open air change, keeping our head and the ground at the same potential.

(b) Yes. The steady discharging current in the atmosphere charges up the aluminium sheet gradually and raises its voltage to an extent depending on the capacitance of the capacitor (formed by the sheet, slab and the ground).

(c) The atmosphere is continually being charged by thunderstorms and lightning all over the globe and discharged through regions of ordinary weather. The two opposing currents are, on an average, in equilibrium.

(d) Light energy involved in lightning; heat and sound energy in the accompanying thunder.

CHAPTER 3

3.1 30 A

3.2 17 Ω, 8.5 V

3.3 (a) 6 Ω

(b) 2 V, 4 V, 6 V

3.4 (a) (20/19) Ω

(b) 10A, 5 A, 4A; 19A

3.5 1027 °C

3.6 2.0×10^{-7} Ωm

3.7 0.0039 $°C^{-1}$

3.8 867 °C

3.9 Current in branch AB = (4/17) A,

in BC = (6/17) A, in CD = (–4/17) A,

in AD = (6/17) A, in BD. = (–2/17) A, total current = (10/17) A.

3.10 (a) X = 8.2 Ω; to minimise resistance of the connection which are not accounted for in the bridge formula.

(b) 60.5 cm from A.

(c) The galvanometer will show no current.

3.11 11.5 V; the series resistor limits the current drawn from the external source. In its absence, the current will be dangerously high.

3.12 2.25 V

3.13 2.7×10^4 s (7.5 h)

3.14 Take the radius of the earth = 6.37×10^6 m and obtain total charge of the globe. Divide it by current to obtain time = 283 s. Still this method gives you only an estimate; it is not strictly correct. Why?

3.15 (a) 1.4 A, 11.9 V

(b) 0.005 A; impossible because a starter motor requires large current (~ 100 A) for a few seconds.

3.16 The mass (or weight) ratio of copper to aluminium wire is (1.72/2.63) × (8.9/2.7) ≅ 2.2. Since aluminium is lighter, it is preferred for long suspensions of cables.

3.17 Ohm's law is valid to a high accuracy; the resistivity of the alloy manganin is nearly independent of temperature.

3.18 (a) Only current (because it is given to be steady!). The rest depends on the area of cross-section inversely.

(b) No, examples of non-ohmic elements: vacuum diode, semiconductor diode.

(c) Because the maximum current drawn from a source = ε/r.

(d) Because, if the circuit is shorted (accidentally), the current drawn will exceed safety limits, if internal resistance is not large.

3.19 (a) greater, (b) lower, (c) nearly independent of, (d) 10^{22}.

3.20 (a) (i) in series, (ii) all in parallel; n^2.

(b) (i) Join 1 Ω, 2 Ω in parallel and the combination in series with 3Ω, (ii) parallel combination of 2 Ω and 3 Ω in series with 1 Ω, (iii) all in series, (iv) all in parallel.

(c) (i) (16/3) Ω, (ii) 5 R.

3.21 *Hint:* Let X be the equivalent resistance of the infinite network. Clearly, $2 + X/(X+1) = X$ which gives $X = (1 + \sqrt{3})$ Ω; therefore the current is 3.7 A.

3.22 (a) ε = 1.25 V.

(b) To reduce current through the galvanometer when the movable contact is far from the balance point.

(c) No.

(d) No. If ε is greater than the emf of the driver cell of the potentiometer, there will be no balance point on the wire AB.

(e) The circuit, as it is, would be unsuitable, because the balance point (for ε of the order of a few mV) will be very close to the end A and the percentage error in measurement will be very large. The circuit is modified by putting a suitable resistor R in series with the wire AB so that potential drop across AB is only slightly greater than the emf to be measured. Then, the balance point will be at larger length of the wire and the percentage error will be much smaller.

3.23 1.7 Ω

Chapter 4

4.1 $\pi \times 10^{-4}$ T $\simeq 3.1 \times 10^{-4}$ T

4.2 3.5×10^{-5} T

4.3 4×10^{-6} T, vertical up

4.4 1.2×10^{-5} T, towards south

4.5 0.6 N m^{-1}

4.6 8.1×10^{-2} N; direction of force given by Fleming's left-hand rule

4.7 2×10^{-5} N; attractive force normal to A towards B