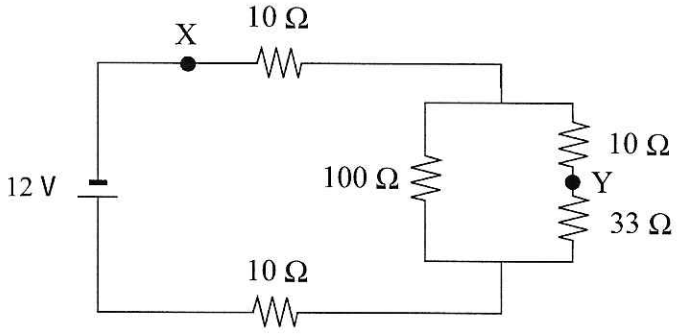
c) What is the power output of the battery? **(2 marks)**

d) The external circuit is most likely to consist of

- ❒ a bulb.
- ❒ a kettle.
- ❒ a calculator.

(Check one response.) **(1 mark)**

10. What is the potential difference between points X and Y? **(7 marks)**



CIRCUITRY

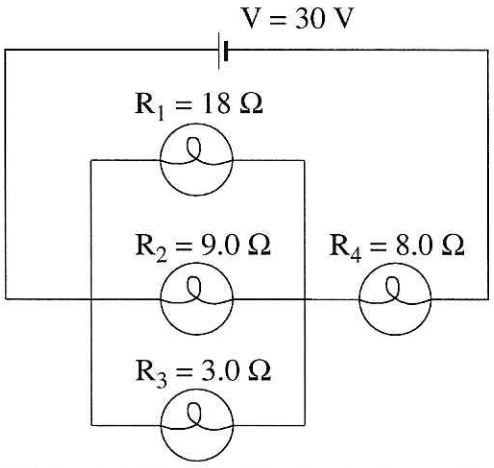
PROVINCIAL EXAMINATION ASSIGNMENT

ANSWER KEY / SCORING GUIDE

PART A: Multiple Choice (each question worth ONE mark)

Q	K	Q	K
1.	A	21.	B
2.	C	22.	A
3.	D	23.	C
4.	C	24.	D
5.	C	25.	B
6.	A	26.	C
7.	B	27.	A
8.	B	28.	B
9.	C	29.	C
10.	A	30.	D
11.	D	31.	A
12.	B	32.	A
13.	A	33.	C
14.	B	34.	D
15.	C	35.	C
16.	D	36.	D
17.	C	37.	D
		38.	B
19.	C	39.	A
20.	C	40.	B

1. a) Find the current in the 8.0 Ω bulb shown below. **(5 marks)**



$$\frac{1}{R} = \frac{1}{18} + \frac{1}{9.0} + \frac{1}{3.0} = \frac{9}{18} \quad \leftarrow \textbf{1 mark}$$

$R_p = 2.0\ \Omega$ $\leftarrow$ **1 mark** } **2 marks**

$R_T = 2.0\ \Omega + 8.0\ \Omega$ $\leftarrow$ **½ mark**

$= 10.0\ \Omega$ $\leftarrow$ **1 mark** } **1½ marks**

$$I = \frac{V}{R} \quad \leftarrow \textbf{½ mark}$$

$$= \frac{30}{10.0} = 3.0\ A \quad \leftarrow \textbf{1 mark}$$

1½ marks

b) (i) The 3.0 Ω bulb is removed from the circuit so that only 3 bulbs remain.
The 8.0 Ω bulb will now: **(Circle one)** **(1 mark)**

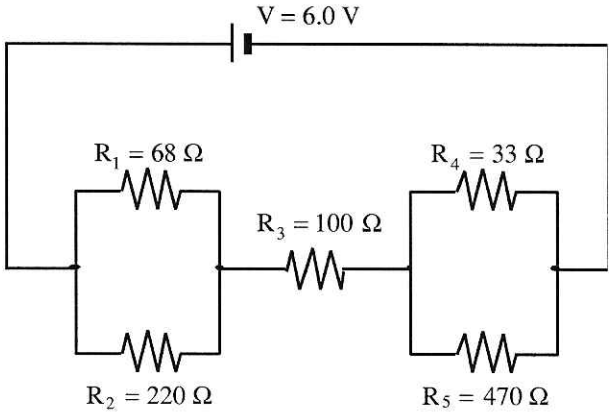
A. be dimmer.
B. be brighter.
C. remain the same.

