Problem 1. b

The charge entering a certain element is shown.

Find: Current at
   a) t = 1 ms
   b) t = 6 ms
   c) t = 10 ms

\[ i = \frac{dq}{dt} \]

Need to find equation of lines from 0 to 2 sec.

From 0 to 2:
\[ q(t) = \frac{80mc}{2m} t + 0 \]
\[ q(t) = 40t \]

From 8 to 12:
\[ q(t) = -\frac{80mc}{4m} t + 240mc \]

\[ i = \frac{dq}{dt} \]

@ t = 1 ms \[ i = \frac{dq}{dt} = \frac{80mc}{2m} \times 40A = \]

@ t = 6 ms \[ i = \frac{dq}{dt} = 0A \leq \]

@ t = 10 ms \[ i = \frac{dq}{dt} = -20A \leq \]
Problem 1.8

The current flowing past a point in a device is shown.

Find: The total charge through the point.

\[ Q = \int_{0}^{t} i \, dt \]

\[ Q = \int_{0}^{1} t \, dt + \int_{1}^{2} 10 \, dt \]

\[ Q = \left[ \frac{t^2}{2} \right]_0^1 + 10t \bigg|_1^2 \]

\[ Q = \left( \frac{1}{2} \right) + (20 - 10) \]

\[ Q = 15 \text{ C} \]

\[ \text{Solution} \]
Problem 1.11

Given: A rechargeable flashlight battery is capable of delivering 85 mA for about 12 hours.

Find: How much charge can it release at that rate.
   If its terminal voltage is 1.2 V, how much energy can the battery deliver?

Solution: Convert hours to sec.

\[
12\text{ hr} \cdot 60\text{ min} \cdot 60\text{ sec} = 43200\text{ sec} = 12\text{ hr}.
\]

\[
Q = \int_0^t i(t) dt = \int_0^{43200} 0.085 dt = 0.085 t \left|_0^{43200}\right.
\]

\[
Q = 0.085 \times (43200 - 0) \text{ sec} = 3672\text{ A} \cdot \text{sec} = 3672\text{ C}.
\]

\[
w = \int_0^t p(t) dt = \int_0^t v(t)i(t) dt = \int_0^{43200} 1.2 \times 0.085 dt = \int_0^{43200} 0.102 V \cdot \text{A} \cdot dt =
\]

\[
= 0.102 \text{ V} \cdot \text{A} \left|_0^{43200}\right.
\]

\[
= 0.102 \times (43200 - 0) \text{ sec}
\]

\[
= 4406.4\text{ J} \cdot \text{sec}
\]

\[
\frac{w \cdot \text{sec}}{J} = \int
\]

\[
\approx 4406.4\text{ J}
\]
Problem 1.14

Given: The voltage \( V \) across a device and the current \( I \) are:
\[ V(t) = 50 \cos(2\pi t) V \]
\[ I(t) = 10(1 - e^{-0.5t}) A \]

Find: The total charge in the device at \( t = 15 \), the power consumed by the device at \( t = 15 \)

\[ Q = \int_0^t i dt \]
\[ Q = \int_0^t 10(1 - e^{-0.5t}) dt \]
\[ Q = 10t + 20(e^{-0.5t}) \bigg|_0^{15} \]
\[ Q = 10(15) + 20(e^{-0.5(15)}) - 20 \]
\[ Q = (150 - 20(0.393)) \]
\[ Q = 129.5 \text{ C} \]

\[ P(t) = V(t)I(t) \]
\[ P(t) = 50 \cos(2\pi t)(1 - e^{-0.5t}) \text{ W} \]

\[ P(15) = 50 \cos(2\pi(15))(1 - e^{-0.5(15)}) \]
\[ P(15) = 50 \cos(30)(1 - e^{-0.5(15)}) \]
\[ P(15) = -8.19 \text{ W} \]
Problem 1.16

Given: The figures showing the current through and voltage across a device.

Find: a) Sketch the power delivered to the device for $t > 0$.

b) Find the total energy absorbed by the device for the period of $0 < t < 4s$.

Current $i(t)$:

$$i(t) = \begin{cases} 
30t & 0 < t < 2 \\
-30t + 120 & 2 < t < 4
\end{cases}$$

Voltage $v(t)$:

$$v(t) = \begin{cases} 
5 & 0 < t < 2 \\
-5 & 2 < t < 4
\end{cases}$$

Power $P$:

$$P = \begin{cases} 
5(30t) & 0 < t < 2 \\
-5(-30t + 120) & 2 < t < 4
\end{cases} = \begin{cases} 
150t & 0 < t < 2 \\
150t - 600 & 2 < t < 4
\end{cases}$$
Problem 1b. Cont.

\[ w \dot{e} \int_{t_0}^{t} p \, dt = \int_{t_0}^{t} 150e^2 \, dt \int_{t_0}^{t} (50e - 600) \, dt \]

\[ = 150 \frac{e^{t^2}}{2} \bigg|_{t_0}^{t} + \left( \frac{150 e^2}{2} - 600 e \right) \bigg|_{t_0}^{t} \]

\[ = \frac{150 (t^2 - t_0^2)}{2} + \left( \frac{150 (t^2 - t_0^2)}{2} - 600 (t - t_0) \right) \]

\[ = 300 - 300 \]

\[ w = 0 \text{ J} \]
Problem 1.18

Find: The power absorbed by each of the elements.

\[ E = 10 \text{V} + 10 \text{V} + 8 \text{V} \]

\[ P_1 = (10 \text{A})(30 \text{V}) \]
\[ P_1 = 300 \text{W} \]

\[ P_2 = (10 \text{A})(10 \text{V}) \]
\[ P_2 = 100 \text{W} \]

\[ P_3 = (14 \text{A})(20 \text{V}) \]
\[ P_3 = 280 \text{W} \]

\[ P_4 = (-8 \text{V})(14 \text{A}) \]
\[ P_4 = -112 \text{W} \]

\[ P_5 = (-12 \text{V})(0.4 \text{A})(10) \]
\[ P_5 = -48 \text{W} \]

Check: \( E P = 0 \)
\[ P_1 + P_2 + P_3 + P_4 + P_5 = 0 \]
\[ -300 + 100 + 280 - 112 - 48 = 0 \]
\[ 0 = 0 \]

\[ \checkmark \]
**Problem 1.20**

Find $V_o$ in the circuit.

**KVL Loop 1**

$-30V + 12V + V_o = 0$

$V_o = 30 - 12$

$V_o = 18V$

**Check with KVL**

$-V_o + 28 - 5I_o = 0$

$-V_o = 28 - 5I_o$

$V_o = 28 - 10$

$V_o = 18V$
Problem 1.28

A 30-W incandescent lamp is connected to a 120-V source and is left burning continuously in an otherwise dark staircase. Determine:

a) The current through the lamp

\[ I = \frac{P}{V} \]
\[ I = \frac{30 \text{ W}}{120 \text{ V}} = 0.25 \text{ A} \]

b) The cost of operating the light for 1 non-leap year if electricity costs 12 cents per kWh.

\[ \text{Cost} = \frac{0.12 \text{ c/kWh}}{\text{kWh}} \times \frac{365 \text{ days}}{\text{yr}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{30 \text{ W}}{1000 \text{ W}} \times \frac{1 \text{ yr}}{365 \text{ days}} = \$31.54/\text{yr} \]