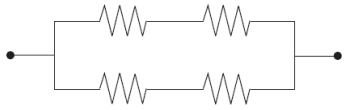
Circuits Review

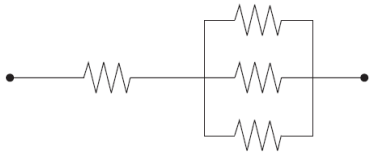
Multiple Choice

1. Which of the following arrangements would draw the largest current when connected to the same potential difference? All resistors have the same value.

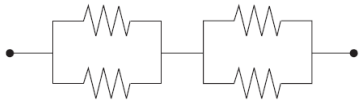
A.



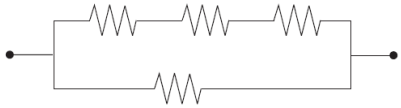
B.



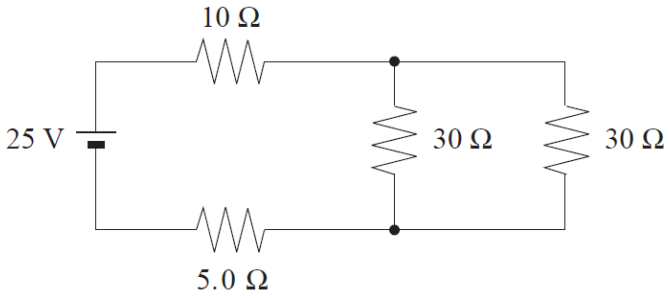
C.



D.



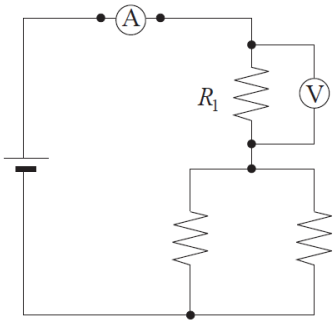
2. What is the power dissipated by the $5.0\ \Omega$ resistor in the following circuit?



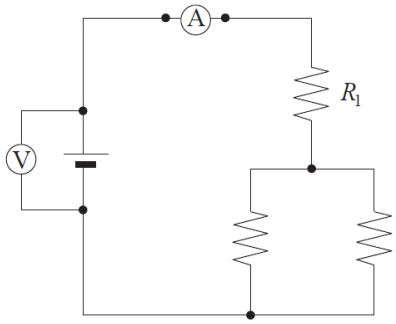
A. 0.56 W
B. 3.5 W
C. 6.2 W
D. 130 W

3. Which one of the following shows the correct placement of an ammeter and a voltmeter to determine the power output of resistor R_1?

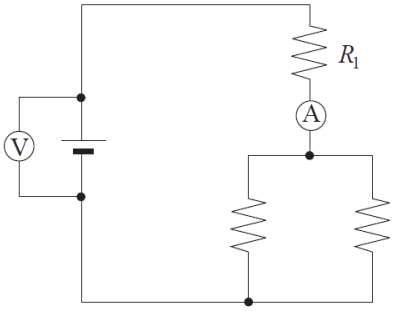
A.



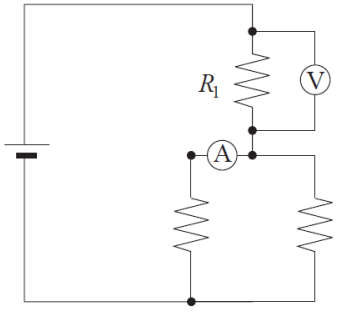
B.



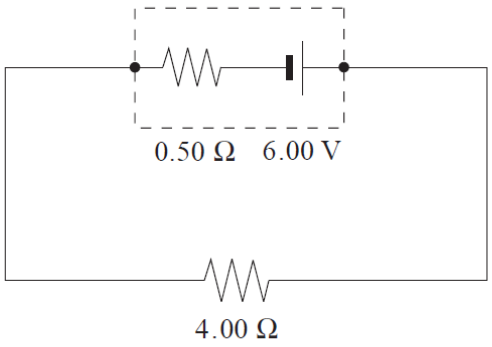
C.



D.

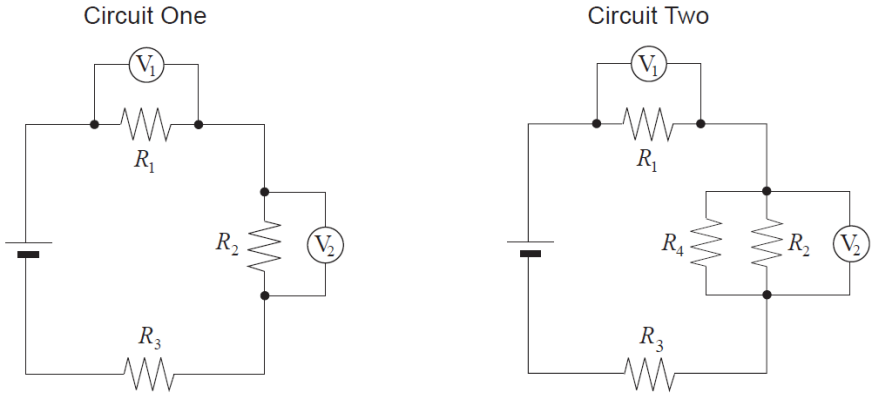


4. What is the terminal voltage of the battery in the circuit shown below?



A. 5.25 V
B. 5.33 V
C. 6.00 V
D. 6.67 V

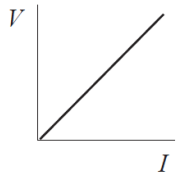
5. In circuit one, resistors and voltmeters are connected as shown. In circuit two, an additional resistor R_4 is placed in parallel with resistor R_2.