A. be dimmer.

(ii) Using principles of electrical circuits, explain your answer to b(i). **(3 marks)**

With fewer bulbs in the parallel combination, the overall resistance of the circuit will be greater. The total current flow from the battery will now be smaller. Since the total current must flow through the 8.0 Ω resistor, it will be dimmer.

2. Consider the circuit shown in the diagram below.



a) What is the total resistance of the circuit? **(3 marks)**

$$\frac{1}{R^{||}_1} = \frac{1}{68\ \Omega} + \frac{1}{220\ \Omega}$$

$$R^{||}_1 = 51.9\ \Omega$$

$$\frac{1}{R^{||}_2} = \frac{1}{33\ \Omega} + \frac{1}{470\ \Omega}$$

$$R^{||}_2 = 30.8\,\Omega$$

$$\therefore R_T = R^{||}_1 + 100\ \Omega + R^{||}_2$$

$$= 51.9\ \Omega + 100\ \Omega + 30.8\ \Omega$$

$$= 182.7\ \Omega \rightarrow 1.8\times10^{2}\ \Omega$$

← **3 marks**

b) What is the current through the 100 Ω resistor? **(2 marks)**

$$I_{circuit} = I_{100} = \frac{V}{R_T}$$

$$= \frac{6.0\ V}{182.7\ \Omega}$$

$$= 3.3\times10^{-2}\,\text{A}$$

← **2 marks**

c) What is the power dissipated in the 100 Ω resistor? **(2 marks)**

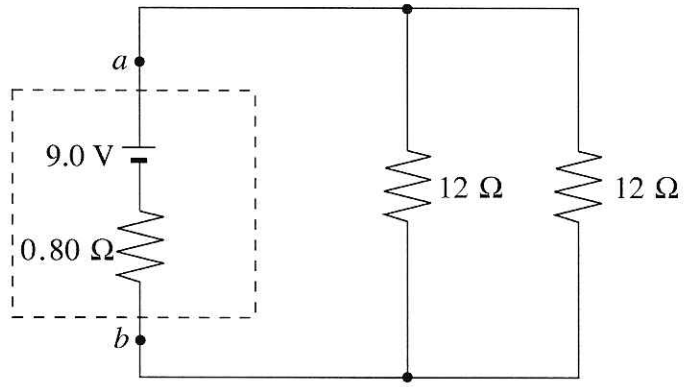
$$P_{100} = I^2R$$

$$= (0.0328\ A)^2 \cdot 100\ \Omega$$

$$= 0.11\ \text{W}$$

← **2 marks**

3. A 9.0 V battery with an internal resistance of 0.80 Ω is connected to two resistors as shown below. Determine the terminal voltage V_{ab} of the battery. **(7 marks)**



$$\frac{1}{R \text{ parallel}} = \frac{1}{12} + \frac{1}{12},\ R \text{ parallel} = 6.0\ \Omega \quad \leftarrow \textbf{1 mark}$$

$$R_t = 6.8\ \Omega \quad \leftarrow \textbf{1 mark}$$

$$I_t = \frac{V_t}{R_t} = \frac{9.0\text{ V}}{6.8\ \Omega} = 1.32\text{ A} \quad \leftarrow \textbf{1 mark}$$

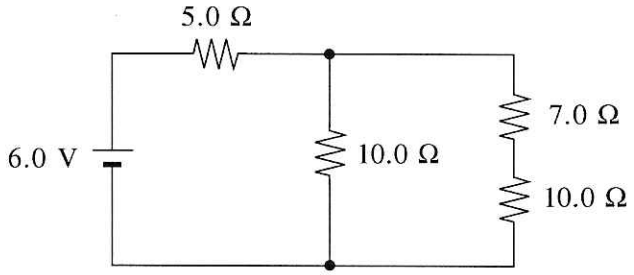
$$V_r = Ir = 1.32(0.8) = 1.06\text{ V} \quad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} \therefore V_{ab} &= \mathcal{E} - Ir \\ &= 9.0 - 1.06 \\ V_{ab} &= 7.9\text{ V} \end{aligned}\right\} \leftarrow \textbf{3 marks}$$

