V = IR✓ 12 = 0,33R✓ R = 36,36 Ω✓	P = V I 4 = I(12) I = 0,33 ..A P = I^2 R ✓ 4 = (0,33^2) R✓ R = 36,73 Ω✓

(3)

9.1.2 Increase/*Toeneem*✓ (1)

9.1.3 No change/*Geen verandering nie*✓

\-

Same potential difference✓ (and resistance)
Dieselfde potensiaalverskil (en weerstand) (2)

9.2.1

V = IR ✓
5 = I(6) ✓
∴ I = 0,83 A

$V_{"lost"}$ = Ir **OR/*OF*** ε = I(R + r)
1 = (0,83)r ✓ 6 = (0,83)(6 + r) ✓
r = 1,20 Ω✓ r = 1,23 Ω✓

(4)

9.2.2 Work done ✓in moving a unit charge ✓ through a cell.
Arbeid verrig ✓om 'n eenheidslading ✓deur 'n sel te beweeg.

ACCEPT/AANVAAR
Energy transferred per unit charge/*Energie oorgedra per eenheidslading*
Work done in moving in 1 C of charge. / *Arbeid verrig deur 1 C lading te beweeg* (2)

9.2.3

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM 9.2.1/*POSITIEWE NASIEN VANAF 9.2.1*
$V_{"lost"}$ = Ir
1,5✓ = I(1,2)
I = 1,25 A

$V_{||} = I_6R_6$
4,5 = I_6(6)✓
I_6 = 0,75 A

$V_x = IR_x$✓ **or/*of*** V = IR
4,5 = (1,25 – 0,75)R_x✓
Rx = 9 Ω✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 9.2.1/*POSITIEWE NASIEN VANAF 9.2.1*

$V_{"lost"} = Ir$
$1,5\checkmark = I(1,2)$
$I = 1,25$ A

$V_{||} = I_pR_p$
$4,5 = (1,25)R_p\checkmark$
$R_p = 3,6\ \Omega$

$\frac{1}{R_{//}} = \frac{1}{R_X} + \frac{1}{R_6}$ ✓
$\frac{1}{R_{//}} = \frac{1}{R_X} + \frac{1}{6}\checkmark$
$\therefore R_{//} = \frac{6R_X}{R_X + 6} = 3,6$
$R_X = 9\ \Omega\checkmark$

$R_{//} = \frac{R_X R_6}{R_X + R_6}$ ✓
$3,6 = \frac{(R_X)(6)}{(R_X + 6)}$ ✓
$R_X = 9\ \Omega\checkmark$

(5)
[17]

QUESTION/*VRAAG 10*

10.1.1 a to b/*a na b* ✓ (1)

10.1.2 Fleming's left hand rule /Left hand motor rule✓
Fleming se linkerhandreël / *Linkerhand motorreël*

ACCEPT/*AANVAAR*
Right hand rule
Regterhandreël (1)

10.1.3 Split rings /commutator ✓ (1)
Splitringe / *kommutator*

10.2.1 Mechanical/Kinetic energy to electrical energy. ✓✓ (2 or/*of* 0)
Meganiese /kinetiese energie na elektriese energie (2)

10.2.2

OPTION 1/*OPSIE 1*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}\checkmark$
$= \frac{430}{\sqrt{2}}\checkmark$
$= 304,06$ V
$I = \frac{V}{R}\checkmark$
$= \frac{304,06}{400}$ ✓
$= 0,76$ A✓

OPTION 2/*OPSIE 2*

$V_{max} = I_{max}R$ ✓
$430 = I_{max}(400)$ ✓
$I_{max} = 1,075$
$I_{rms} = \frac{I_{max}}{\sqrt{2}}\checkmark = \frac{1,075}{\sqrt{2}}$ ✓
$= 0,76$ A✓

(5)

OPTION 3/*OPSIE 3*

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{(-2)2} = \frac{(9\times10^{9})(2\times10^{-9})(2\times10^{-5})}{(0,25)^2}$

$= 5,76 \times 10^{-3}$ N to the west/*na wes*

$F_{(-2)(-8)} = \frac{(9\times10^{9})(2\times10^{-9})(8\times10^{-6})}{(0,15)^2}$

$= 6,4 \times 10^{-3}$ N to the west/*na wes*

$F_{net} = (5,76 \times 10^{-3} + 6,4 \times 10^{-3})$ ✓

$= 1,22 \times 10^{-2}$ N ✓to the west/*na wes* ✓ (4)

8.3 $2,44 \times 10^{-2}$ N✓ (1)

[11]

QUESTION 9/*VRAAG 9*

9.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. (provided temperature and all other physical conditions are constant) ✓✓

Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly)

OR/*OF*

.

The current in a conductor is directly proportional to the potential difference across the conductor, provided temperature and all other physical conditions are constant ✓✓

Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur mits temperatuur en alle fisiese toestande konstant bly (2)

9.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V = IR$✓	$V = IR$✓
$V_8 = (0,5)(8)$✓ $= 4$ V	$V_8 = (0,5)(8)$ ✓ $= 4$ V
$V_8 = V_{16}$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$\therefore V_{16} = 4$ V	$= \frac{1}{8} + \frac{1}{16}$ ✓
$I_{16} = \frac{V}{R} = \frac{4}{16} = 0,25$ A	$R = 5,33\ \Omega$
$I_{tot//} = A_1 = (0,5 + 0,25)$ ✓ $= 0,75$ A✓	$I_{tot//} = \frac{4}{5,33}$
	$A_1 = 0,75$ A✓

(4)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$I_1R_1 = I_2R_2$✓ $(0,5)(8) = I_{16}(16)$ ✓ $I_{16} = \frac{(8)(0,5)}{16} = 0,25$ A $I_{tot//} = A_1 = (0,5 + 0,25)$ ✓$= 0,75$ A✓	$2R_{8\Omega} = R_{16\Omega}$✓ $\therefore I_{R16} = ½ I_{R8}$ ✓ $\therefore I_{R16} = ½ (0,5) = 0,25$ A $A_1 = (0,5 + 0,25)$ ✓ $= 0,75$ A✓

(4)

