PHYSICAL SCIENCES

MATERIAL FOR GRADE 12

THIRD TERM

ELECTRIC CIRCUITS

MEMORANDA

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QUESTION 11/*VRAAG 11*

11.1 Any two/*Enige twee*:
Temperature / *Temperatuur*✓
Cross sectional area (thickness) of material / *Deursnitoppervlak (dikte) van materiaal.* ✓
Length/*Lengte* [12.1.1] (2)

11.2

Option 1 / Opsie 1

Conductor Q✓/*Geleier Q* ✓

For the same potential difference, ✓ wire Q has a higher current than wire P. ✓ Therefore wire Q has a lower resistance than wire P. ✓
Vir dieselfde potensiaalverskil, het draad Q 'n hoër stroom as draad P. Dus het draad Q 'n laer weerstand as draad P

Option 2 / Opsie 2

Conductor Q✓/*Geleier Q*
The gradient of the graph for wire Q is bigger than that for wire P. ✓
Die gradiënt van die grafiek vir draad Q is groter as dié vir draad P
Gradient = $\frac{I}{V}$ is bigger ✓, thus $\frac{V}{I}$ = R is smaller. ✓
Gradiënt = $\frac{I}{V}$ *is groter , dus* $\frac{V}{I}$ = *R is kleiner*

Option 3 / Opsie 3

Conductor Q✓/*Geleier Q* ✓

The gradient of the graph for wire Q is bigger than that for wire P. ✓
Die gradiënt van die grafiek vir draad Q is groter as dié vir draad P
Gradient = $\frac{1}{R}$ is bigger ✓, thus R is smaller. ✓
Gradiënt = $\frac{1}{R}$ *is groter , dus R is kleiner*

Option 4 / Opsie 4

Conductor Q✓/*Geleier Q* ✓
Gradient / Gradiënt = $\frac{I}{V}$ = conductance ✓✓ / konduktansie (geleidings vermoë)
Wire Q has a higher conductance than wire P✓/*Draad Q het 'n hoër konduktansie (geleidingsvermoë) as draad P*

[12.1.2] (4)
[6]

QUESTION 12/*VRAAG 12*

12.1 $V_{int} = 45 - 43,5 = 1,5\ V$ ✓

$I = \frac{V}{R}$ ✓ $= \frac{1,5}{0,5}$ ✓ $= 3\ A$ OR/OF

$V_{12\,\Omega} = IR_{12\,\Omega} = 3 \times 12$ ✓ $= 36\ V$ OR/OF

$V_{//} = 43,5$ ✓ $- 36 = 7,5\ V$ ✓

$I = \frac{V_{//}}{R} = \frac{7,5}{10}$ ✓ $= 0,75\ A$ ✓

emf/*emk* = $V_{ext} + V_{int}$ ✓
$45 = 43,5$ ✓ $+ I(0,5)$ ✓

$I = 3\ A$

emf/emk = I(R+r) OR/*OF* V = IR
$45 = 3(R + 0,5)$ ✓ $45 = 3R$ ✓
$R = 14,5\ \Omega$ $R = 15\ \Omega$

$R_p = 14,5 - 12 = 2,5\ \Omega$ ✓ $R_p = 15 - 12 - 0,5 = 2,5\ \Omega$ ✓

$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$

$\frac{1}{2,5} = \frac{1}{10} + \frac{1}{r}$

$R = 3,33\ \Omega$ ✓

Current divides in ratio 3:1

$\frac{1}{4} \times 3$ ✓ $= 0,75\ A$ ✓

[12.1.3] (8)

12.2 $I_R = 3 - 0,75 = 2,25\ A$ ✓

$R = \frac{V_{//}}{I} = \frac{7,5}{2,25}$ ✓ $= 3,33\ \Omega$ ✓ OR/OF

emf/*emk* = I(R+r)
$45 = 3(R + 0,5)$ ✓
$R = 14,5\ \Omega$

$R_p = 14,5 - 12 = 2,5\ \Omega$ ✓

$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} \therefore \frac{1}{2,5} = \frac{1}{10} + \frac{1}{r} \therefore R = 3,33\ \Omega$ ✓

[12.1.3] (3)