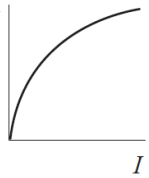


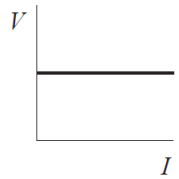
How have the values of V_1 and V_2 in circuit two changed compared to those in circuit one?

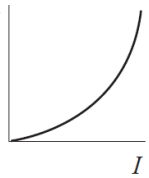
	V_1	V_2
A.	no change	decreased
B.	decreased	increased
C.	increased	decreased
D.	increased	no change

6. Which of the following graphs illustrates Ohm's law?

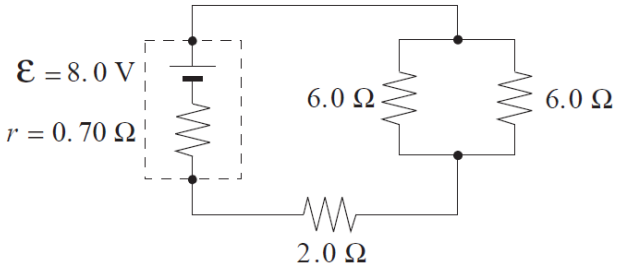
A. 

B. 

C. 

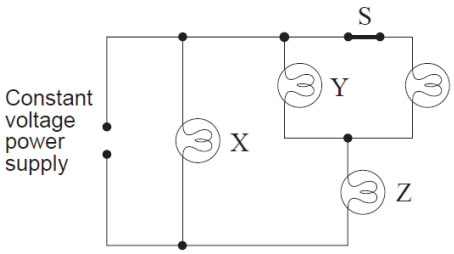
D. 

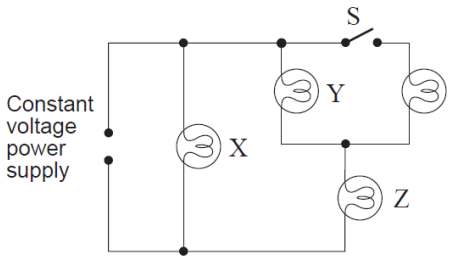
7. In the following circuit, what is the terminal voltage of the battery?



A. 6.9 V
B. 7.0 V
C. 8.0 V
D. 9.0 V

8. If switch S is opened, how does the brightness of each bulb (X, Y, and Z) compare to the situation when the switch was closed?

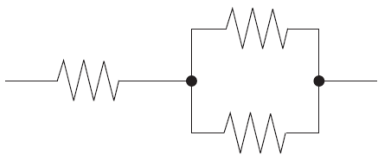


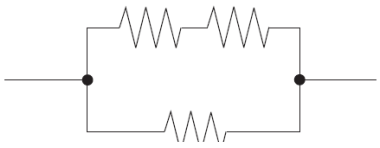


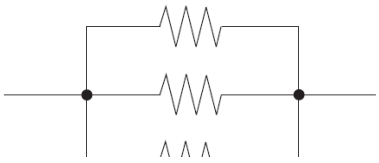
	BULB X	BULB Y	BULB Z
A.	same	same	same
B.	same	dimmer	brighter
C.	same	brighter	dimmer
D.	dimmer	dimmer	dimmer

9. Which of the following combinations of three identical resistors has the least equivalent resistance?

A.


B.


C.


D.


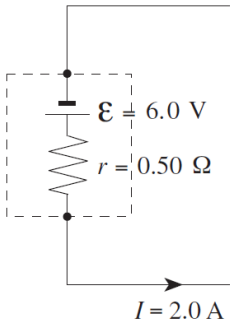
10. An electrical device with a constant resistance draws 0.75 A when connected to a 4.8 V source. What are the current and power for this device when it is connected to a 6.0 V source?

	CURRENT (A)	POWER (W)
A.	0.75	3.6
B.	0.75	5.6
C.	0.94	3.6
D.	0.94	5.6

11. Current is a measure of

A. the number of charges stored in a cell.
B. the amount of energy given to a charged object.
C. the charge passing a point in a circuit in a given time.
D. the resistance to the flow of charged particles in a circuit.

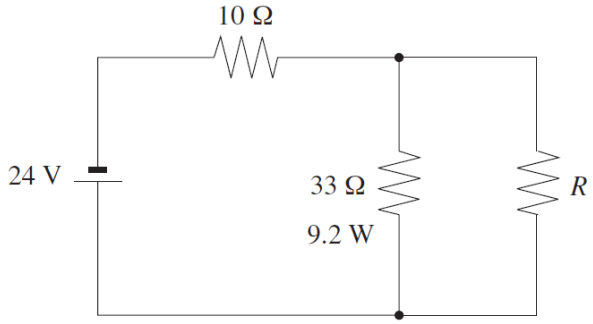
12. The battery in the diagram below is delivering a current of 2.0 A.



What will be the reading on a voltmeter connected to the battery terminals?

A. 1.0 V
B. 5.0 V
C. 6.0 V
D. 7.0 V

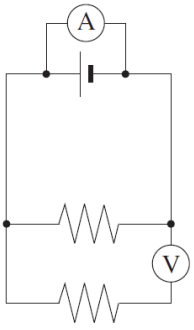
13. What is the total power dissipated by the three resistors in the circuit shown below?



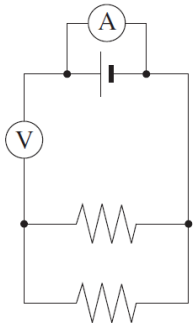
A. 12 W
B. 16 W
C. 23 W
D. 30 W

14. Which of the following diagrams shows an ammeter correctly placed to measure the circuit current and a voltmeter correctly placed to measure the potential difference across the battery?

