GRADE 12 REVISION 2013
ELECTRICITY AND MAGNETISM: ELECTRIC CIRCUITS - MEMORANDUM

MULTIPLE CHOICE QUESTIONS

1[1] A ✓✓
2[2] A ✓✓
3[2] C ✓✓
4[3] B ✓✓
5[4] A ✓✓
6[5] D ✓✓
7[6] C ✓✓

STRUCTURED QUESTIONS

QUESTION 1[7]

1.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{60} + \frac{1}{60}$ ✓

$\therefore R_p = 30\ \Omega$ ✓

1.2 $R_{ext} = 30 + 25 = 55\ \Omega$ ✓
Emf $= I(R + r)$ ✓
$\therefore 12$ ✓$= I(55 + 1,5)$ ✓
$\therefore I = 0,21$ A ✓

1.3 $V = IR$ ✓
$= (0,21)(30)$ ✓
$= 6,3$ V ✓

QUESTION 2[7]

2.1 1,5 V ✓

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

$= \frac{0,65 - 1,5}{1,0 - 0}$ ✓ ✓

$= -0,85\ \Omega$ ✓

2.3 Internal resistance ✓✓

2.4 Decreases ✓
When I increase*:*
"Lost volts"/ Ir increases. ✓
V_{ext} = <u>emf – Ir decreases.</u> ✓

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[1] Nov 2012
[2] Nov 2011
[3] Nov 2008
[4] Mrch 2012
[5] Mrch 2011
[6] Mrch 2010
[7] Nov 2012

QUESTION 3[8]

3.1 12 V ✓

3.2

3.2.1

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

3.2.2 emf = IR + Ir ✓
12 = 9,6 + 4r ✓
∴ r = 0,6 Ω ✓

2.3

Option 1	**Option 2**
emf = I(R + r) ✓ 12 = 6(R + 0,6) ✓ R_{ext} = 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 : 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 $I_{tail\ lamps}$ = 6 – 3,5 = 2,5 A $R_{tail\ lamps} = \frac{V}{I}$ ✓ $= \frac{8,4}{2,5}$ ✓ = 3,36 Ω $R_{tail\ lamp}$ = 1,68 Ω ✓
Option 3	**Option 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 R = 1,68 Ω ✓	For parallel combination: $I_1 + I_2$ = 6 A ∴ $\frac{V}{2,4} + \frac{V}{R_{taillamps}}$ ✓ = 6 ✓ 8,4✓ $(\frac{1}{2,4} + \frac{1}{R_{taillamps}})$✓ = 6 ∴ $R_{tail\ lamps}$ = 3,36 $R_{tail\ lamp}$ = 1,68 Ω ✓

3.4 Increases ✓
Resistance increases, current decreases ✓
Ir (lost volts) decreases ✓

QUESTION 4[9]

4.1 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. ✓

[8] Nov 2011
[9] Nov 2010

4.2

4.2.1 $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}$ ✓ = $\frac{1}{1,4}+\frac{1}{1,4}$ ✓ ∴ R_p = 0,7 Ω ✓

OR

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

4.2.2

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

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

$0,7 = \frac{V}{15}$ ✓
∴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
∴$V_{headlight} = \frac{7}{8}$ ✓✓x 12 ✓
= 10,5 V ✓
= 11,83 V ✓

4.2.3

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 ✓

4.3 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.

QUESTION 5[10]

5.1 9 V ✓
Potential difference measured when:
switch is open / no current flows / circuit is open/no work done is in external circuit ✓

5.2

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 ✓

5.3 Decreases ✓

5.4 Increases ✓
Resistance decreases. ✓
Current increases. ✓
Ir increases.

QUESTION 6[11]

6.1 Any two:
Temperature ✓
Cross sectional area (thickness) of material ✓
Length

6.2

Conductor 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. ✓

OR

Conductor Q✓
The gradient of the graph for wire Q is bigger than that for wire P. ✓
Gradient = $\frac{I}{V}$ is bigger ✓, thus $\frac{V}{I}$ = R is smaller. ✓

[10] Nov 2009
[11] Nov 2008

QUESTION 7[12]

7.1 $V_{int} = 45 - 43,5 = 1,5$ V ✓

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

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

✓ ✓

$V_{//} = 43,5 -$ ✓ $36 = 7,5$ V

(If only $V_{//} = 7,5$ V: 2 marks)

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

7.2 $I_R = 3 - 0,75 = 2,25$ A ✓

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

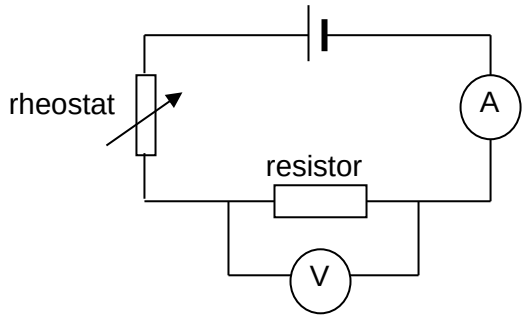
7.3 Increases ✓

The total resistance increases, ✓

therefore the current decreases ✓ therefore $V_{internal}$ decrease ✓ therefore reading on V increases.

QUESTION 8

8.1



Criteria for circuit diagram	**Mark**
Battery connected to the resistor as shown – correct symbols used.	✓
Rheostat connected in series with resistor – correct symbols used.	✓
Ammeter connected in series so that it measures the current through resistor – correct symbols used.	✓
Voltmeter connected in parallel across resistor – correct symbols used.	✓

8.2 Temperature ✓

8.3 B ✓

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

[12] Nov 2008

QUESTION 9

9.1 $\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓$= \frac{1}{4} + \frac{1}{16}$ ✓

$\therefore$ R = 3,2 Ω

$R_{effective}$ = 3,2 Ω + 2 Ω + 0,8 Ω✓
= 6 Ω ✓

9.2

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

9.3 $V_{parallel}$ = IR ✓
= (2)(3,2) ✓
= 6,4 V

$V_{8\Omega} = \frac{6,4}{2}$ ✓= 3,2 V ✓

QUESTION 10

10.1 **Option 1**

$\frac{1}{R_e} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓ $= \frac{1}{9} + \frac{1}{23}$ ✓ $\therefore$ R = 6,47 Ω

R_{tot} = 6,47 + 2 + 0,2 ✓= 8,67 Ω

$I = \frac{V}{R}$ ✓$= \frac{12}{8,67}$✓ = 1,38 A ✓

Option 2

$\frac{1}{R_e} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓ $= \frac{1}{9} + \frac{1}{23}$ ✓ $\therefore$ R = 6,47 Ω

R_{ext} = 6,47 + 2 ✓= 8,47 Ω

Emf = I(R + r) ✓$\therefore$ 12 = I(8,47 + 0,2) ✓$\therefore$ I = 1,38 A ✓

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

QUESTION 11[13]

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

11.2 Equal ✓
2 A divides equally at T (and since I_M = 1 A it follows that I_N = 1 A) ✓

11.3 emf = IR + Ir ✓∴ 17 = 14 + Ir ✓∴ Ir = 3 V

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

11.4 $V_N = IR_N$ ✓= (1)(2) ✓= 2 V ✓

11.5 V_Y = 14 – 2 = 12 V ✓
$V_Y = IR_Y$ ✓∴ 12 = (2)R_Y ✓
∴ R_Y = 6 Ω ✓

[13] March 2010