12.3 Increases/*Toeneem* ✓
The total resistance increases, ✓
therefore the current decreases✓ therefore $V_{internal}$ decrease ✓ therefore reading on V increases
Die totale weerstand neem toe Stroom neem af, V_{intern} neem af en dus neem V toe

[12.2.3] (4)
[15]

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QUESTION 12/*VRAAG 12*

12.1 $\frac{1}{R_e} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{1}{9}$ ✓ + $\frac{1}{23}$ ✓

$R = 6,47\ \Omega$ ✓

$R_{tot} = 6,47 + 2 + 0,2 = 8,67\ \Omega$ ✓

$I = \frac{V}{R} = \frac{12}{8,67}$ ✓ $= 1,41$ A✓

[12.1.3] (6)

12.2 Decreases ✓/*Afneem*

Effective resistance of circuit decreases ✓ (No current through 15 Ω and 8 Ω resistances)
Current increases ✓
Ir (lost volts) increases ✓
$V_{external}$ decreases

Effektiewe weerstand van die stroombaan neem af ✓ (Geen stroom deur die 15 Ω- en 8 Ω-weerstande)
Stroom neem toe ✓
Ir (verlore volts) neem toe ✓
$V_{ekstern}$ *neem af*

[12.2.2] (4)
[10]

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QUESTION 12/*VRAAG 12*

12.1.1 $V_1 = 12$ V ✓
$V_2 = 12$ V ✓ [12.1.2] (2)

12.1.2 $V_2 = 0$ V ✓ [12.1.2] (1)

12.1.3 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\therefore \frac{1}{R_p} = \frac{1}{12} + \frac{1}{6}$ ✓ $\therefore R_p = 4\ \Omega$

(+)

R(total/*totaal*) = 4 + 2 ✓ = 6 Ω ✓ [12.2.3] (4)

12.1.4 $R = \frac{V}{I}$ ✓ $\therefore 6 = \frac{9}{I}$ ✓ $\therefore I = 1{,}5$ A

EMF/*EMK* = IR + Ir ✓

12 = 9 ✓ + (1,5)r

$\therefore r = 2\ \Omega$ ✓ [12.1.3] (5)

12.2.1 In parallel:
$P_Y > P_X$ (given/*gegee*)

$V_Y = V_X$ ✓ (V is constant – parallel/*V is konstant – parallel*)
$\therefore \frac{V^2}{R_Y} > \frac{V^2}{R_X}$ ✓
$\therefore R_Y < R_X$ ✓ [12.1.3] (3)

12.2.2 In series/*In serie*
$I_Y = I_X$ / I is the same/*is dieselfde* ✓
$I^2R_Y < I^2R_X$ ✓
$P\ \alpha\ R$ ✓ (I constant/*konstant*) OR/OF $P_Y < P_X$ [12.2.2] (3)
[18]

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QUESTION 11/*VRAAG 11*

11.1 The current through a conductor is directly proportional to the potential difference across its ends at constant temperature. ✓✓

Die stroom in'n geleier is direk eweredig aan die potetsiaal-verskil oor sy ente by konstante temperatuur.

Only/*Slegs* $2/2$ or/*of* $0/2$

[12.2.1] (2)

11.2 Equal / *gelyk* ✓
2 A divides equally at T (and since I_M = 1 A it follows that I_N = 1 A) ✓
2 A verdeel gelyk by T en omdat I_M = 1 A volg dit dat I_N = 1 A)

OR/*OF*

$I \alpha \frac{1}{R}$, $\therefore R_M = R_N$

[12.2.2] (2)

11.3 emf = IR + Ir ✓$\therefore$ 17 = 14 + Ir ✓$\therefore$ Ir = 3 V

$r = \frac{V_{lost}}{I}$ ✓$= \frac{3}{2}$ ✓ = 1,5 Ω ✓

[12.1.3] (5)

11.4 $V_N = IR_N$ ✓= (1)(2) ✓= 2 V ✓ [12.2.3] (3)

11.5 V_Y = 14 – 2 = 12 V ✓

$V_Y = IR_Y$ ✓$\therefore$ 12 = (2)R_Y ✓
$\therefore R_Y$ = 6 Ω ✓

[12.1.3] (4)

[16]

QUESTION 10

10.1 The current in a conductor is directly proportional to the potential difference ✓
across its ends at constant temperature. ✓

OR
The ratio of potential difference to current is constant✓
at constant temperature ✓ [12.2.1] (2)

