ANSWERS

1

(a) V=IR = 0.50 × 18.0 = <u>9.0 V</u>

(b) Current = 0.50 + 2(0.50) = <u>1.50 A</u>

(c) Potential difference between R and S = (1.50 A x 2.0 Ω) + 9.0 V
= 3.0 V + 9.0 V = <u>12 V</u>

(d) Power = V^2/R = $12^2/4$ = <u>36 W</u>

2

(a) V = IR ➔ I = V / R = (1.5 × 3) / 18
= 0.25 A

(b) I = Q / t ➔ Q = I x t = 0.25 A x 1 s = 0.25 C

3

(a) The resistance of constantan wire remains <u>constant</u> with change in temperature.

(b) When current flows through a tungsten wire, <u>the wire is heated up</u> and, according to Fig. 12.1, the <u>resistance of the wire increases</u>.
By V = IR, the <u>current through the bulb decreases</u> over time.

(c) 1000 Ω

(d) When there is a fire, the <u>temperature of the thermistor increases.</u>

The <u>resistance</u> of the thermistor <u>decreases with increasing temperature</u> (Fig. 12.1) and its <u>p.d. decreases.</u>

The <u>p.d. across the fixed resistor and the fire alarm</u> (in parallel with the fixed resistor) <u>increases</u>.

When this <u>p.d. exceeds V_o</u>, the <u>fire alarm is triggered</u>.

(e) V_o = [R / (R + R_t) x 9.0]   = (2000 / (600 + 2000)) x 9.0
= (2000/2600) x 9.0 V = 6.923 ≈ 6.9 V

4

a i Effective resistance of the voltmeter and X connected in parallel:

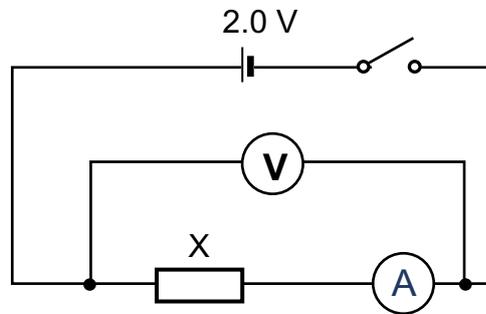$$\frac{1}{R_e} = \frac{1}{2500\Omega} + \frac{1}{2000\Omega}$$

R_e= 1111 Ω

Reading of ammeter = $\dfrac{2.0\ V}{1111\Omega}$ = 1.8 × 10^{-3} A

a ii Value of X obtained = $\dfrac{2.0\ \text{V}}{0.0018\ \text{A}}$ =1100 Ω (2 s.f.)

b   As the **resistance of X is close to the resistance of the voltmeter**, the current that flows through the voltmeter is not negligible.
The ammeter measures the **total current flowing through X and the voltmeter.**

c

5

(a) As temperature increases, resistance of the thermistor <u>decreases</u> due to the <u>increase in concentration of free mobile electrons</u> **[1]**.
OR
Since <u>potential difference across the thermistor decreases</u> as the temperature increases, it implies that the <u>resistance</u> of the thermistor <u>decreases.</u>

(b) The potential difference across the air-conditioning unit <u>increases</u> because the potential difference across the thermistor decreases.

(c) 30°C

(d) **(i)** 56 V

(ii) Current in circuit = 56/1630 = 0.034355 A
                        = <u>0.034 A</u> or <u>34 mA</u> (2 s.f.)

(iii) p.d. across air conditioning unit = 230 – 56 = <u>174 V</u>

(iv) Therefore, resistance of air conditioning unit
            = 174/0.034355
            = <u>5060 Ω (3 s.f.)</u>

(e) At 58°C, p.d. across thermistor is <u>32 V (from graph)</u>

p.d. across air conditioning unit = 230 – 32 = <u>198 V</u>

Current through thermistor = 198/**5060** =<u>0.03913 A</u>

Therefore, resistance of thermistor = 32/0.03913 = <u>818 Ω (3 s.f.)</u>

6

(a)   75 Ω

(b)   effective resistance = 75 + 15 = 90 Ω
        I = V / R = 2.0 / 90 = 0.022 A

(c)

(i)   Correct statement of relationship between thermistor temperature and its resistance. R increases as T decreases OR vice-versa is sufficient.
        Clear indication of role of heating element to raise temperature of thermistor.
        Mention of either increase in current or potential difference causing the bulb to light up.
        Mention of significance of the parallel arrangement – maintain constant V across the parallel branches OR use of potential divider effect in the thermistor/bulb branch.

(ii)   Let the resistance of thermistor be R at the lowest temperature.

        V = IR,   2.0 = (12.1 x 10^{-3}) x (R + 15)
                       R + 15 = 165.3
                       R   = 150.3 Ω
        From the graph,
        temperature of the thermistor $\approx$ 40 $\degree$C