9.3

OPTION 1/*OPSIE 1*

$V = IR$
$V_{20\Omega} = (0,75)(20)$ ✓ $= 15$ V
$V_{//tot} = (15 + 4)$ ✓ $= 19$ V
$V_R = 19$ V
$P = VI$✓
$12 = (19)I$ ✓
$I_R = A_2 = 0,63$ A✓

(5)

OPTION 2/*OPSIE 2*

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{8} + \frac{1}{16}$✓
$R_{//} = 5,33\ \Omega$
$R_{//} + R_{20} = (5,33 + 20)$ ✓ $= 25,33\Omega$
$V_{//tot} = I(R_{//} + R_{20})$
$= (0,75)(25,33)$
$= 19$ V
$P = VI$
12✓ $= I(19)$ ✓
$I_R = A_2 = 0,63$ A✓

OR/*OF*

$R = \frac{R_1R_2}{R_1 + R_2} = \frac{8 \times 16}{8 + 16}$✓ $= 5,33\ \Omega$

(5)

OPTION 3/*OPSIE 3*

$V = IR$
$V_{20\Omega} = (0,75)(20)$ ✓ $= 15$ V
$V_{//tot} = (15 + 4)$ ✓ $= 19$ V
$V_R = 19$ V
$P = \frac{V^2}{R}$
$12 = \frac{(19)^2}{R}$
$R = 30,08\ \Omega$
$P = I^2R$✓
$12 = I^2(30,08)$✓
$I = 0,63$ A✓

(5)

9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$(\varepsilon) = I(R + r)$ ✓ $= V_{terminal} + V_{int}$ $= 19 + (0,75 + 0,63)(1)$ ✓ $= 20,38$ V✓	$V_{int} = Ir$ $= (0,75 + 0,63)(1)$✓ $= 1,38$ V $\varepsilon = V_{terminal} + V_{int}$ ✓ $= 19 + 1,38$ $= 20,38$ V ✓

(3)

OPTION 3/OPSIE 3

$R = \frac{V}{I} = \frac{19}{0,63} = 30,16\ \Omega$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{30,16} + \frac{1}{25,33}$ $\therefore R_p = 13,77\ \Omega$

$I_{tot} = 0,63 + 0,75 = 1,38$ A

$\varepsilon = I(R + r)$ ✓
$= (1,38)(13,77 + 1)$✓
$= 20,38$ V✓

[14]

7.3

7.3.1 Left /*Links* (west/*wes*) ✓ (1)

7.3.2 Take right as positive/*Neem regs as positief*

$E_{net} = E_A + E_B$ ✓

$$(3\times10^4) = -\frac{(9\times10^9)(2\times10^{-6})}{(1{,}5)^2} + \frac{(9\times10^9)Q_{final}}{(1)^2}$$ ✓ ✓

$Q_{final} = 4{,}22 \times 10^{-6}$ C ✓

$Q = ne$

$4{,}22 \times 10^{-6} = \frac{n(1{,}6\times10^{-19})}{}$ ✓

$n_f = 2{,}64 \times 10^{13}$ electrons/*elektrone* ✓

electrons removed/*elektrone verwyder*

$= (2{,}64 \times 10^{13} + 1{,}25 \times 10^{13})$ ✓

$= 3{,}89 \times 10^{13}$ electrons/*elektrone* ✓ (8)

[18]

Notes / *Aantekeninge*

No. electrons should be removed $= n_f - n_i$
allocate the 1 mark for the subtraction
Aantal elektrone wat verwyder moet word $= n_f - n_i$
Ken 1 punt toe vir aftrekking

QUESTION 8/*VRAAG 8*

8.1.1 Ensure that the wires have:/*Maak seker dat die drade*
The same length/*dieselfde lengte het*.✓
The same thickness/cross-sectional area/*dieselfde dikte/deursnit-area/ oppervlakte het*✓ (2)

8.1.2 Wire **A** (Resistor A)/*Draad A* ✓

$R = \frac{\Delta V}{\Delta I}$ ✓

$R_A = \frac{4{,}4}{0{,}4}$ ✓ $= 11\ \Omega$ ✓

$R_B = \frac{2{,}2}{0{,}4}$ ✓ $= 5{,}5\ \Omega$ ✓

$E = I^2 R\Delta t$ ✓

-

Accept any correct coordinates chosen from the graph
Aanvaar enige korrekte koördinate van die grafiek gekies.

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde tyd en stroom, sal die verwarming in A hoër wees omdat sy weerstand groter is as die van B.

ACCEPT/***AANVAAR***: $P = I^2R$
For the same current, the heat produced per unit time in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde stroom, sal die hitte vrygestel per eenheidstyd in A hoër wees omdat sy weerstand groter is as die van B. (8)

8.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$I_{5,5\Omega} : I_{11\Omega}$ 2 : 1 $I_{5,5\Omega}$ = (0,2)(2) ✓✓ = 0,4 A✓	V = IR $V_{11\ \Omega}$ = 0,2 x 11 =2,2 V✓ $V_{5,5} = V_{11}$ = 2,2 V✓ $I_{5,5} = \frac{2,2}{5,5}$ = 0,4 A✓

(3)

8.2.2

OPTION 1/OPSIE 1	**Notes / *Aantekeninge***
V = IR I_{tot} = (0,4 + 0,2) ✓ = 0,6 A $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$✓ $\frac{1}{Rp} = \frac{1}{11} + \frac{1}{5,5}$ ✓ R_P = 3,67 Ω $R_T = R_P + R_A$ = 3,67 + 11✓ =14,67Ω $\varepsilon = I(R + r)$ ✓ 9 = 0,6(14,67 +r) ✓ r = 0,33 Ω ✓	Accept/*Aanvaar* $R_P = \frac{R_1 R_2}{R_1 + R_2}$ ✓ $= \frac{11 \times 5,5}{11 + 5,5}$ ✓ = 3,67 Ω

(7)

OPTION 2/*OPSIE 2*
I_{tot} = (0,4 + 0,2) ✓ = 0,6 A $V_{ext} = V_{11\ \Omega} + V_{//}$ ✓ = $[I_{tot}(R_{11}) + 2,2]$ = 0,6 (11) ✓ + 2,2 = 8,8V✓ $\varepsilon = V_{ext} + I_{tot}(r)$ ✓ 9 = 8,8 + 0,6r✓ r = 0,33 Ω✓