10.2.1 $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}$ ✓ $=\frac{1}{1,4}+\frac{1}{1,4}$ ✓ $\therefore R_p = 0,7\ \Omega$ ✓

OR

$R_p = \frac{R_1R_2}{R_1+R_2}$ ✓ $=\frac{1,4\times1,4}{1,4+1,4}$ ✓$= 0,7\ \Omega$ ✓

[12.2.3] (3)

10.2.2

OPTION 1:
emf = I(R + r) ✓
$\therefore$ 12 = I(0,7 + 0, 1) ✓
$\therefore$ I = 15 A

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

$0,7 = \frac{V}{15}$ ✓

$\therefore$V = 10,5 V ✓

OPTION 2:
$I = \frac{V}{R}$ ✓ $= \frac{12}{0,8}$ ✓ = 15 A

V = IR
= (15)(0,7) ✓
= 10,5 V ✓

emf = I(R + r)
12 = $V_{external}$ + (15)(0,1) ✓
$V_{external}$ = 12 – (15)(0,1)
= 10,5 V ✓

$V_{"lost"}$ = Ir = (15)(0,1) ✓= 1,5 V
$V_{external}$ = 12 – 1,5 V = 10,5 V✓

$I_{headlight} = \frac{15}{2}$ = 7,5 A✓
V = IR = (7,5)(1,4) = 10,5 V✓

OPTION 3
Voltage divides 0,7: 0,1 / 7:1
$\therefore V_{headlight} = \frac{7}{8}$ ✓✓x 12 ✓
= 10,5 V ✓

[12.2.3] (4)

10.2.3

OPTION 1

$P = \frac{V^2}{R}$ ✓

$= \frac{10,5^2}{1,4}$ ✓

= 78,75 W ✓

OPTION 2

I(light) = 7,5 A

P = VI ✓

= (10,5)(7,5) ✓

= 78,75 W ✓

OPTION 3

I(light) = 7,5 A

$P = I^2R$ ✓

$= (7,5)^2(1,4)$ ✓

= 78,75 W ✓

OPTIONS ACCEPTED ONLY BECAUSE BULBS ARE IDENTICAL:

$P_{total} = \frac{V^2}{R}$ ✓

$= \frac{(10,5)^2}{0,7}$

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

P_{total} = VI ✓

= (10,5)(15)

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

$P_{total} = I^2R$ ✓

$= (15)^2(0,7)$

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

[12.2.3] (3)

10.3 Decreases ✓

\- (Effective/ total) resistance decreases. ✓

(Total) current increases. ✓

"Lost volts" / $V_{internal}$ / Ir increases, thus potential difference / V (across headlights) decreases.✓

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

[12.1.3] (4)

[16]

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QUESTION 9

9.1
$R = \frac{V}{I}$ ✓
$= \frac{12}{1,2}$ ✓
$= 10\ \Omega$ ✓ [12.2.3] (3)

9.2
$R_{total} = R + r$ ✓
10✓ = (6 + 3,6)✓ + r
r = 0,4 Ω ✓ [12.2.3] (4)

9.3
$W = I^2Rt$ ✓
$= (1,2)^2(6)(180)$ ✓ OR $(1,2)^2(6)(3 \times 60)$
$= 1\ 555,2$ J ✓/$1,56 \times 10^3$J [12.2.3] (3)

9.4 9.4.1 Decreases ✓ (or any equivalent word) [12.2.2] (1)

9.4.2 Increases ✓ (or any equivalent word) [12.2.2] (1)

9.5
Increases ✓
R_{ext} decreases ✓ (significantly).
I through battery increases ✓ (significantly).

<u>$W = I^2rt$</u>/ Energy transfer to the battery / work done by battery <u>increases</u> (substantial). ✓

OR

$W = \frac{V^2}{r}t$ / Energy transfer to the battery / work done by battery <u>increases</u> (substantial). [12.1.3] (4)

[16]

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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 $R_{\text{tail lamps/agterligte}} = \frac{V}{I}$ ✓ $= \frac{8,4}{2,5}$ ✓ $= 3,36\ \Omega$ $R_{\text{tail lamp/agterlig}}$ = 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)

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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]

QUESTION 11

11.1 emf is the maximum amount of energy per unit charge which the cell can produce√√
emk is die maksimum hoeveelheid energie per eenheidslading wat die sel kan produseer. (2)

