Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

$t = 8.0 \times 3600 = 28\,800$ s; $q = 2.5 \times 10^{-6} \times 28\,800 =$ **72 mC**; $N = \dfrac{0.072}{1.60 \times 10^{-19}} =$ $\mathbf{4.5 \times 10^{17}}$ electrons

2.2

charge = area $= \frac{1}{2}(2.0)(4.0) + (3.0)(4.0) =$ **16 C**; average current $= \dfrac{16}{5.0} =$ **3.2 A**

2.3

$p = vi = 12 \times (-0.50) =$ **−6.0 W**; negative, so it **supplies** 6.0 W: for example a battery or another source

2.4

$0.005 \times 4.73 = 0.024$ V, plus $2 \times 0.01 = 0.02$ V; uncertainty = **0.044 V** $\approx 0.9\%$; result $(\mathbf{4.73 \pm 0.04})$ **V**

3.1

$R = \dfrac{12.0}{0.250} =$ **48.0** Ω; $P = 12.0 \times 0.250 =$ **3.00 W**

% uncertainties: $\dfrac{0.1}{12.0} = 0.83\%$, $\dfrac{0.005}{0.250} = 2.0\%$; add them: 2.8%

$R = (48.0 \pm 1.4)$ Ω; $P = (3.00 \pm 0.09)$ W

the ammeter: its 2.0% is more than twice the voltmeter's 0.83%, so improve the current reading first

3.2

without: $\dfrac{1.50}{10.0} =$ **150 mA**; with: $\dfrac{1.50}{10.5} =$ **142.9 mA**

error $= \dfrac{142.9 - 150}{150} = -4.8\%$

need $\dfrac{10}{10 + R_A} > 0.99$, so $R_A <$ **0.10** Ω

3.3

(a) radio: $15 \times 10^{-3} \times 2.0 = 30$ mC; sleep: $20 \times 10^{-6} \times 598 = 12.0$ mC; total **42.0 mC**; average $= \dfrac{42.0 \text{ mC}}{600 \text{ s}} =$ **70 µA**

(b) $\dfrac{2500 \text{ mAh}}{0.070 \text{ mA}} =$ $\mathbf{3.6 \times 10^4}$ **h = 4.1 years**

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(c) usable 2000 mAh: $\dfrac{2000}{0.070} = 2.9 \times 10^4$ h = 3.3 years: **fails**; every 20 min: $\dfrac{30 + 20 \times 10^{-3} \times 1198}{1200} =$ 45 µA; $\dfrac{2000}{0.045} = 4.4 \times 10^4$ h = 5.1 years: just passes, with almost no margin