(7)

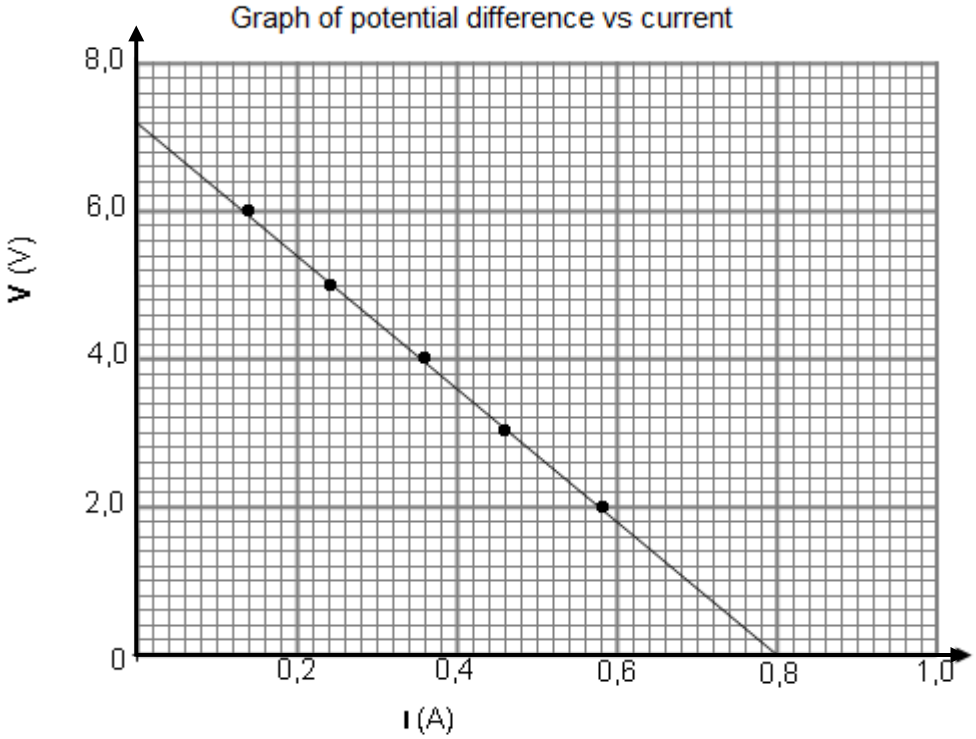
8.2.3 Decrease/*Afneem* ✓
The total resistance increases ✓/ *Die totale weerstand neem toe* (2)
[22]

QUESTION 8/*VRAAG 8*

8.1.1 Keep the temperature (of battery) constant.
Hou die temperatuur (van battery) konstant (1)

8.1.2

Grafiek van potensiaalverskil teenoor stroom



Criteria for drawing line of best fit:/*Kriteria vir teken van lyn van beste pas:*	Marks/ *Punte*
ALL points correctly plotted (at least 4 points) *ALLE punte korrek gestip (ten minste 4 punte)*	✓✓
Correct line of best fit if all plotted points are used (at least 3 point) *Korrekte lyn van beste pas indien alle punte gebruik word (ten minste 3 punte)*	✓

(3)

8.1.3 7,2 V✓
(Accept any readings between 7,0 V and 7,4 V or the value of the y-intercept
/*Aanvaar enige lesing tussen 7,0 V en 7,4 V of die waarde van die y-afsnit* (1)

8.1.4

$$\text{Slope/}\textit{Helling} = \frac{\Delta V}{\Delta I}$$
$$= \frac{0 - 7{,}2}{0{,}8 - 0} \checkmark\checkmark = -9$$
$$r = 9\ \Omega \checkmark$$

(3)

8.2.1

OPTION 1/*OPSIE 1*

$P = VI$ ✓
$100 = 20(I)$ ✓
$I = 5$ A ✓ (3)

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$V = IR$
$20 = I(4)$ ✓
$I = 5$ A ✓ (3)

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$P = I^2R$
$100 = I^2(4)$ ✓
$I = 5$ A ✓

8.2.2

OPTION 1/*OPSIE 1*

$P = \frac{V^2}{R}$ ✓
$R = \frac{(20)^2}{150}$ ✓
$= 2{,}67\ \Omega$ ✓ (3)

OPTION 2/OPSIE 2

$P = VI$ ✓
$150 = (20)I$
$I = 7{,}5$ A

$V = IR$
$20 = (7{,}5)R$ ✓
$R = 2{,}67\ \Omega$ ✓

OR/*OF*

$P = I^2R$
$150 = (7{,}5)^2R$ ✓
$R = 2{,}67\ \Omega$ ✓ (3)

OPTION 3/*OPSIE 3*

I_X : I_Y
5 : 7,5
1 : 1,5

R_X : R_Y
1,5 : 1✓
4 ✓: 2,67 Ω✓

(3)

8.2.3

OPTION 1/*OPSIE 1*

$P = VI$ **OR/*OF*** $P = I^2R$

$I_{150W} = \frac{150}{20}$ ✓ = 7,5 A $I_{150W} = \sqrt{\frac{150}{2,67}}$ ✓ = 7,5 A

I_{tot} = (5 + 7,5) ✓
$\varepsilon = I(R + r)$ ✓
24 = 12,5(R + r)
24 = $V_{ext} + V_{ir}$
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

OPTION 2/*OPSIE 2*

$V = Ir$✓
I_{tot} = (5 + 7,5) ✓
(24 - 20) ✓= 12,5 r✓
$\therefore r = \frac{4}{12,5}$
r = 0,32 Ω✓

(5)

OPTION 3/*OPSIE 3*

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

$\frac{1}{R_{//}} = \frac{1}{4} + \frac{1}{2,67}$ ✓ OR/*OF* $R_{//} = \frac{(4)(2,67)}{4 + 2,67}$

$\therefore R_{||}$ =1,6 Ω

$I_{tot} = \frac{20}{1,6}$ = 12,5 A✓

$\varepsilon = I(R + r)$ ✓

24 = 12,5(R + r)
24 = $V_{ext} + V_{ir}$
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

