(a) What is the current in a 5.6 Ω resistor connected to a battery with an 0.2 Ω internal resistance if the terminal voltage of the battery is 10 V. (b) What is the emf of the battery?

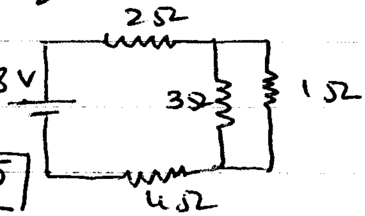
Given
$$V_{term} = 10\ V$$
$$R = 5.6\ \Omega$$
$$r = 0.2\ \Omega$$
$$I = ?$$
$$\mathcal{E} = ?$$

(a)
$$V_{term} = IR$$
$$10 = I \times 5.6$$
$$\therefore\quad I = 10/5.6 = \boxed{1.79\ A}$$

(b)
$$I = \frac{\mathcal{E}}{R+r} \quad \text{OR} \quad V = \mathcal{E} - Ir \quad \text{Eq: 28.1}$$
$$IR + Ir = \mathcal{E}$$
$$V + Ir = \mathcal{E}$$
$$\therefore$$
$$V = \mathcal{E} - Ir$$
$$10 = \mathcal{E} - 1.79(0.2)$$
$$\mathcal{E} = 10 + 0.36$$
$$\mathcal{E} = \boxed{10.36}\ V$$

RESISTORS IN SERIES AND IN PARALLEL 102-28
2A

Calculate the power dissipated in each resistor in the circuit shown in fig.



From the fig

$$R_p = \frac{1}{3} + \frac{1}{1} = \frac{1+3}{3} = \frac{4}{3} = \boxed{0.75\ \Omega}$$

resistors

, but $R_S = 2 + 0.75 + 4 = \underline{6.75\ \Omega}$

Now $V = IR \Longrightarrow I_{batt} = \frac{V}{R_{eq}} = \frac{18}{6.75} = \boxed{2.67\ A}$

$\Rightarrow P = IV, \Longrightarrow P = I^2R$

$\Longrightarrow P_{2\Omega} = (2.67)^2(2) = \boxed{14.25\ W}$ this is power dissipated across 2Ω resistor

$P_{4\Omega} = (2.67)^2(4) = \boxed{28.5\ W}$ power across 4Ω resistor.

Now to find power for 3Ω and 1Ω resistors, which are in parallel. in this case first find Voltage for series resistors, since for series resistors I is same but V is different, and vice versa for parallel resistors.

$V_2 = IR = 2.67 \times 2 = \underline{5.34}\ V$

$V_4 = IR = 2.67 \times 4 = \underline{10.68\ V} \Rightarrow V_2 + V_4 = 16\ V$

$\Rightarrow$ Voltage across 3Ω and 1Ω resistors

$18 - 16 = 2V = V_3$ and $= V_1$, since for parallel resistors V is the same.

$\Rightarrow I$ across 3Ω and I Ω

$V = IR \Rightarrow 2 = I_3 \times 3 \Rightarrow I_3 = 0.67\ A$

and $2 = I_1 \times 1 \Rightarrow I_1 = 2\ A$

P.T.O

$P = I_3^2 R$

$\Rightarrow \quad P_3 = (0.67)^2(3) = \boxed{1.33\ W}$ through $3\,\Omega$

$P_1 = I_1^2 R = (2)^2(1) = \boxed{4.0 W}$ through $1\,\Omega$

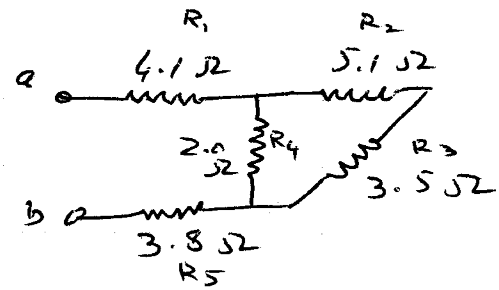
Total power $= P_1 + P_2 + P_3 + P_4 = 4.0 + 14.25 + 1.33 + 28.5$

$P_{Tot} = 48\ W$

Now $\quad P = IV = 2.67 \times 18 = \boxed{48\ W}$

RESISTORS IN SERIES AND IN PARALLEL $102 \frac{28}{2}$

Find the equivalent resistance between points a and b in given figure 28.29



Sol let $R_s = R_2 + R_3$

$$R_s = 5.1\,\Omega + 3.5\,\Omega = 8.6\,\Omega$$

Now $R_p = \frac{2 \times 8.6}{2 + 8.6} = \frac{1}{R_4} + \frac{1}{R_5}$

$$R_p = \frac{17.2}{10.6} = \boxed{1.62}$$

$\frac{1}{R_{eq}} = \frac{1}{R_4} + \frac{1}{R_s}$

$= \frac{1}{2.0} + \frac{1}{8.6}$

$= \frac{8.6+2}{2 \times 8.6}$

$\frac{1}{R_p} = \frac{10.6}{17.2}$

$R_p = \frac{17.2}{10.6} = 1.62\,\Omega$

therefore $R_{net} = 3.8 + 4.1 + 1.62$

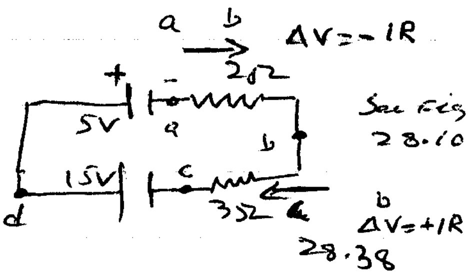
$$= \boxed{9.52\,\Omega}$$

$V = IR$

$I = V/R = \frac{10}{9.52} = 1.05\,A$

$W = IV = 1.05 \times 10 = 10.5\,W$

Two batteries and two resistors are connected in the single loop shown in figure 28.38. Given that the potential at point 'd' equals zero, determine the potentials at point (a) a, (b) b, (c) c.



Using Kirchhoff's law, clockwise around the loop.

$$\therefore \quad -5V - I(2\Omega) - I(3\Omega) + 15V = 0$$

$$\therefore \quad I = \frac{10V}{5\Omega} = \boxed{2\ A}$$

$\therefore$ (a) $V_a = -5V$

(b) $V_b = -5V - 2A \times 2\Omega = -9V$

(c) $V_c = -5V - 2A \times 2\Omega - 2A \times 3\Omega$

$= \boxed{-15V}$

RC CIRCUITS

A 4-MΩ resistor and a 3-μF capacitor are connected in series with a 12-V power supply.
(a) What is the time constant for the circuit?
(b) Express the current in the circuit and charge on the capacitor as a function of time.

$$R = 4\text{-}M\Omega = 4\times10^{6}\ \Omega$$
$$C = 3\times10^{-6}\ F$$
$$\mathcal{E} = 12\ V$$

...stant ...cy ...takes ...to 1/e of ...value.

(a) $$\tau = RC = 4\times10^{6}\times3\times10^{-6} = \boxed{12\ s}$$

(b)

$$I_{(t)} = \frac{\mathcal{E}}{R}e^{-t/RC} \qquad \text{eq 28.13}$$
$$= \frac{12}{4\times10^{6}}e^{-t/12}$$
$$\boxed{I = 3\times10^{-6}e^{-t/12}\ A}$$

$$q_{(t)} = C\mathcal{E}(1-e^{-t/RC}) \qquad \text{eq 28.14}$$
$$= 3\times10^{-6}\times12(1-e^{-t/12})$$
$$\boxed{q_{(t)} = 36\times10^{-6}(1-e^{-t/12})}\ C$$