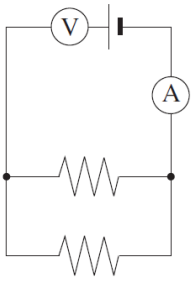
A.



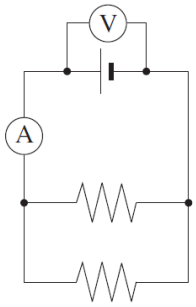
B.



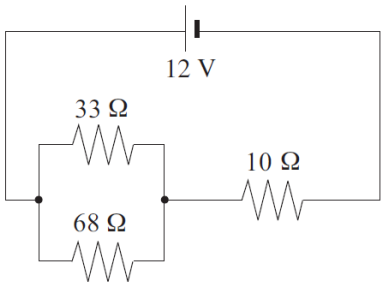
C.



D.

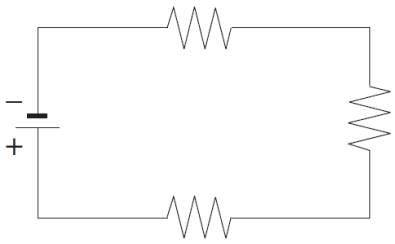


15. What is the current through the 10 Ω resistor in the circuit shown below?



A. 0.11 A
B. 0.37 A
C. 1.2 A
D. 1.7 A

16. Examine the electric circuit below.



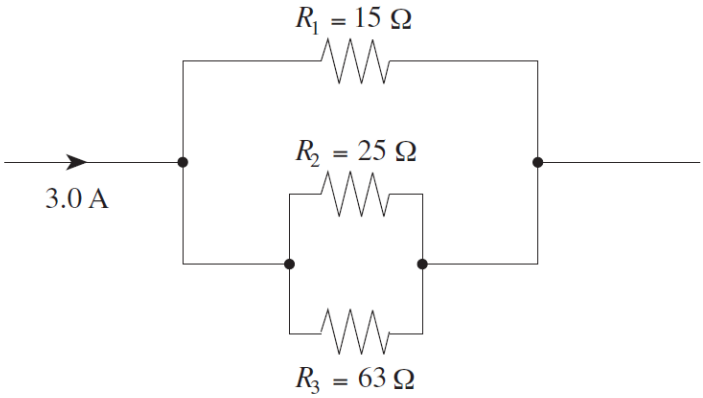
What is the direction of conventional current and electron flow in this circuit?

	CONVENTIONAL CURRENT	ELECTRON FLOW
A.	clockwise	clockwise
B.	clockwise	counter-clockwise
C.	counter-clockwise	clockwise
D.	counter-clockwise	counter-clockwise

17. A potential difference of 12 V causes 0.35 C of electric charge to pass through a resistor in 2.6 s. What power does the resistor dissipate?

A. 1.6 W
B. 4.2 W
C. 11 W
D. 89 W

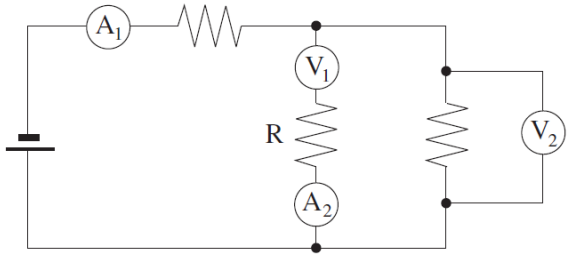
18. The diagram below shows part of an electric circuit.



What is the current through resistor R_1?

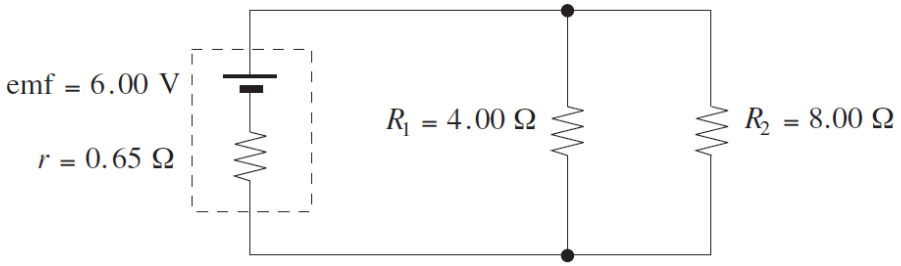
A. 1.0 A
B. 1.4 A
C. 1.6 A
D. 3.0 A

19. Which of the following meter placements would allow you to measure the current through and electric potential difference across resistor, R?



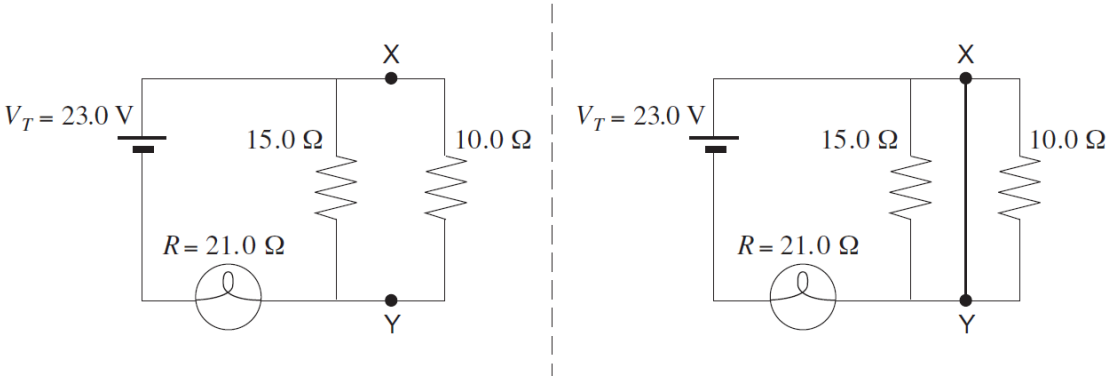
	AMMETER	VOLTMETER
A.	A_1	V_1
B.	A_2	V_1
C.	A_1	V_2
D.	A_2	V_2