OPTION 4/*OPSIE 4*
$P = VI$✓
$250 = (20)I$✓
$I = 12,5$ A

$V = Ir$✓
$4 = (12,5)r$✓
$r = 0,32\ \Omega$ ✓ (5)

8.2.4 Device Z is a voltmeter ✓.
Toestel Z is 'n voltmeter (1)

8.2.5 Device **Z** should be a voltmeter (or a device with very high resistance) because it has a very high resistance✓ and will draw very little current. ✓
The current through **X** and **Y** will remain the same hence the device can operate as rated.
*Toestel **Z** moet 'n voltmeter wees (of 'n toestel met 'n baie hoë weerstand) omdat dit 'n baie hoë weerstand het en baie min sal stroom trek*
*Die stroom deur **X** en **Y** sal dieselfde bly, gevolglik kan die toestel werk soos ontwerp.* (2)
[22]

QUESTION 9/*VRAAG 9*

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

9.2 Rotate the coil faster/Increase the number of coils/ Increase the strength of the magnetic field.
Roteer die spoel vinniger/Verhoog die aantal spoele / Verhoog die sterkte van die magneetveld. (1)

9.3 Slip rings/*Sleepringe*✓ (1)

9.4.1 It is the value of the voltage in a DC circuit✓ that will have the same heating effect as an AC circuit. ✓
Dit is die waarde van die potensiaalverskil in 'n GS-stroombaan✓ wat dieselfde verhittingseffek het as 'n WS-stroombaan✓ (2)

9.4.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓
$= \frac{339,45}{\sqrt{2}}$ ✓
$V_{rms} = 240,03$ V ✓ (3)
[8]

QUESTION 9/*VRAAG 9*

9.1 The amount of energy ✓ given to each coulomb of charge ✓passing through the battery./*Die hoeveelheid energie ✓ oorgedra aan elke coulomb lading ✓ wat deur die battery beweeg.*

OR/*OF*

The maximum ability of a cell to do work./*Die maksimum vermoë van 'n sel om arbeid te verrig.* (2)

9.2 3 V ✓ (1)

9.3

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $= \frac{1}{4} + \frac{1}{1}$ ✓$= \frac{5}{4}$ $\therefore R_p = 0{,}8\ \Omega$ V = IR✓ 2,8 = I(0,8) ✓ I = 3,5 A✓	Current through 4 Ω resistor/*Stroom deur 4 Ω-weerstand*: V = IR✓ 2,8 = I(4) ✓ $\therefore$ I = 0,7 A Current through 1 Ω resistor/ *Stroom deur 1 Ω-weerstand*: V = IR 2,8 = I(1) ✓ $\therefore$ I = 2,8 A Total current through battery/*Totale stroom deur battery*: $I_T = I_1 + I_2$ = 0,7 + 2,8 ✓= 3,5 A ✓

(5)

9.4 **POSITIVE MARKING FROM QUESTION 9.3./*POSITIEWE NASIEN VAN VRAAG 9.3.***

OPTION 1 / *OPSIE 1*

Emf = I(R + r) ✓
3 ✓= 3,5(0,8 + 2r) ✓
2r = 0,06 Ω (0,057 Ω) ✓
$\therefore$ r = 0,03 Ω✓

OPTION 2 / *OPSIE 2*

$V_{"lost"}$ = 3 – 2,8 ✓= 0,2 V
$V_{"lost"}$ =Ir_{total}✓
0,2 = 3,5r ✓
r_{total} = 0,057 Ω✓
$\therefore r_{internal}$ of each cell = 0,03 Ω✓ (5)

9.5

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

9.5.2 Decreases/*Neem af* ✓
Total resistance decreases./*Totale weerstand verminder.* ✓
Current (through battery) increases./*Stroom (deur die battery) verhoog* ✓
'Lost volts' increases./*'Verlore volts' neem toe*. ✓ (4)

[18]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 From graph/*Van grafiek:* $\frac{R}{V}$ ✓

OR/*OF*

From equation/*Van vergelyking*: $\frac{r}{E}$ (1)

9.1.2 $\frac{1}{E} = 0,65$ ✓

$\therefore E = 1,54$ V✓ (2)

9.1.3 $\frac{r}{E} = \frac{2-1}{4-1}$ ✓✓

$\therefore r = 0,51\ \Omega$ ✓

(Any set of values from the graph can be used to calculate the gradient./*Enige stel waardes van die grafiek kan gebruik word om die gradiënt te bereken.)* (3)

9.2

9.2.1 Emf/*emk* = $I(R + r)$ ✓

$6 = I(9 + 1)$ ✓

$\therefore I = 0,6$ A ✓ (3)

9.2.2 $P = I^2R$ ✓

$1,8 = (0,6)^2R_1$ ✓

$R_1 = 5\ \Omega$

$R_p = 9 - 5 = 4\ \Omega$ ✓

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

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

$\therefore R_2 = 5\ \Omega$ ✓ (5)

9.3 $W = VI\Delta t$ ✓

$= (240)(9,5)(12)(60)$ ✓

$= 1,64 \times 10^6$ J

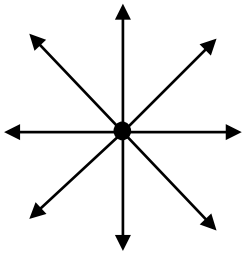
Cost/*Koste* = $\frac{1,64 \times 10^6}{3,6 \times 10^6} \times 1,47$ ✓

= R0,67 or/*of* 67 cents/*sent* ✓ (4)

[18]

QUESTION 8/*VRAAG 8*

8.1



Criteria for sketch:/*Kriteria vir skets:*	
Correct shape - field lines radially around charge. *Korrekte vorm – veldlyne radiaal uitwaarts.*	✓
Direction of field lines away from charge. *Rigting van veldlyne weg van lading af.*	✓

(2)

8.2 Non-uniform / *Nie-uniform* ✓ (1)

8.3
$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9\times10^{9})(16\times10^{-6})}{(0,12)^2} \checkmark$$
$$= 1 \times 10^{7}\ N\cdot C^{-1} \checkmark \text{ east/}oos \checkmark$$ (5)

