Consider the circuit shown in the figure.

a) Calculate the current in 5 Ω resistor.

b) What power is dissipated by the entire circuit?

\[ I = \frac{V}{R_{eq}} = \frac{28}{14} = 2 \text{A} \Rightarrow \text{the same current passes through 5 Ω resistor.} \]

\[ P = \frac{V^2}{R} = \frac{(28)^2}{14} = 56 \text{ W} \]
Three batteries of emf $\varepsilon_1 = 8V$, $\varepsilon_2 = 12V$, and $\varepsilon_3 = 2V$ are connected with five resistors in a circuit as shown in the figure.

a) Find the current $I$ flowing in the circuit.

b) Find the potential difference between points $A$ and $B$, $V_B - V_A$.

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**a)** Start from point $A$ and go around the circuit counter-clock wise.

\[
V_A + \varepsilon_2 - I \times 3 - \varepsilon_3 - I \times 1 - I \times 2 + \varepsilon_1 - I \times 1 - I \times 2 = V_A
\]

\[
\Rightarrow 12 - 3I - 2 - I - 2I + 8 - I - 2I = 0
\]

\[
\Rightarrow 18 - 9I = 0
\]

\[
\Rightarrow I = \frac{18}{9} = 2 \text{ A}
\]

The direction of $I$ has chosen correctly.

**b)**

\[
V_A + \varepsilon_2 - 3I - \varepsilon_3 = V_B
\]

\[
\Rightarrow V_B - V_A = 12 - 3 \times 2 - 2
\]

\[
\Rightarrow V_B - V_A = 4 \text{ V}
\]
A capacitor C that is initially uncharged is connected in series with a resistor R and emf source $\mathcal{E} = 120\text{ V}$. Just after the circuit is completed, the current through the resistor is $6 \times 10^{-5}\text{ A}$. The time constant for the circuit is 10s. Find the resistance of the resistor and the capacitance of the capacitor.

At $t = 0$ we can ignore capacitor:

$$R = \frac{\mathcal{E}}{I_0} = \frac{120}{6 \times 10^{-5}}$$

$\Rightarrow \quad R = 2 \times 10^6 \text{ \Omega}$

$\tau = 10 \text{ s}$

$\tau = RC \quad \Rightarrow \quad C = \frac{\tau}{R} = \frac{10}{2 \times 10^6}$

$\Rightarrow \quad C = 5 \times 10^{-6} \text{ F} = 5 \mu\text{F}$
In the circuit shown in the figure, the capacitor is originally uncharged with switch open. At \( t=0 \) the switch is closed.

a) What is the current supplied by the emf just after the switch is closed?

b) What is the current long time after the switch is closed?

\[ I = \frac{E}{R_{eq}} = \frac{R_1 + R_2}{R_1 R_2} E \]

As \( t \to \infty \) the capacitor becomes fully charged and \( I_1 = 0 \). In this case the circuit becomes:

\[ I = \frac{E}{R_2} \]
Potential difference across resistor 6R is:

\[ V_{AB} = I \times (6R) = 20 \times 10^{-3} \times 6 \times 50 \]

\[ = \sqrt{V_{AB}} = 6 \text{ V} \]

\[ I_1 = \frac{V_{AB}}{2R} = \frac{6}{2 \times 50} = 0.06 \text{ A} \implies I_1 = 60 \text{ mA} \]

\[ I_{total} = I + I_1 = 80 \text{ mA} \]

\[ R_{eq} = \frac{(6R)(2R)}{6R + 2R} + 3R = \frac{12R}{8}R + 3R = \frac{3}{2}R + 3R = 4.5R = 4.5 \times 50 \]

\[ \implies R_{eq} = 225 \Omega \]

\[ E = I_{total} \times R_{eq} = 80 \times 10^{-3} \times 225 = 18 \text{ V} \implies E = 18 \text{ V} \]