20. What current flows through the 4.00 Ω resistor in the following circuit?



A. 0.47 A
B. 1.2 A
C. 1.3 A
D. 1.5 A

21 A circuit is made from two resistors and a light bulb as shown on the left. A short time later a copper wire is connected across points X and Y as shown on the right diagram.



What is the current through the light bulb and what happens to the brightness of the bulb when the wire is connected?

	CURRENT	BRIGHTNESS OF BULB
A.	0.64 A	dimmer
B.	0.64 A	brighter
C.	1.10 A	dimmer
D.	1.10 A	brighter

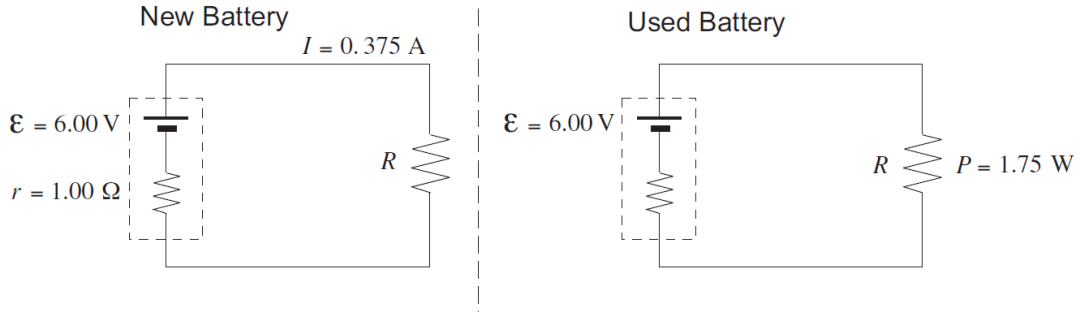
22. What happens to the total resistance of a circuit as one more resistor is added in parallel?

A. The total resistance decreases.
B. The total resistance increases.
C. The total resistance becomes zero.
D. The total resistance does not change.

23. The headlights in a car use 95 W of power. A driver parks her car but leaves the lights on. The 12 V battery has 3.4×10^5 C of stored charge. How long does it take for the battery to lose its charge?

A. 1.1×10^3 s
B. 3.6×10^3 s
C. 4.3×10^4 s
D. 2.7×10^6 s

24. A circuit using a new battery which has an emf of 6.00 V and an internal resistance of 1.00 Ω is shown on the left. The battery is then replaced with a used one that has the same emf of 6.00 V but a different internal resistance.



If resistor R now dissipates 1.75 W, what is the internal resistance of the used battery?

A. 1.00 Ω
B. 2.57 Ω
C. 3.55 Ω
D. 5.60 Ω

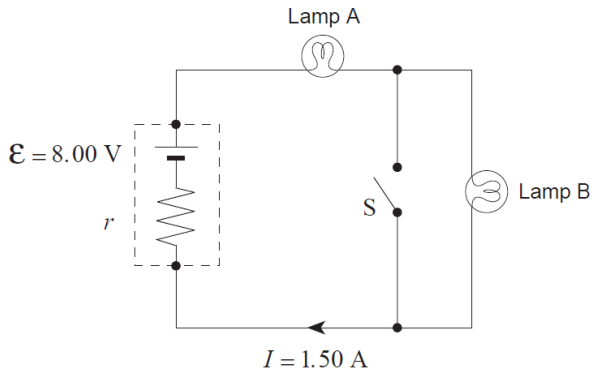
Answers

MC

1. D	9. D	17. A
2. B	10. D	18. C
3. A	11. C	19. D
4. B	12. B	20. B
5. C	13. B	21. D
6. A	14. D	22. A
7. B	15. B	23. C
8. C	16. C	24. B

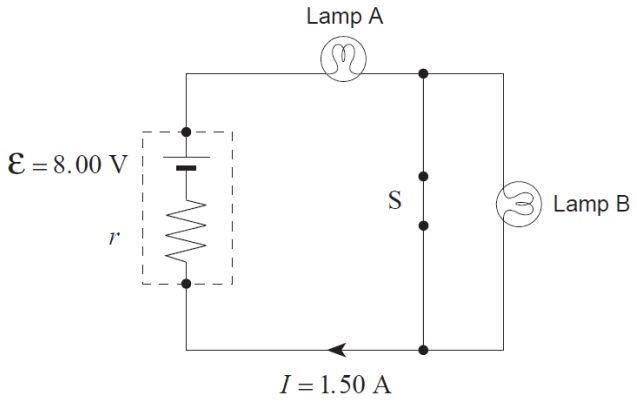
Written Response

1. The circuit shown consists of an 8.00 V battery and two light bulbs. Each light bulb dissipates 5.0 W. Assume that the light bulbs have a constant resistance. Switch S is open.



a) If a current of 1.50 A flows in the circuit, what is the internal resistance r of the battery?
(4 marks)

b) The switch S is now closed.