8.4 Positive / *Positief* ✓ (1)

8.5

West: positive	**West: negative**
$E_A + E_B = E_{net}$	$E_A + E_B = E_{net}$
$-1 \times 10^{7} + E_B \checkmark = 1 \times 10^{7} \checkmark$	$1 \times 10^{7} + E_B \checkmark = -1 \times 10^{7} \checkmark$
$\therefore E_B = 2 \times 10^{7}\ N\cdot C^{-1}$	$\therefore E_B = -2 \times 10^{7}\ N\cdot C^{-1}$ $= 2 \times 10^{7}\ N\cdot C^{-1}$
$E_B = \frac{kQ_B}{r^2}$	$E_B = \frac{kQ_B}{r^2}$
$\therefore 2 \times 10^{7} \checkmark = \frac{(9\times10^{9})Q_B}{(0,23)^2} \checkmark$	$\therefore 2 \times 10^{7} \checkmark = \frac{(9\times10^{9})Q_B}{(0,23)^2} \checkmark$
$\therefore Q_B = 1,18\times10^{-4}\ C \checkmark$	$\therefore Q_B = 1,18\times10^{-4}\ C \checkmark$
(5)	(5)

(5)

[14]

QUESTION 9/*VRAAG 9*

9.1 12 J of energy are transferred to / work done on ✓
each coulomb (of charge) / per C charge ✓ passing through the battery.

12 J energie word oorgedra aan / arbeid word verrig op
elke coulomb (lading) / per C lading wat deur die battery beweeg. (2)

9.2

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$5 = I^2(5)$ ✓
$\therefore I = 1$ A ✓

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$
$5 = \frac{V^2}{5}$ ✓
$V = 5$ V
$P = VI$
$5 = (5)I$ ✓
$I = 1$ A✓

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$
$5 = \frac{V^2}{5}$ ✓
$V = 5$ V
$V = IR$
$5 = I(5)$ ✓
$I = 1$ A✓

(3)

9.3

OPTION 1 / *OPSIE 1*

Emf = $I(R + r)$ ✓
12 ✓= (1)(R + 1)
R = 11 Ω

$R_p = 11 - 5$✓ = 6 Ω

OPTION 2 / *OPSIE 2*

Emf = $I(R + r)$ ✓
12 ✓= (1)(R_p + 5 + 1)✓
$\therefore R_p = 6$ Ω

OPTION 3/OPSIE 3

$V = I R_T$ ✓
12✓ = (1)R
$R_T = 12$ Ω

$R_p = R_T - (5 + 1)$
$= 12 - 6$ ✓
$= 6$ Ω

$\frac{1}{R_p} = \frac{1}{R_{12}} + \frac{1}{R}$ ∴ $\frac{1}{6}$✓$= \frac{1}{12}$✓$+ \frac{1}{4+R_X}$✓∴ $\frac{1}{12} = \frac{1}{4+R_X}$ ∴ 12 = 4 + R_x ∴R_x = 8 Ω✓

OR/*OF*

$R_p = \frac{(4+R_X)(12)}{4+R_X+12}$ ∴ $R_p = \frac{(4+R_X)(12)}{4+R_X+12}$ ∴ 6 = $\frac{(4+R_X)(12)}{4+R_X+12}$ ∴ R_x = 8 Ω ✓

OPTION 4/*OPSIE 4*

$V_{5\Omega} = IR$ ✓
$= (1)(5)$
$= 5$ V

$V_{internal} = Ir$
$= (1)(1)$
$= 1$ V

$V_{parallel} = 12$✓$- (1 + 5)$ ✓
$= 6$ V

$V_{parallel} = IR$
$6 = I(12)$ ✓
$\therefore I = 0,5$ A

$I_{Rx} = 1 - 0,5$
$= 0,5$ A

$V = IR$
6✓ $= (0,5)(4 + R_x)$ ✓
$\therefore R_x = 8$ Ω ✓

(7)

9.4 

No / *Nee* ✓

Total resistance (R) increases. / *Totale weerstand (R) neem toe*.✓
Current (I) decreases / *Stroom (I) neem af.* ✓
(For a constant R) power (P = I^2R) decreases.✓
(Vir konstante R) drywing (P = I^2R) verminder. (4)
[16]

QUESTION 10/*VRAAG 10*

10.1
10.1.1 slip rings / *sleepringe* ✓ (1)

10.1.2 brush(es) / *borsel(s)* ✓ (1)

10.2 Maintains electrical contact with the slip rings.
Handhaaf elektriese kontak met die sleepringe.

OR/*OF*
To take current out/in of the coil.
Om die stroom uit/in die spoel te neem. (1)

10.3 Mechanical /kinetic energy to electrical energy. ✓
Meganiese / kinetiese energie na elektriese energie. (1)

10.4 1½ ✓ (1)

10.5

OPTION 1/ *OPSIE 1*

$f = \frac{1}{T}$ ✓

$= \frac{1}{0,02}$ ✓

= 50 Hz ✓

(3)

OPTION 2/ *OPSIE 2*

$f = \frac{\text{number of cycles}}{\text{time}}$ ✓

$= \frac{1,5}{0,03}$ or/of $\frac{1}{0,02}$ or/of $\frac{0,5}{0,01}$ ✓

= 50 Hz ✓

(3)

(3)

10.6 Parallel to / *Parallel aan* ✓ (1)

8.5.2 **POSITIVE MARKING FROM QUESTION 8.4.2 & 8.5.1.**
POSITIEWE NASIEN VAN VRAAG 8.4.2 & 8.5.1.

$W = F\Delta x\cos\theta$ ✓
$= (3{,}56 \times 10^{-16})(1{,}6 \times 10^{-3})$✓$\cos 0°$✓
$= 5{,}69 \times 10^{-19}$ J ✓

(4)
[15]

QUESTION 9/*VRAAG 9*

9.1
9.1.1 Potential difference/*Potensiaalverskil* ✓ (1)

9.1.2 Temperature/*Temperatuur* ✓
Resistance/*Weerstand* (1)

9.1.3 Current is directly proportional to potential difference. ✓✓
Stroom is direk eweredig aan potensiaalverskil

OR/*OF*
The ratio of potential difference to current is constant. ✓✓
Die verhouding van potensiaalverskil tot stroom is konstant.

