

Solutions

These allocations are for the original questions on this sheet. B1 = one standalone point, M1 = one method point, A1 = one accuracy point.

2.1 $V_x = V_{total}x/L = 6.0 \times 0.30/1.20 = 1.5$ V. Uniform wire resistance is proportional to length; the same current flows throughout, so $V = IR$ gives drop proportional to length.

2.2 Unloaded $V_o = V_i R_2/(R_1 + R_2) = 9 \times 4/6 = 6.0$ V. Loaded lower resistance is $4 \parallel 4 = 2.0$ k Ω . New $V_o = 9 \times 2/(2 + 2) = 4.5$ V.

2.3 $I = \mathcal{E}/(R + r) = 1.5/3.0 = 0.50$ A. $V = \mathcal{E} - Ir = 1.5 - 0.50 \times 0.50 = 1.25$ V. $P_{int} = I^2 r = 0.50^2 \times 0.50 = 0.125$ W.

3.1 Heating the thermistor releases more mobile carriers, reducing its resistance. Its fraction $R_T/(R_f + R_T)$ decreases, so the named output falls. In metal, increased lattice scattering dominates with approximately unchanged carrier density, so resistance rises. Illumination releases more carriers in an LDR, reducing its resistance.

3.2 Use an ammeter and variable external load in series; voltmeter across the cell. Record several V, I pairs and plot V against I . From $V = \mathcal{E} - Ir$, gradient = $-r$ and intercept = $\mathcal{E}$. $r = -\Delta V/\Delta I = -(1.25 - 1.45)/(0.50 - 0.10) = 0.50$ Ω . $\mathcal{E} = V + Ir = 1.45 + 0.10 \times 0.50 = 1.50$ V. Short-circuit current causes heating and can change cell conditions or damage the cell; use current limiting and open the switch between readings.

3.3 Illumination releases additional mobile carriers in the LDR, so its resistance decreases. With fixed resistor below, $R_f/(R_{LDR} + R_f)$ rises, so the output rises. With the LDR below, its own fraction $R_{LDR}/(R_f + R_{LDR})$ falls, so the output falls.