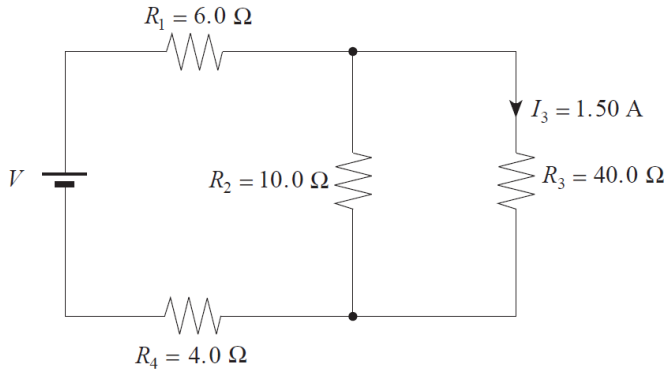
Lamp A will now be

i) ☐ brighter.
☐ the same brightness as before.
☐ dimmer.

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

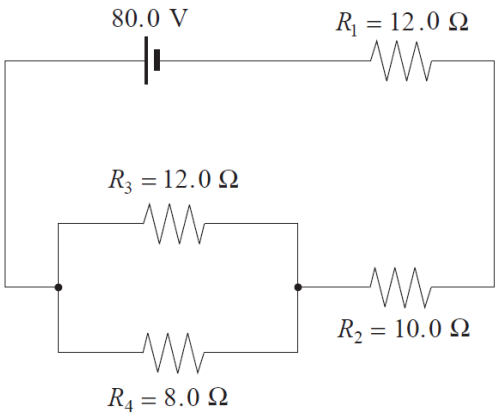
c) Using principles of physics, explain your answers to b). **(3 marks)**

2. A current of 1.50 A flows through the 40.0 Ω resistor.

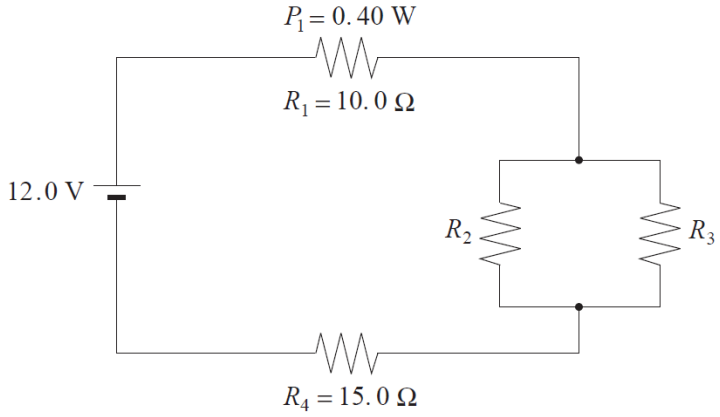


What is the potential difference of the power supply? **(7 marks)**

3. What is the power dissipated in the 8.0 Ω resistor in the circuit as shown? **(7 marks)**

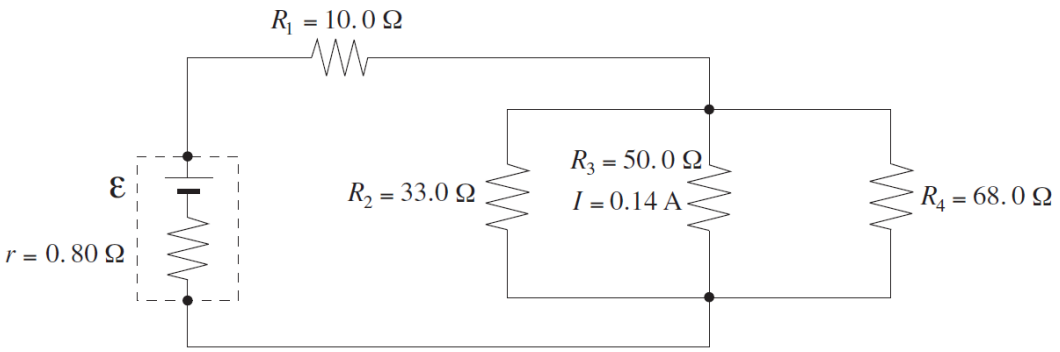


4. In the circuit below, resistor R_1 dissipates 0.40 W. Resistors R_2 and R_3 are identical.



What is the resistance of R_2? **(7 marks)**

5. The current through the 50.0 Ω resistor in the circuit below is 0.14 A.



a) Determine the emf of the battery. **(5 marks)**

b) Determine the power dissipated in the battery's internal resistance. **(2 marks)**

6. A 12 V battery transfers 33 C of charge to an external circuit in 7.5 s.

a) What current flows through the circuit? **(2 marks)**

b) What is the resistance of the circuit? **(2 marks)**

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)**

7. Two identical light bulbs, wired in parallel to a battery, are equally bright. When one of the bulbs burns out, however, the other bulb is observed to glow brighter. Using principles of physics, explain why the battery causes the remaining bulb to glow more brightly. **(4 marks)**

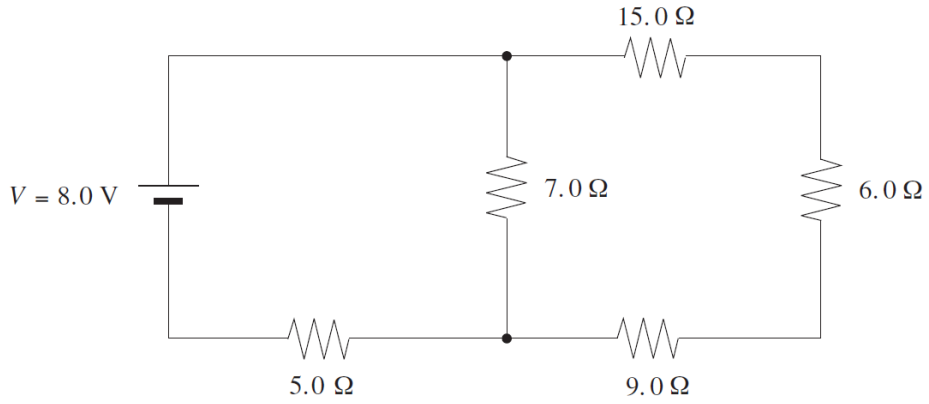
8. A 12 V battery from a car is used to operate a 65 W headlight.