IF/*INDIEN*:
Current is proportional to potential difference. ✓
Stroom is eweredig aan potensiaalverskil. (2)

9.1.4 Gradient/m = $\frac{0{,}18 - 0}{0{,}5 - 0}$ ✓ ✓ = 0,36

$R = \frac{1}{0{,}36}$ = 2,78 Ω ✓✓ (4)

Notes/*Aantekeninge:*
Accept any set of correct values from the graph.
Aanvaar enige stel waardes vanaf die grafiek.

9.2
9.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{6} + \frac{1}{10}$ ✓

$\therefore R_p$ = 3,75 Ω ✓ (3)

9.2.2 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VAN VRAAG 9.2.1.

OPTION 2 / *OPSIE 2*	**Notes/*Aantekeninge***
$V_p = I_{10\ \Omega}R$ $= 0,6 \times 10$ ✓ $= 6$ V $I_p = \frac{V_p}{R_p}$ $= \frac{6}{3,75}$ ✓ $= 1,6$ A ✓ ✓ Any one / *Enige een*	Do not penalise for subscripts. *Moenie penaliseer indien onderskrifte weggelaat is nie.*

OPTION 1/*OPSIE 2*	**Notes/*Aantekeninge***
$V_{10\ \Omega} = I_{10\ \Omega}R$ $= 0,6 \times 10$ ✓ $= 6$ V $I_{6\Omega} = \frac{V}{R}$ $= \frac{6}{6}$ ✓ $= 1$ A $I_{tot} = 1 + 0,6 = 1,6$ A ✓ ✓ Any one / *Enige een*	Do not penalise for subscripts. *Moenie penaliseer indien onderskrifte weggelaat is nie.*

(4)

9.2.3 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VAN VRAAG 9.2.1.

$E = I(R + r)$ ✓
30 ✓ $= 1,6(3,75 + 5 + 8 + r)$ ✓
$\therefore r = 2\ \Omega$ ✓ (4)

[19]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{60} + \frac{1}{60}$ ✓

$\therefore R_p = 30\ \Omega$ ✓ (3)

9.1.2

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2:***
$R_{ext} = 30 + 25 = 55\ \Omega$ ✓	$R_{tot} = (30 + 25)$ ✓$+1,5 = 56,5\ \Omega$
Emf/*emk* = I(R + r) ✓	V = IR✓
$\therefore 12$ ✓= I(55 + 1,5) ✓	12✓ = I(56,5) ✓
$\therefore$ I = 0,21 A ✓	$\therefore$ I = 0,21 A ✓

(5)

9.1.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
V = IR ✓	V = IR ✓
= (0,21)(30) ✓	= (0,105)(60) ✓
= 6,3 V ✓	= 6,3 V ✓

(3)

9.2

9.2.1 1,5 V ✓ (1)

9.2.2 gradient/m $= \frac{\Delta V}{\Delta I}$

$= \frac{0,65 - 1,5}{1,0 - 0}$ ✓✓

$= -0,85\ \Omega$ ✓ (3)

9.2.3 Internal resistance ✓✓
Interne weerstand (2)

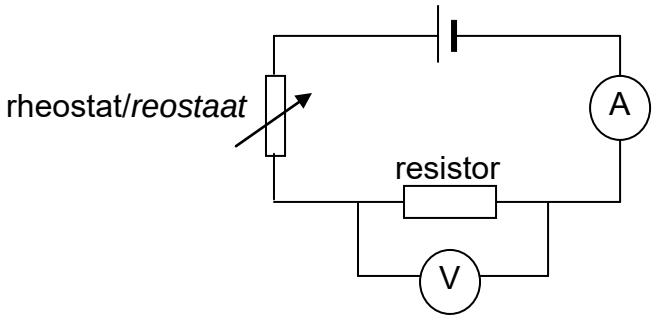
9.2.4 Decreases/*Verminder* ✓

When I increases/*Wanneer I toeneem:*
"Lost volts"/ Ir increases./*"Verlore volts"/Ir neem toe.* ✓
V_{ext} = emf – Ir decreases. ✓/V_{ext} = *emk – Ir neem af.* (3)

[20]

QUESTION 9/*VRAAG 9*

9.1
9.1.1



Criteria for circuit diagram/*Kriteria vir stroombaandiagram*	**Mark/*Punt***
Battery connected to the resistor as shown – correct symbols used. *Battery aan resistor geskakel soos getoon – korrekte simbole is gebruik.*	✓
Rheostat connected in series with resistor – correct symbols used. *Reostaat in serie geskakel met resistor – korrekte simbole is gebruik.*	✓
Ammeter connected in series so that it measures the current through resistor – correct symbols used. *Ammeter in serie geskakel sodat dit die stroom deur die resistor meet – korrekte simbole is gebruik.*	✓
Voltmeter connected in parallel across resistor – correct symbols used. *Voltmeter in parallel geskakel oor resistor – korrekte simbole is gebruik.*	✓

(4)

9.1.2 Temperature/*Temperatuur* ✓ (1)

9.1.3 B ✓

The ratio $\frac{V}{I}$ is greater than that of A. ✓✓

B ✓

Die verhouding $\frac{V}{I}$ *is groter as die van A.* ✓✓

OR/*OF*

B ✓

The ratio $\frac{I}{V}$ is smaller than that of A. ✓✓

B ✓

Die verhouding $\frac{I}{V}$ *is kleiner as die van A.* ✓✓

(3)

9.2

9.2.1 $\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓ $= \frac{1}{4} + \frac{1}{16}$ ✓

$\therefore$ R = 3,2 Ω ↘

$R_{effective/effektief}$ = 3,2 Ω + 2 Ω + 0,8 Ω✓
= 6 Ω ✓ (4)

9.2.2

Option 1/*Opsie 1:*	**Option 2/*Opsie 2*:**
V = IR ✓ 12 = I(6) ✓ I = 2 A ✓	emf = I(R + r) ✓ 12 = I(5,2 + 0,8) ✓ I = 2 A ✓

(3)