OR

$$V_{ab} = 1.32(6) = 7.9V \leftarrow \textbf{3 marks}$$

4. Consider the circuit shown below.



a) What is the current through the 7.0 Ω resistor? **(5 marks)**

$$\frac{1}{R_{||}} = \frac{1}{10.0\ \Omega} + \frac{1}{(10.0+7.0)\ \Omega}$$

$R_{||} = 6.30\ \Omega$ ← **½ mark**

$R_T = 5.0\ \Omega + 6.30\ \Omega$

$= 11.3\ \Omega$ ← **½ mark**

$$I_T = \frac{V}{R_T}$$

$$= \frac{6.0\ \text{V}}{11.3\ \Omega}$$

$= 0.53\ \text{A}$ ← **1 mark**

$V_{||} = I_T \cdot R_{||}$

$= 0.53\ \text{A} \cdot 6.3\ \Omega$

$= 3.34\ \text{V}$ ← **1 mark**

$$\therefore I_7 = \frac{V_{||}}{(10.0+7.0)\ \Omega}$$

$$= \frac{3.34\ \text{V}}{17.0\ \Omega}$$ ← **1 mark**

$= 0.20\ \text{A}$ ← **1 mark**

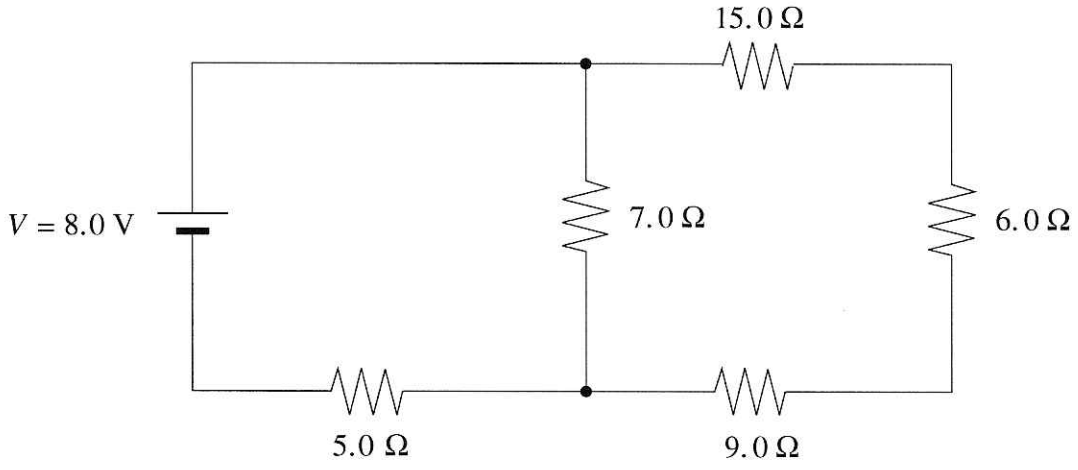
b) How much charge flows through the 7.0 Ω resistor in a 30 s interval? **(2 marks)**