a) How much energy does the headlight use in 1.5 hours? **(2 marks)**

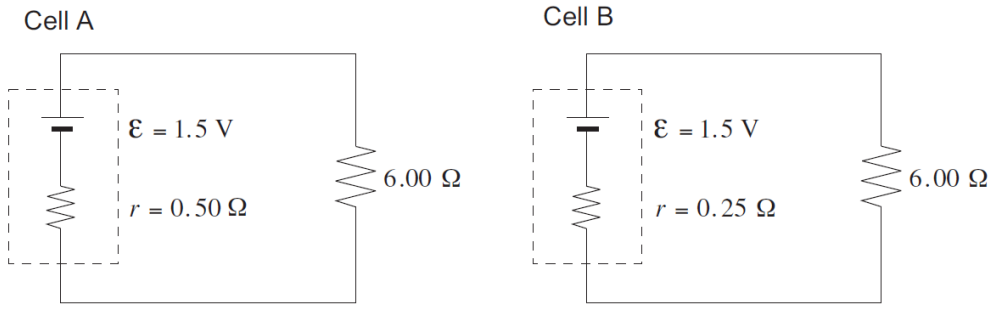
b) What total charge passes through the headlight during this time? **(3 marks)**

c) What is the total number of electrons that pass through the headlight during this time period? **(2 marks)**

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

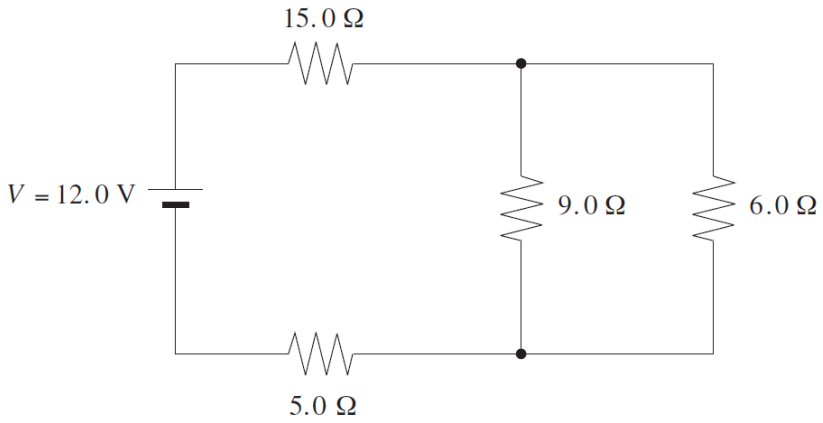


10. Each of the two cells shown is connected to an external 6.00 Ω resistor.



With supporting calculations, state which cell delivers the greater power to the 6.00 Ω resistor. **(7 marks)**

11. How much energy does the 6.0 Ω resistor dissipate in 15 seconds in the circuit shown? **(7 marks)**



WR Answers

1.

a) If a current of 1.50 A flows in the circuit, what is the internal resistance r of the battery?
(4 marks)

Resistance Solution:

$$P = I^2R$$

$$\therefore R_{bulb} = \frac{P}{I^2}$$

$$= \frac{5.0}{(1.50)^2}$$

$$= 2.22\ \Omega \quad \leftarrow \textbf{1 mark}$$

$$R_T = \frac{\mathcal{E}}{I}$$

$$= \frac{8.00}{1.50}$$

$$= 5.33\ \Omega \quad \leftarrow \textbf{1 mark}$$

$$\therefore r = R_T - 2\cdot(R_{bulb})$$

$$= 5.33 - 2(2.22) \quad \leftarrow \textbf{1 mark}$$

$$= 0.89\ \Omega \quad \leftarrow \textbf{1 mark}$$

Voltage Solution:

$$P = IV$$

$$5 = 1.5\ \text{V}$$

$$V_{bulb} = 3.3\ \text{V} \quad \leftarrow \textbf{1 mark}$$

$$V_{terminal} = 3.3 \times 2$$

$$V_{terminal} = 6.7 \quad \leftarrow \textbf{1 mark}$$

$$V_{terminal} = \mathcal{E} - Ir$$

$$6.7 = 8 - 1.5r \quad \leftarrow \textbf{1 mark}$$

$$r = 0.89\ \Omega \leftarrow \textbf{1 mark}$$

Power Solution:

$$P_T = IV$$

$$= 1.5(8)$$

$$= 12\ \text{W} \quad \leftarrow \textbf{1 mark}$$

$$P_{bulbs} = 2(5) = 10 \leftarrow \textbf{1 mark}$$

$$P_r = 12 - 10 \quad \leftarrow \textbf{1 mark}$$

$$P_r = 2\ \text{W}$$

$$P = I^2R$$

$$r = \frac{2}{1.5^2}$$

$$= 0.89\ \Omega \quad \leftarrow \textbf{1 mark}$$

Lamp A will now be **(1 mark)**

i)
- ☑ brighter.
- ☐ the same brightness as before.
- ☐ dimmer.