9.2.3

Option 1/*Opsie 1*:	**Option 2/*Opsie 2*:**
$V_{parallel}$ = IR ✓ =(2)(3,2) ✓ = 6,4 V ↓ $V_{8\Omega} = \frac{6,4}{2}$ ✓= 3,2 V ✓	$V_p = \frac{R_p}{R}$ x V ✓ $= \frac{3,2}{6}$ ✓ x 12 ✓ = 6,4 V $\therefore V_{8\Omega}$ = 3,2 V ✓
Option 3/*Opsie 3*:	**Option 4/*Opsie 4*:**
$I_{8\Omega} = \frac{4}{20}(2)$ ✓ = 0,4 A ↓ $V_{8\Omega}$ = IR ✓ = (0,4)(8) ✓ = 3,2 V ✓	emf = I(R + r) ✓ 12 = $IR_{2\,\Omega}$ + V_p + Ir 12 = (2)(2) + V_p + (2)(0,8) ✓ Vp = 6,4 V ↓ $V_{8\Omega} = \frac{6,4}{2}$ ✓= 3,2 V ✓

(4)
[19]

8.4

Option 1 / *Opsie 1*

$F_{TR} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^{9})(1{,}5\times10^{-9})(3\times10^{-9})}{1^2}$ ✓

$= 4{,}05 \times 10^{-8}$ N to the left/towards P
na links/na P toe

✓Any one
Enige een

$F_{PR} = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^{9})(1{,}5\times10^{-9})(3\times10^{-9})}{0{,}5^2}$ ✓

$= 1{,}62 \times 10^{-7}$ N to the right/towards T
na regs/na T toe

To the right / towards T as positive: / *Na regs* / *na T toe as positief*
$F_{net} = 1{,}62 \times 10^{-7} - 4{,}05 \times 10^{-8}$
$= 1{,}22 \times 10^{-7}$ N $(1{,}215 \times 10^{-7}$ N)
$= 1{,}22 \times 10^{-7}$ N ✓ to the right / towards T / *na regs / na T toe* ✓ (6)

[12]

QUESTION 9 / *VRAAG 9*

9.1 Current / I / *stroom* ✓ (1)

9.2
9.2.1 (4,0 ✓ ; 0,64) ✓ (2)

9.2.2 Temperature was not kept constant. ✓✓
Temperatuur is nie konstant gehou nie. ✓✓ (2)

9.3 Gradient/m = $\frac{\Delta y}{\Delta x} = \frac{0{,}64 - 0}{4 - 0}$ ✓ ✓ = 0,16

$R = \frac{1}{0{,}16} = 6{,}25\ \Omega$ ✓✓ (4)

[9]

QUESTION 10 / *VRAAG 10*

10.1 12 V ✓ (1)

10.2.1

Option 1 / *Opsie 1:*	**Option 2 / *Opsie 2:***
$I = \frac{V}{R}$ ✓ $= \frac{9{,}6}{2{,}4}$ ✓ = 4 A	emf = IR + Ir✓ 12 = I(2,4) + 2,4✓ ∴ I = 4 A✓

(3)

10.2.2

Option 1 / *Opsie 1:*	**Option 2 / *Opsie 2*:**
emf/*emk* = IR + Ir ✓ 12 = 9,6 + 4r ✓ ∴ r = 0,6 Ω ✓	$V_{lost/verlore}$ = Ir ✓ 2,4 = 4r ✓ ∴ r = 0,6 Ω ✓
Option 3 / *Opsie 3*: emf/*emk* = I(R + r) ✓ 12 = 4(2,4 + r) ✓ ∴ r = 0,6 Ω ✓	

(3)

10.3

Option 1 / *Opsie 1*:	**Option 2 / *Opsie 2*:**
emf/*emk* = I(R + r) ✓ 12 = 6(R + 0,6) ✓ $R_{ext/eks}$ = 1,4 Ω $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{1,4} = \frac{1}{2,4} + \frac{1}{R}$ ✓ ∴ R = 3,36 Ω Each tail lamp/*Elke agterlig:* : R = 1,68 Ω ✓	Emf = $V_{terminal}$ + Ir ✓ 12 = $V_{terminal}$ + 6(0,6) ✓ ∴ $V_{terminal}$ = 8,4 V $I_{2,4\ \Omega} = \frac{V}{R} = \frac{8,4}{2,4}$ = 3,5 A $I_{\text{tail lamps/agterligte}}$ = 6 – 3,5 = 2,5 A $R_{\text{tail lamps/agterligte}} = \frac{V}{I}$ ✓ $= \frac{8,4}{2,5}$ ✓ = 3,36 Ω $R_{\text{tail lamp/agterlig}}$ = 1,68 Ω ✓
Option 3 / *Opsie 3:*	**Option 4 / *Opsie 4:***
V = IR ✓ 12 = (6)R ✓ R_{ext} = 2 Ω ∴$R_{parallel}$ = 2 – 0,6 = 1,4 Ω $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{1,4} = \frac{1}{2,4} + \frac{1}{R}$ ✓ ∴ R = 3,36 Ω Each tail lamp/*Elke agterlig*: R = 1,68 Ω ✓	For parallel combination: $I_1 + I_2$ = 6 A *Vir parallelle kombinasie: $I_1 + I_2$ = 6 A* ∴ $\frac{V}{2,4} + \frac{V}{R_{taillamps}}$ ✓ = 6 ✓ 8,4✓ $(\frac{1}{2,4} + \frac{1}{R_{taillamps}})$✓ = 6 ∴ $R_{\text{tail lamps/agterligte}}$ = 3,36 $R_{\text{tail lamp/agterligte}}$ = 1,68 Ω ✓

(5)

10.4 Increases / *Vermeerder* ✓
Resistance increases, current decreases ✓
Ir (lost volts) decreases ✓

Vermeerder ✓
Weerstand verhoog, stroom verlaag ✓
Ir (verlore volts) verminder / neem af. ✓

(3)
[15]

10.3 $E(6\ \mu C) = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^{9})(6\times10^{-6})}{(0,2)^2}$ ✓ ✓

$= 1,35 \times 10^{6}\ N\cdot C^{-1}$ to the left/*na links*

$E(4\ \mu C) = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(4\times10^{-6})}{(0,6)^2}$ ✓ ✓

$= 1 \times 10^{5}\ N\cdot C^{-1}$ (to the right / *na regs)*

To the right as positive/*Na regs as positief:*

$E_{net/netto} = -1,35 \times 10^{6} + 1 \times 10^{5} = -1,25 \times 10^{6}\ N\cdot C^{-1}$ ✓