$Q = I \cdot t$

$= 0.20\ \text{A} \cdot 30\ \text{s}$

$= 6.0\ \text{C}$ ← **2 marks**

5. What is the potential difference across the 6.0 Ω resistor in the circuit shown? **(7 marks)**



$R_{p_1} = 15.0\ \Omega + 6.0\ \Omega + 9.0\ \Omega$

$= 30.0\ \Omega$ ← **1 mark**

$\frac{1}{R_p} = \frac{1}{7.0} + \frac{1}{30.0}$

$R_p = 5.68$ ← **1 mark**

$R_T = 5.0 + 5.68$

$= 10.68$ ← **1 mark**

$I_T = \frac{V_T}{R_T} = \frac{8.0}{10.68} = 0.75$ ← **1 mark**

$V_p = V_T - V_5$

$= 8.0\ \text{V} - 0.75 \times 5.0$

$= 4.25$ ← **1 mark**

$I_p = \frac{V_p}{R_p} = \frac{4.25}{30.0} = 0.142$ ← **1 mark**

$V_6 = I_p R$

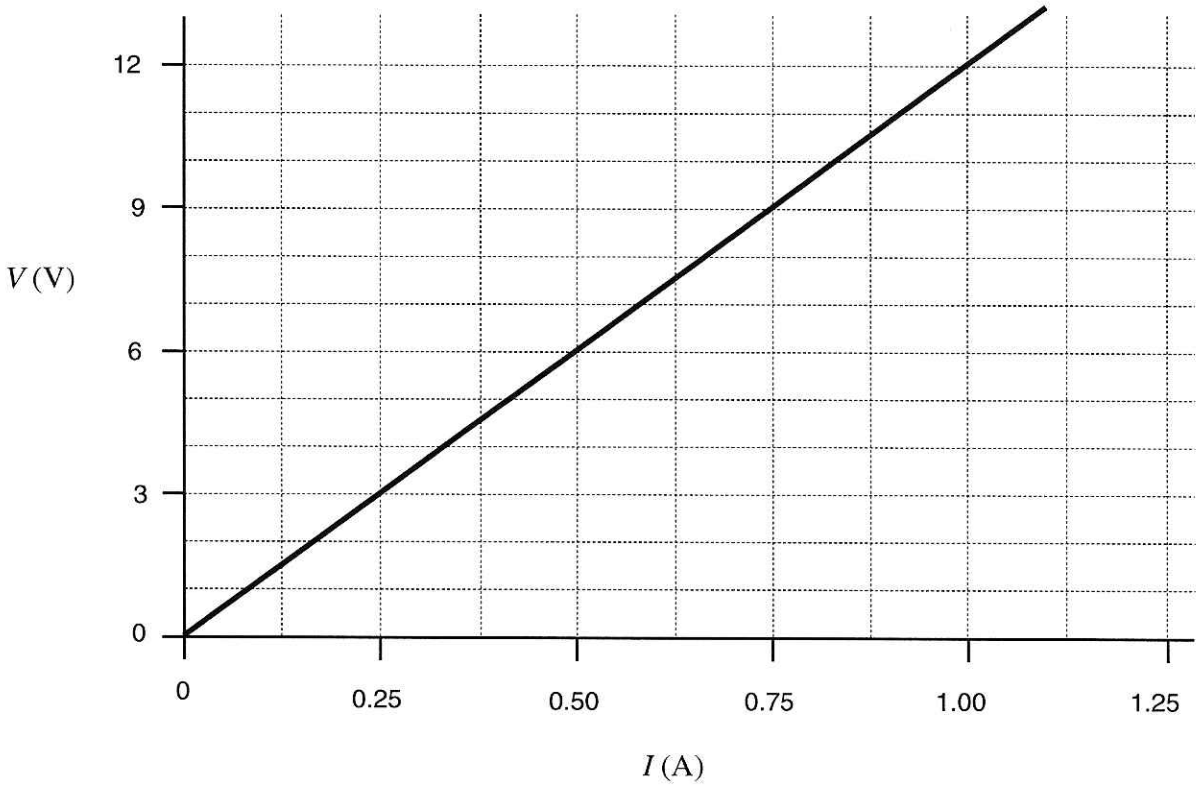
$= 0.142 \times 6.0$

$= 0.85\ \text{V}$ ← **1 mark**

6. A student connects a power supply to a circuit and measures the potential difference V at its terminals and the current I delivered to the circuit.

V (V)	0.0	3.0	6.0	9.0	12.0
I (A)	0.00	0.25	0.50	0.75	1.00

a) Plot a graph of V versus I on the axes below. **(2 marks)**



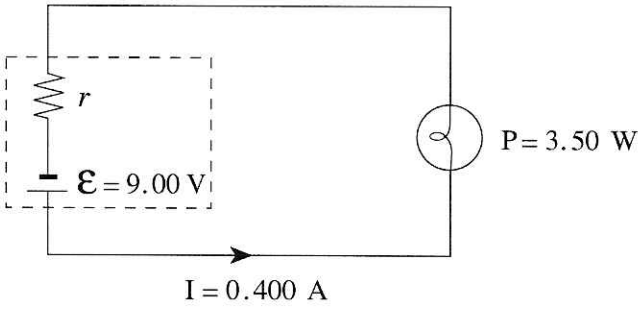
b) Calculate the slope of the line, expressing your answer in appropriate units. **(2 marks)**

$$slope = \frac{\Delta V}{\Delta I} = 12 \text{ V/A}$$ ← **1 mark; units 1 mark**

c) What does the slope of the line represent? **(1 mark)**

The slope represents the resistance of the circuit. ← **1 mark**

7. The circuit shown in the diagram below consists of a $9.00\ \text{V}$ battery and a $3.50\ \text{W}$ light bulb.



a) If a current of $0.400\ \text{A}$ leaves the battery, what is the internal resistance, r, of the battery? **(5 marks)**

$$P = VI$$
$$3.5 = V(0.4)$$
$$8.75\ \text{V} = V$$

← **2 marks**

$$V_T = \mathcal{E} - Ir$$
$$8.75 = 9 - Ir$$
$$0.25 = (0.4)r$$
$$0.63\ \Omega = r$$

← **3 marks**