(Check one response.)

The battery's terminal voltage will now be **(1 mark)**

ii)
- ☐ greater than before.
- ☐ the same as before.
- ☑ less than before.

(Check one response.)

Total circuit resistance decreases when the switch is closed. Therefore, the circuit current increases. ← 1 mark
Since $P = I^2R$, the power dissipated by Lamp A increases and it will therefore be brighter. ← 1 mark
Since the circuit current has increased, the voltage drop across the internal resistance increases and the terminal voltage drops. ← 1 mark

2.

$V_3 = I_3 R$

$= 1.50(40.0)$

$V_3 = 60.0 \text{ V}$

$V_2 = V_3 = 60.0 \text{ V}$ ← **2 marks**

$I_2 = \frac{V_2}{R_2} = \frac{60.0}{10.0} = 6.00 \text{ A}$ ← **1 mark**

$I_t = I_3 + I_2 = 1.50 + 6.00 = 7.50 \text{ A}$ ← **1 mark**

$V_1 = I_1 R_1$

$V_1 = 7.50(6.0)$

$V_1 = 45 \text{ V}$ ← **1 mark**

$V_4 = I_4 R_4$

$= 7.50(4.0)$

$V_4 = 30 \text{ V}$ ← **1 mark**

$V_t = V_b = V_1 + V_{||} + V_4$

$= 45 + 60 + 30$

$V_b = 135 \text{ V}$ ← **1 mark**

Alternate Solution:

$V_3 = I_3 R$

$= 1.50(40.0)$

$V_3 = 60.0 \text{ V}$

$V_2 = V_3 = 60.0 \text{ V}$ ← **2 marks**

$I_2 = \frac{V_2}{R_2} = \frac{60.0}{10.0} = 6.00 \text{ A}$ ← **1 mark**

$I_t = I_3 + I_2 = 1.50 + 6.00 = 7.50 \text{ A}$ ← **1 mark**

$R_p = \frac{1}{\frac{1}{R_3} + \frac{1}{R_2}} = \frac{1}{\frac{1}{40.0} + \frac{1}{10.0}}$

$= 8.00 \ \Omega$

$R_T = 6.0 \ \Omega + 8.0 \ \Omega + 4.0 \ \Omega$

$= 18.0 \ \Omega$ ← **2 marks**

$V_0 = (I_0)(R_T)$

$= (7.50)(18.0) = 135 \text{ V}$ ← **1 mark**

3.

$\frac{1}{R_{||}} = \frac{1}{R_3} + \frac{1}{R_4}$

$= \frac{1}{12.0} + \frac{1}{8.0}$

$R_{||} = 4.8 \ \Omega$ ← **1 mark**

$R_t = R_1 + R_2 + R_{||}$

$= (12.0 + 10.0 + 4.8)$

$R_t = 26.8 \ \Omega$ ← **1 mark**

$I_t = \frac{V_t}{R_t} = \frac{80.0}{26.8} = 2.99 \text{ A}$ ← **2 marks**

$V_1 = I_t R_1 = 2.99(12) = 35.9 \text{ V}$

$V_2 = I \cdot R_2 = 2.99(10) = 29.9 \text{ V}$

$V_{||} = 80.0 - (35.9 + 29.9)$

$= 14.3 \text{ V}$ ← **2 marks**

$P = \frac{V^2}{R} = \frac{14.3^2}{8.0} = 26 \text{ W}$ ← **1 mark**

4.

$P = I^2 R$

$P_1 = I^2 R_1$

$I = \left(\frac{P_1}{R_1}\right)^{\frac{1}{2}}$

$= \left(\frac{0.40}{10}\right)^{\frac{1}{2}}$

$= 0.20 \text{ A}$ ← **2 marks**

$V_1 = IR$

$= 0.2(10)$

$= 2 \text{ V}$ ← **1 mark**

$V_4 = IR$

$= 0.2(15)$

$= 3 \text{ V}$ ← **1 mark**

$V_3 = V_4 = 12 - V_1 - V_4$

$= 7 \text{ V}$ ← **1 mark**

$I_2 = I_3$ ← **1 mark**

$V_3 = I_3 R_3$

$7 = 0.1 \ R_2$

$R_2 = 70 \ \Omega$ ← **1 mark**

Alternate Key:

$P = I^2 \cdot R$

$P_1 = I^2 \cdot R_1$

$\therefore I = \left(\frac{P_1}{R_1}\right)^{\frac{1}{2}}$

$= \left(\frac{0.40}{10.0}\right)^{\frac{1}{2}}$

$= 0.20 \text{ A}$

$\therefore R_{circuit} = \frac{V}{I}$

$= \frac{12.0}{0.20}$

$= 60.0 \ \Omega$

$\therefore R_{||} = 60.0 \ \Omega - (10.0 \ \Omega + 15.0 \ \Omega)$

$= 35.0 \ \Omega$

$\therefore R_2 = R_3 = 2 \cdot 35.0 \ \Omega$

$= 70.0 \ \Omega$

5. a) Determine the emf of the battery. **(5 marks)**

$V_{||} = I \cdot R$

$= I_3 \cdot R_3$

$= 0.14 \cdot 50.0$

$= 7.0 \text{ V}$ ← **1 mark**

$\therefore I_2 = \dfrac{V_{||}}{R_2}$

$= \dfrac{7.0}{33.0}$

$= 0.21 \text{ A}$ ← **½ mark**

$I_4 = \dfrac{V_{||}}{R_4}$

$= \dfrac{7.0}{68.0}$

$= 0.10 \text{ A}$ ← **½ mark**

$\therefore I_{||} = I_2 + I_3 + I_4$

$= 0.21 + 0.14 + 0.10$

$= 0.45 \text{ A}$ ← **1 mark**

$R_{||} = \dfrac{1}{\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}}$

$= 15.4 \ \Omega$ ← **½ mark**

$R_T = R_1 + R_{||} + r$

$= 10.0 + 15.4 + 0.80$

$= 26.2 \ \Omega$ ← **½ mark**

$\therefore \mathcal{E} = I \cdot R_T$

$= 0.45 \cdot 26.2$

$= 11.9 \text{ V}$

$= 12 \text{ V}$ ← **1 mark**

b) Determine the power dissipated in the battery's internal resistance. **(2 marks)**

