2020 Sec 4 Physics Assignment AS15.1
D.C Circuit - Answers

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: $V = IR$
   - Entire circuit: e.m.f. = $I_{main} R_{eff}$
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!

AS 15.1

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) $I = V / R = 0.50$ A

(c) $Q = I t = 0.50$ C

2 (a) $I = 1.0$ A
(b) $I = 0.50$ A

3 (a) Find resistance of the two resistors 12 Ω and 6.0 Ω in parallel:
$1/(1/12) + (1/6.0) = 4.0\ \Omega$
Find resistance of the two resistors 3.0 Ω and 6.0 Ω in parallel:
$1/(1/3.0) + (1/6.0) = 2.0\ \Omega$

Find resistance of the two resistors 4.0 Ω and 2.0 Ω in series:

$R_T = 6.0\ \Omega$

(b) $I = 12 / (4.0 + 2.0) = 2.0$ A
(c) $I = 12 / (4.0 + 3.0) = 1.7$ A
(d) $I = 12 / (6.0 + 3.0) = 1.3$ A

4 (a) $V_X = 12/2 = 6$ V, $V_y = 0$ V
(b) 0.60 A

5 (a) $R = 5 + ¾ = 5.75\ \Omega = 5.8\ \Omega$
(b) 1.04 A

6 5.0 V

7 (a) 2.4 A

(b) 1.62 Ω

(c) The current flowing through the 5 Ω resistor is unchanged (still 2.4 A) as the voltage across the 5 Ω is unchanged at 12 V even with the addition of the 2 Ω resistor.

8 (a) 0.40 A

(b) 0 A Current in 4 Ω resistor

9 **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.
- 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. 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.

10 (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= 4V : 2V

$V_{L2} = V_{L3}$ = 2.0 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_{L1} = 4.0 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 not directly proportional to current or p.d.: **NOT twice as bright**!

(b) The two lamps are in series.

$V_{L1} = V_{L3}$ = 3.0 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.

$V_{L2} = V_{L3}$ = 6.0 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.

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(a) V = 6.0 V, $I = V / R_{total}$ = 0.020 A

(b) V = 3.0 V, same I = 0.020 A

(c) V = 0.0 V, same I = 0.020 A

Note: Brightness of lamp is <u>not</u> directly proportional to V or I^2