$E_{net/netto} = 1,25 \times 10^{6}\ N\cdot C^{-1}$ to the left / *na links* ✓

OR/*OF*

$E_{net} = \frac{kQ}{r^2}$ ✓ $= 9 \times 10^{9}\left(\frac{-6\times10^{-6}}{(0,2)^2} + \frac{(4\times10^{-6})}{(0,6)^2}\right)$ ✓ ✓

$= -1,35 \times 10^{6} + 1 \times 10^{5} = -1,25 \times 10^{6}$

$E_{net/netto}$ = 1,25 x 10^{6} N·C^{-1} in the direction of the field of the 6 μC charge/*in die rigting van veld van die 6* μ*C lading* ✓ [12.1.3] (6)

10.4 New charge/*Nuwe lading* = $\frac{(+4\times10^{-6}) + (-6\times10^{-6})}{2}$ ✓

$= -1 \times 10^{-6}$ C or/*of* – 1 μ*C*

$U = \frac{kQ_1Q_2}{r}$ ✓

$= \frac{(9\times10^{9})(-1\times10^{-6})(-1\times10^{-6})}{(0,4)}$ ✓ ✓

$\therefore$ U = 2,25 x 10^{-2} J ✓ (0,02 J)

[12.1.3] (5)

[16]

QUESTION 11 / *VRAAG 11*

11.1 9 V ✓

Potential difference measured when:
switch is open / no current flows / circuit is open/no work done is in external circuit ✓
Potensiaalverskil gemeet wanneer:
die skakelaar oop is / geen stroom vloei nie / stroombaan oop is / geen arbeid verrig word in die eksterne stroombaan nie [12.2.2] (2)

11.2

Option 1 / *Opsie 1*:

Emf = IR + Ir ✓
9 ✓= 3(3R) ✓ + 3(0,3) ✓

$\therefore R = R_1 = \frac{9-0,9}{9} = 0,9\ \Omega$ ✓

Option 2 / *Opsie 2*:

Emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$V_{ext} = I(R_1 + R_2)$
8,1 = 3(3R) ✓ ∴ R_1 = 0,9 Ω ✓

Option 3 / *Opsie 3*:

emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$\therefore V_1 = \frac{8,1}{3} = 2,7$ V ($R_1 + R_2 = 3R$)

$R_1 = \frac{V_1}{I} = \frac{2,7}{3}$ ✓ = 0,9 Ω ✓

Option 4 / *Opsie 4*:

$R_t = \frac{V}{I}$ ✓ = $\frac{9}{3}$ ✓ = 3 Ω

$R_2 + R_1$ = 3 – 0,3 ✓ = 2,7 Ω = 3R

$\therefore R_1 = R = \frac{2,7}{3}$ ✓ = 0,9 Ω ✓

Option 5 / *Opsie 5*:

V_{int} = Ir ✓ = (3)(0,3) ✓ = 0,9 V

V_{ext} = 9✓ – 0,9 = = 8,1 V

$V_1 = IR_1 \therefore V_1 = 3R$
$V_{R2} = IR_2 \therefore V_{R2} = 3(2R) = 6R$

$V_1 + V_{R2} = 3R + 6R = 9R$
∴ 8,1 = 9R ✓ ∴ R = 0,9 Ω ✓

[12.1.3] (5)

11.3.1 Decreases / *Verminder* ✓ [12.2.2] (1)

11.3.2 Increases / *Vermeerder* ✓
Resistance decreases / *Weerstand verminder* ✓
Current increases / *Stroom vermeerder* ✓
Ir increases / *Ir vermeerder*

OR/*OF*
Increases / *Vermeerder* ✓
Current passes through wire QN / wire QN shorts the parallel combination of resistors R_2 and R_3 ✓
All the current passes through R_1 and also through battery, thus Ir increases ✓
Die stroom gaan deur draad QN / draad QN veroorsaak 'n kortsluiting van die parallelle kombinasie resistors R_2 en R_3
Al die stroom gaan deur R_1 en deur die battery, dus verhoog Ir [12.2.2] (3)

[11]

QUESTION 12/*VRAAG 12*

12.1.1 $I_{rms} = \frac{V_{rms}}{R}$ ✓ = $\frac{36}{12}$ ✓ = 3 A✓

OR/*OF*
$V_{4\,\Omega} + V_{8\,\Omega}$ = 36 V and/en $V_{4\,\Omega}:V_{8\,\Omega}$ = 1:2
$\therefore$ $V_{4\,\Omega}$ = 12 V
$I_{4\,\Omega} = \frac{V}{R}$ ✓ = $\frac{12}{4}$ ✓ = 3 A ✓ [12.2..3] (3)

12.1.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$\therefore$ 3 = $\frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max}$ = 4,24 A ✓ [12.2.3] (3)

12.1.3 $P_{ave} = I^2_{rms}R$ ✓ = $(3)^2(4)$ ✓ = 36 W✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = V_{rms}I_{rms}$ ✓ = (12)(3) ✓ = 36 W ✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = \frac{V^2_{rms}}{R}$ ✓ = $\frac{12^2}{4}$ ✓ = 36 W ✓ [12.2.3] (3)

12.2 $P_{4\,\Omega}$ = ½ P_8 or $P_{8\,\Omega}$ = 2 $P_{4\,\Omega}$ or /*of*
Smaller / *Kleiner* ✓($P_{4\,\Omega} < P_{8\,\Omega}$) or/*of* $P_{8\,\Omega} > P_{4\,\Omega}$)

$P_{ave} = I^2_{rms}R$, but since
I_{rms} is constant / *omdat* I_{wgk} *konstant is*✓
$P \propto R$ ✓

OR/*OF*
$P_{4\,\Omega}$ = ½ P_8 or $P_{8\,\Omega}$ = 2 $P_{4\,\Omega}$ or /*of*
Smaller / *Kleiner* ✓

$P_{ave} = V_{rms}I_{rms}$, since
I_{rms} is constant / *omdat* I_{wgk} *konstant is* ✓
$P_{ave} \propto V$ ✓ [12.2.2] (3)
[12]

