1

Charge and Current

—

Solution 1.1
Here is where the solution goes.

—

Solution 1.2
We will use the relationship $A = It$ But first, let's convert from mA to A:

$$30\,\text{mA} \;=\; 30\,\text{mA}\left(\frac{1\,\text{A}}{1000\,\text{mA}}\right) \;=\; 0.03\,\text{A}\;. \tag{1.1}$$

1. Using $Q = It$, we have

$$\begin{aligned} Q &= 0.03\,\text{A}(15\,\text{min})\;, && (1.2)\\ &= 0.03\,\text{C}/\,\text{s}(15\,\text{min})\left(\frac{60\,\text{s}}{1\,\text{min}}\right)\;, && (1.3)\\ &= 9\,\text{C}. && (1.4) \end{aligned}$$

2. Now we set $Q = 100$ C and solve for t.

$$t \;=\; \frac{Q}{I} \;=\; \frac{100\,\text{C}}{0.03\,\text{C}/s} \;=\; 3,333\,\text{s}\;. \tag{1.5}$$

   A time of $3,333$ is not very intuitive, so it is probably best to convert to minutes:

$$t \;=\; 3,333\,\text{s}\left(\frac{1\,\text{min}}{60\,\text{s}}\right) \;\approx\; 56\,\text{min}\;. \tag{1.6}$$

—

Solution 1.3
Here is where the solution goes.

—

Solution 1.4
Here is where the solution goes.

—

Solution 1.5
The solutions follow directly from the definition of current, $I = Q/t$, and the definition of an amp: 1 A $= 1$ C/s.

1.

$$I = \frac{60\,\text{C}}{4\,\text{s}} = 15\,\text{C/s}\,. \tag{1.7}$$

2.

$$I = \left(\frac{15\,\text{C}}{2\,\text{min}}\right)\left(\frac{1\,\text{min}}{60\,\text{s}}\right) = 0.125\,\text{A}\,. \tag{1.8}$$

3.

$$I = \left(\frac{3\times 10^{22}\,\text{C}}{1\,\text{h}}\right)\left(\frac{1\,\text{h}}{60\,\text{min}}\right)\left(\frac{1\,\text{min}}{60\,\text{s}}\right) = 8.3\times 10^{18}\,\text{A}\,. \tag{1.9}$$

—

Solution 1.6
We need to calculate the current I and see if it is larger than 5 amps. Using the definition of current, $I = Q/t$,

$$I = \left(\frac{25,000\,\text{C}}{1\,\text{h}}\right)\left(\frac{1\,\text{h}}{60\,\text{min}}\right)\left(\frac{1\,\text{min}}{60\,\text{s}}\right) = 6.95\,\text{A}\,. \tag{1.10}$$

The current is larger than 5. Thus the fuse will blow.

—

Solution 1.7
Insert solution.

—

Solution 1.8
We will use the relationship capacity $= It$. (Remember that capacity is just a measure of how much charge a battery can deliver.) Solving this relationship for t and plugging in, we find:

$$t = \frac{\text{capacity}}{I} = \frac{48\,\text{Ah}}{10\,\text{A}} = 4.8\,\text{h}\,. \tag{1.11}$$

—

Solution 1.9
Insert solution.

—

Solution 1.10
We use ohm's law, $V = IR$ and the fact that one ohm is equal to one volt per amp.

$$V = IR = (0.5\,\text{A})(100\,\Omega) = 50\,\text{V}\,. \tag{1.12}$$

—

Solution 1.11
Insert solution.

—

Solution 1.12
Insert solution.