$P_r = I^2 \cdot r$ ← **1 mark**

$= (0.45)^2 \cdot 0.80$

$= 0.16 \text{ W}$ ← **1 mark**

6. A 12 V battery transfers 33 C of charge to an external circuit in 7.5 s.

a) What current flows through the circuit? **(2 marks)**

$I = \dfrac{q}{t}$ ← **½ mark**

$= \dfrac{33 \text{ C}}{7.5 \text{ s}}$ ← **½ mark**

$= 4.4 \text{ A}$ ← **1 mark**

b) What is the resistance of the circuit? **(2 marks)**

$R = \dfrac{V}{I}$ ← **½ mark**

$= \dfrac{12}{4.4}$ ← **½ mark**

$= 2.7 \ \Omega$ ← **1 mark**

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

$P = V \cdot I$ ← **$\frac{1}{2}$ mark**

$= 12(4.4)$ ← **$\frac{1}{2}$ mark**

$= 53$ W ← **1 mark**

d) The external circuit is most likely to consist of

- [x] a bulb.
- [ ] a kettle.
- [ ] a calculator.

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

7.

9. Two identical light bulbs, wired in parallel to a battery, are equally bright. When one of the bulbs burns out, however, the other bulb is observed to glow brighter. Using principles of physics, explain why the battery causes the remaining bulb to glow more brightly. **(4 marks)**

When one of two bulbs, wired in parallel to a battery, burns out, the resistance of the circuit increases. ← **1 mark**

This results in a smaller current being delivered by the battery. ← **1 mark**

The internal resistance of the battery causes the terminal voltage to increase, because $V_T = \mathcal{E} - Ir$. ← **1 mark**

The bulb will now dissipate more power, because $P = \frac{V^2}{R}$. ← **1 mark (not in isolation)**

If the number of paths for current is reduced to one, the current increases in the remaining path. ← **1 mark**

} ← **Any 4 for 4 marks**

8.

a) How much energy does the headlight use in 1.5 hours?

$E = P \times t$ ← **$\frac{1}{2}$ mark**

$= 65 \times 1.5 \times 3600$ ← **1 mark**

$= 3.5 \times 10^5$ J ← **$\frac{1}{2}$ mark**

b) What total charge passes through the headlight during this time?

$Q = \frac{\Delta E}{V}$ ← **$\frac{1}{2}$ mark**

$= \frac{3.5 \times 10^5 \text{ J}}{12 \text{ V}}$ ← **2 marks**

$= 29\,000$ C ← **$\frac{1}{2}$ mark**

OR

$Q = It$ ← **$\frac{1}{2}$ mark**

$= (5.42 \text{ A})(5\,400 \text{ s})$ ← **2 marks**

$= 29\,000$ C ← **$\frac{1}{2}$ mark**

c) What is the total number of electrons that pass through the headlight during this time period?

$N = \frac{Q}{e}$ ← **1 mark**

$= \frac{29\,000}{1.6 \times 10^{-19} \text{ C}}$ ← **1 mark**

$= 1.8 \times 10^{23}$ electrons

9.

$R_{p1} = 15.0\ \Omega + 6.0\ \Omega + 9.0\ \Omega$

$= 30.0\ \Omega$ ← **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**

10.

Cell A:

$I = \frac{\varepsilon}{6.00 + r}$ ← **1 mark**

$I = \frac{1.5}{6.50}$

$= 0.23$ ← **1 mark**

$P_L = I^2 R$

$= 0.23^2 \times 6.00$

$= 0.32\ \text{W}$ ← **1 mark**

Cell B:

$I = \frac{\varepsilon}{6.00 + r}$ ← **1 mark**

$I = \frac{1.5}{6.25}$

$= 0.24$ ← **1 mark**

$P_L = I^2 R$

$= 0.24^2 \times 6.00$

$= 0.35\ \text{W}$ ← **1 mark**

Therefore, cell B delivers more power. ← **1 mark**

Note: Sig figs were ignored, since answer is not numerical. Also, units were ignored for the same reason.

11.

$\frac{1}{R_p} = \frac{1}{9.0} + \frac{1}{6.0}$

$R_p = 3.6$ ← **1 mark**

$R_T = R_{15} + R_p + R_5$

$= 15.0 + 3.6 + 5.0$

$= 23.6\ \Omega$ ← **1 mark**

$I_T = \frac{V_T}{R_T} = \frac{12.0}{23.6}$

$= 0.508\ \text{A}$ ← **1 mark**

$V_p = V_T - V_{15} - V_5$

$= 12.0 - 0.51 \times 15.0 - 0.51 \times 5.0$

$= 1.83\ \text{V}$ ← **2 marks**

$I_6 = \frac{V_p}{R_6} = \frac{1.83}{6.0}$

$= 0.305\ \text{A}$ ← **1 mark**

$E = VIt$

$= 1.83 \times 0.305 \times 15$

$= 8.4\ \text{J}$ ← **1 mark**