



## 2025 Sec 4 Physics Assignment 15A D.C Circuit (Sample Solutions)

### Reminders:

1. Use subscripts for similar quantities belonging to different components, e.g.  $R_1$ ,  $R_2$ .
2. Write down the **basic formulae** before substitution.
  - Component:  $V = I R$
  - Entire circuit: e.m.f. =  $I_{\text{main}} R_{\text{eff}}$
3. Show all key mathematical steps clearly.
4. **Redraw & rearrange** circuit components and wiring to **simplify** circuit diagrams
  - Note short-circuits, switches open/closed, junctions, etc.
5. **Evaluate your final answer!** (2 or 3 s.f.)

- 1 (a) Find resistance of the two resistors in parallel:  
 $1/(1/10) + (1/10) = 5.0 \Omega$   
Hence total resistance =  $R_T = 3.0 + 5.0 = 8.0 \Omega$
- (b)  $I = V / R = 4.0 \text{ V} / 8.0 \Omega = 0.50 \text{ A}$   
  
(wrong method:  $4.0 \text{ V}$  divided by  $3.0 \Omega$ )
- (c) Each resistor gets  $0.50 \text{ A} \div 2 = 0.25 \text{ A}$  of current.  
 $Q = I t = (0.25 \text{ A}) (2.0 \text{ s}) = 0.50 \text{ C}$
- 2 (a)  $I = 1.0 \text{ A}$  **Note: Redraw and simplify the circuits!**
- (b)  $I = 0.50 \text{ A}$
- 3 (a) Find resistance of the two resistors  $12 \Omega$  and  $6.0 \Omega$  in parallel:  
 $1/(1/12) + (1/6.0) = 4.0 \Omega$   
  
Find resistance of the two resistors  $3.0 \Omega$  and  $6.0 \Omega$  in parallel:  
 $1/(1/3.0) + (1/6.0) = 2.0 \Omega$   
  
Find resistance of the two resistors  $4.0 \Omega$  and  $2.0 \Omega$  in series:  
 $R_T = 6.0 \Omega$
- (b)  $I = 12 / (4.0 + 2.0) = 2.0 \text{ A}$
- (c)  $I = 12 / (4.0 + 3.0) = 1.7 \text{ A}$

4 (a)  $V_x = 12 / 2 = 6 \text{ V}; \quad V_y = 0 \text{ V}$

**Why is  $V_y = 0 \text{ V}$ ?**

When there is no current, both terminals of the appliance are at the same electric potential, hence the potential difference across that appliance is zero.

- (b) same p.d. and resistance across each branch,  
so both have same current = 0.30 A  
hence new ammeter reading =  $0.30 \text{ A} \times 2 = 0.60 \text{ A}$

**OR**

2 lamps in series:  $R = 12 \text{ V} / 0.30 \text{ A} = 40 \Omega$

2 branches in parallel: effective resistance,  $R_e = 40 / 2 = 20 \Omega$

Main current = e.m.f. /  $R_e = 12 \text{ V} / 20 \Omega = 0.60 \text{ A}$

- 5 Rearrange the circuit to see that the 3 resistors are in parallel.

$$R_e = 5.0 \Omega / 3$$

$$\text{e.m.f.} = I R_e = 3.0 \text{ A} \times 5.0 \Omega / 3 = 5.0 \text{ V}$$

- 6 (a) In 2<sup>nd</sup> branch, current =  $V / R = 12 \text{ V} / 5.0 \Omega = 2.4 \text{ A}$

- (b) In 1<sup>st</sup> branch, current =  $5.0 \text{ A} - 2.4 \text{ A} = 2.6 \text{ A}$

$$R = V / I \quad \rightarrow \quad X + 3.0 \Omega = 12 \text{ V} / 2.6 \text{ A}$$

$$X = 1.62 \Omega = 1.6 \Omega \text{ (1.d.p.)}$$

- (c) All 3 branches are in parallel with the battery.

The current flowing through the  $5.0 \Omega$  resistor is unchanged (still 2.4 A) as the voltage across the  $5.0 \Omega$  is unchanged at 12 V even with the addition of the  $2.0 \Omega$  resistor.

- 7 (a)  $I = V / R = 4.0 \text{ V} / 10 \Omega = 0.40 \text{ A}$

- (b) 0 A since S acts as a short-circuit across the  $4.0 \Omega$

[Note: answer for question (b) is not  $4.0 \text{ V} / 6.0 \Omega = 0.67 \text{ A}$ , since question did not ask for current through that  $6.0 \Omega$  resistor.]

8 **Note:** May use potential divider method, treat resistance wire as 2 variable resistors in series as the jockey moves!

- The p.d. across the wire is proportional to its resistance when current through it is constant.  $V = I R \quad \rightarrow \quad V \propto R$
- Resistance of that wire is proportional to its length.
- When S is **at A**, voltmeter reading is **zero** as the resistance across it is zero.
- As S moves from A towards B, the p.d. across the length of wire AS increases with increasing resistance, based on potential divider concept. Hence the voltmeter reading **V increases**.
- When S is **at B**, the **voltmeter reading is 4.0 V** as the voltmeter is across the maximum length of the resistance wire AB.

Need to specify the minimum and maximum voltmeter readings.

**Language Notes:**

- **DO NOT** write: *voltage flows through* a component
- You may write: current (flows) through a component  
OR p.d. or voltage (established) across a component

9 (a) Let resistance of each lamp be  $R$ .

$L_2$  and  $L_3$  are in parallel, so effective resistance is found to be  $R/2$

Ratio of resistance of  $L_1$ :  $L_2$  and  $L_3$  (in parallel)  
 $= R : R/2$   
 $= 2 : 1$

So ratio of p.d.s is also  $= 2 : 1 = 4 \text{ V} : 2 \text{ V}$

$$V_{L_2} = V_{L_3} = 2.0 \text{ V}$$

Lamps  $L_2$  and  $L_3$  will be **equally dim** as the p.d. across each of them is lower than the rated value of 3.0 V.

$$V_{L_1} = 4.0 \text{ V}$$

Lamp  $L_1$  will be **brighter than normal** as the p.d across it is higher than the rated value of 3.0 V.

**Note:**

- Rating of 3.0 V means when a p.d. of 3.0 V is applied across the lamp, it has normal brightness.
- Redraw the circuit and simplify if it helps you to understand the circuit better.
- Brightness is *not* directly proportional to current or p.d.: **NOT twice as bright!**

(b) The two lamps are **in series**.

$$V_{L_1} = V_{L_3} = 3.0 \text{ V}$$

Lamp  $L_3$  and lamp  $L_1$  will **both be operating at normal brightness** as the p.d. across each of them is equal to the rated value of 3.0 V.

**Note:**

When a lamp is removed, the wires next to it are **NOT** reconnected unless stated!

(c) The two lamps are **in parallel**.

$$V_{L_2} = V_{L_3} = 6.0 \text{ V}$$

Lamps  $L_2$  and  $L_3$  will **both be very bright** (and likely to fuse) as the p.d. across each of them is doubled the rated value of 3.0 V.

10 (a)  $I = V / R_{\text{total}} = 0.020 \text{ A}$

(b)(i)  $V = 6.0 \text{ V}$

(ii)  $V = 3.0 \text{ V}$

(iii)  $V = 0.0 \text{ V}$

**Note:** Brightness of lamp is not directly proportional to  $V$  or  $I$ .