11.2 $V_{INT} = I \times r$√
$(30 - 28,5)$ √ $= 3 \times r$ √
$r = 0,5\ \Omega$√ (4)

11.3 0 V√ (1)

11.4 remains constant/bly dieselfde √ (1)

11.5 $1/R = 1/r_1 + 1/r_2$ √
$= 1/7 + 1/3$
$R = 2,1\Omega$√
$V = I R$√
$= 3 \times 2,1$
$= 6,3$ V√ (4)

11.6 $W = I^2Rt$ √
$= 3^2 \times 0,5 \times 60$ √
$= 270$ J √

$W = VIt$ ✓
$= 1,5 \times 3 \times 60$ ✓
$= 270$ J √

$W = V^2\Delta t/R$
$=(1,5)^2 \times 60/0,5$
$= 270$ J √ (3)
[15]

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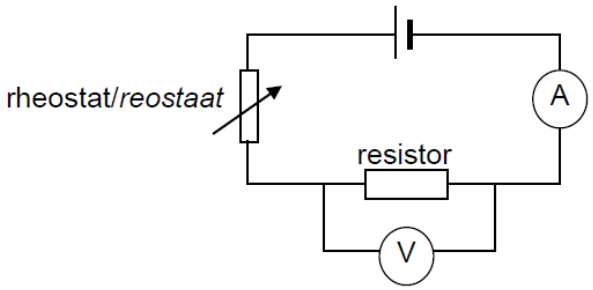
QUESTION 9/*VRAAG 9*

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)

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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]

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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 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)

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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/*VRAAG 9*

9.1 The maximum work done per unit charge.√√/
Die maksimum arbeid verrig per eenheid lading. √√ [12.2.2] (2)

9.2 $\frac{1}{R_P} = \frac{1}{4} + \frac{1}{6}$ √

$R_p = 2{,}4\ \Omega$ √

R (total) = 2,4 + 6 + 10 + 2 √

= 20, 4 Ω

$I = \frac{V}{R}$ √= $\frac{30}{20{,}4}$ √= $1{,}47\ A$√

OR /OF

R_{ex} = 2,4 + 6 +10 √ = 18, 4 Ω

emf = I (R +r) √

30 = I (18,4 + 2)√

I = 1,47 A √

(6)

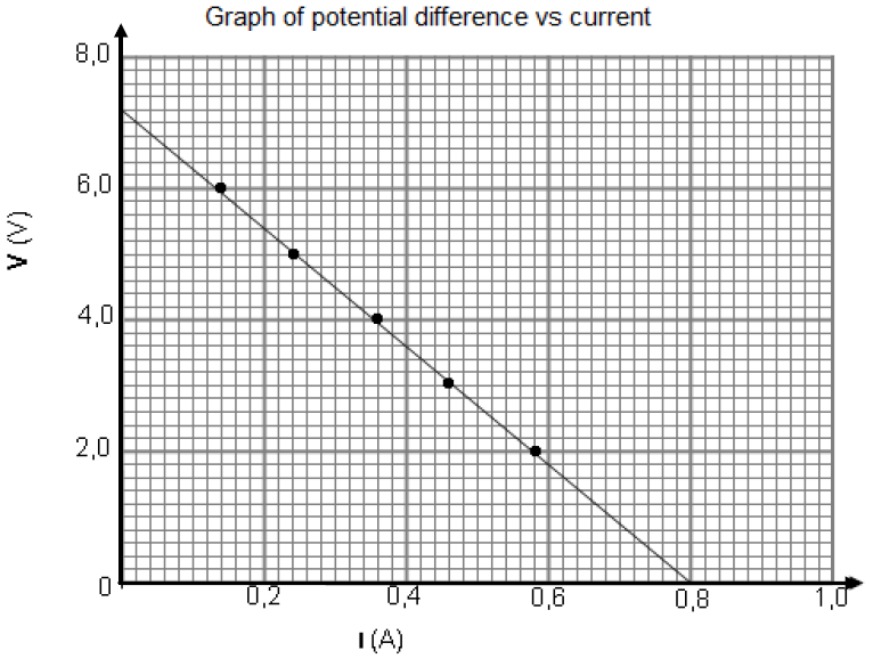
9.3 $V_p = IR_p$√= (1,47)(2,4) √= $3{,}53\ V$√ [12.3.1] (3)
[11]

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

$$\text{Slope/}Helling = \frac{\Delta V}{\Delta I}$$

$$= \frac{0 - 7{,}2}{0{,}8 - 0} \checkmark\checkmark = -9$$

$$r = 9\ \Omega\checkmark$$

(3)

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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)

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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

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

(5)

OPTION 2/*OPSIE 2*

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

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

$\therefore R_{||} = 1,6\ \Omega$

$I_{tot} = \frac{20}{1,6} = 12,5$ A✓

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

(5)

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OPTION 4/*OPSIE 4*

P = VI✓
250 = (20)I✓
I = 12,5 A

V = Ir✓
4 = (12,5)r✓
r = 0,32 Ω ✓ (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 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 Ω✓

$R_B = \frac{2,2}{0,4}$ ✓ = 5,5 Ω✓

$E = I^2 R\Delta t$✓

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)

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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✓	$V = IR$ $V_{11\ \Omega} = 0,2 \times 11$ $=2,2$ 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 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$✓ $\frac{1}{Rp} = \frac{1}{11} + \frac{1}{5,5}$ ✓ $R_P = 3,67\ \Omega$ $R_T = R_P + R_A$ $= 3,67 + 11$✓ $=14,67\Omega$ $\varepsilon = I(R + r)$ ✓ $9 = \underline{0,6(14,67 + r)}$ ✓ $r = 0,33\ \Omega$ ✓	Accept/*Aanvaar* $R_P = \frac{R_1 R_2}{R_1 + R_2}$ ✓ $= \frac{11 \times 5,5}{11 + 5,5}$ ✓ $= 3,67\ \Omega$

(7)

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

(7)

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

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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) (2)

9.2

OPTION 1/*OPSIE 1*

$V = IR$✓

$V_8 = (0,5)(8)$ ✓ $= 4$ V

$V_8 = V_{16}$

$\therefore V_{16} = 4$ V

$I_{16} = \frac{4}{16} = 0,25$ A✓

$I_{tot//} = A_1 = (0,5 + 0,25) = 0,75$ A✓ (4)

OPTION 2/*OPSIE 2*

$V = IR$✓

$V_8 = (0,5)(8)$ ✓ $= 4$ V

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

$= \frac{1}{8} + \frac{1}{16}$✓

$R = 5,33\ \Omega$

$I_{tot//} = \frac{4}{5,33}$

$A_1 = 0,75$ A✓ (4)

OPTION 3/*OPSIE 3*

$I_1R_1 = I_2R_2$✓

$(0,5)(8) = I_{16}(16)$ ✓

$I_{16} = = \frac{(8)(0,5)}{16} = = 0,25\ \Omega$✓

$I_{tot//} = A_1 = (0,5 + 0,25) = 0,75$ A✓ (4)

OPTION 4/*OPSIE 4*

$2R_{8\Omega} = R_{16\Omega}$✓

$\therefore I_{R16} = ½\ I_{R8}$ ✓

$\therefore I_{R16} = ½\ (0,5) = 0,25$✓

$A_1 = = (0,5 + 0,25) = 0,75$ A✓ (4)

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9.3

OPTION 1/*OPSIE 1*

POSITIVE MARKING FROM 9.2
POSITIEWE NASIEN VANAF 9.2

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

(5)

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 9.3
POSITIEWE NASIEN VANAF 9.3

Combined resistance/*Gekombineerde weerstand*:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{8} + \frac{1}{16}$$ ✓

$R = 5,33\Omega$

OR/*OF*

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

$R_{tot} = (5,33 + 20)$ ✓ $= 25,33\Omega$
$V = IR_{tot}$
$= (0,75)(25,33)$
$= 19$ V
$P = VI$✓
$12 = I\,(19)$ ✓
$I_R = A_2 = 0,63$ A✓

(5)

9.4 **POSITIVE MARKING FROM 9.2 AND 9.3**
POSTIEWE NASIEN VANAF 9.2 en 9.3

$(\varepsilon) = I(R + r)$ ✓
$= V_{terminal} + V_{lost}$
$= 19 + [(0,75+0,63)(1)]$ ✓
$= 20,38$ V✓

(3)
[14]

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