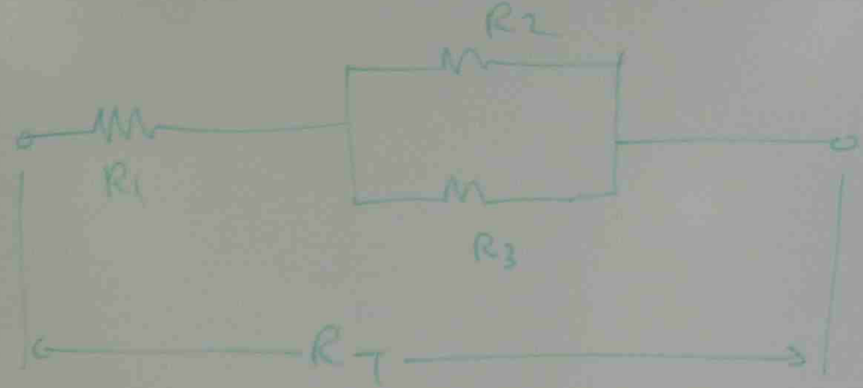
DC SERIES AND PARALLEL CIRCUITS



$$R_{23} = \frac{R_2 R_3}{R_2 + R_3}$$

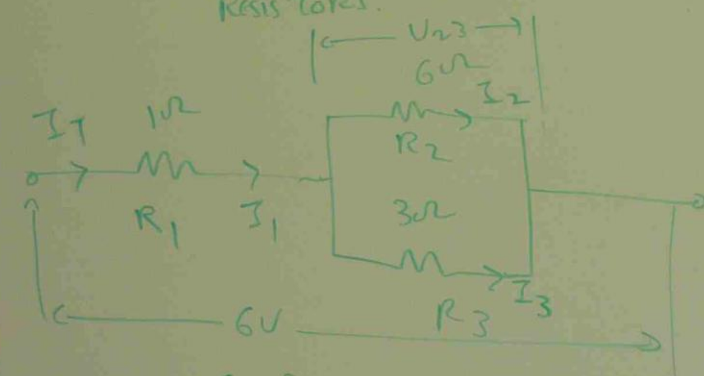
$$R_T = R_1 + R_{23} = R_1 + \frac{R_2 R_3}{R_2 + R_3}$$

Pb ①

A 1Ω RESISTOR IS CONNECTED IN SERIES WITH THE PARALLEL COMBINATION OF A 6Ω AND A 3Ω RESISTOR TO A 6 V SUPPLY.

CALCULATE (a) THE EFFECTIVE OVER ALL RESISTANCE OF THE CIRCUIT

(b) THE CURRENT IN EACH OF THE THREE RESISTORS.



$$R_{23} = \frac{6 \times 3}{6+3} = \frac{18}{9} = 2\Omega$$

(a) $R_T = R_1 + R_{23} = 1 + 2 = 3\Omega$

$I_T = \frac{6}{3} = 2$ Amp. $\Rightarrow I_1 = 2A$

R_1 (1Ω) CURRENT = 2 Amp

$V_{23} = I_T \times R_{23}$

$= 2 \times 2 = 4V$

$I_2 = \frac{V_{23}}{R_2} = \frac{4}{6} = 0.66$ Amp

RIES WITH THE PARALLEL

RESISTOR TO A 6 V

ALL RESISTANCE OF THE

OF THE THREE

$$I_T = \frac{6}{3} = 2 \text{ Amp} \Rightarrow I_1 = 2A$$

R_1 (1Ω) CURRENT = 2 Amp

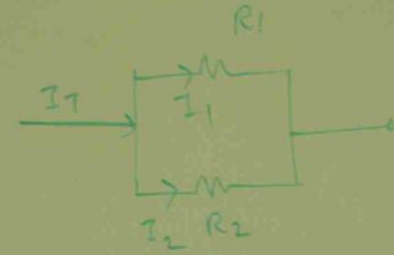
$$V_{23} = I_T \times R_{23}$$

$$= 2 \times 2 = 4V$$

$$I_2 = \frac{V_{23}}{R_2} = \frac{4}{6} = 0.66 \text{ Amp}$$

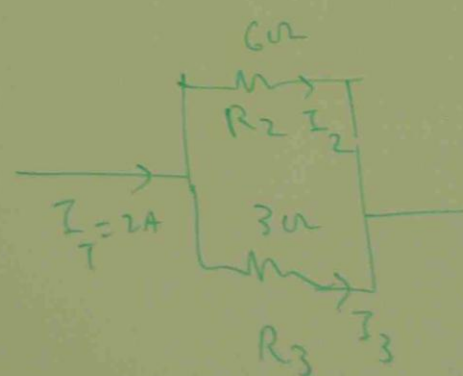
$$I_3 = \frac{V23}{R_3} = \frac{4}{3} = 1.33 \text{ Amp.}$$

CURRENT DIVIDER RULE



$$I_1 = I_T \times \frac{R2}{R_1+R2}$$

$$I_2 = I_T \times \frac{R1}{R_1+R2}$$



$$I_2 = I_T \times \frac{R_3}{R_2+R_3}$$

$$= 2 \times \frac{3}{6+3}$$

$$= \frac{6}{9} = 0.66 A$$

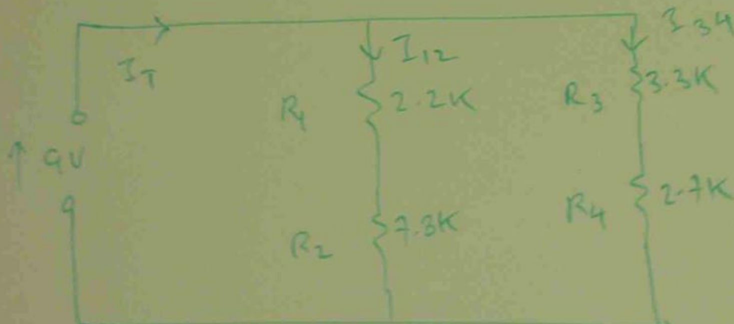
$$I_3 = I_T \times \frac{R_2}{R_2+R_3} = 2 \times \frac{6}{6+3} = \frac{12}{9} = 1.33A$$

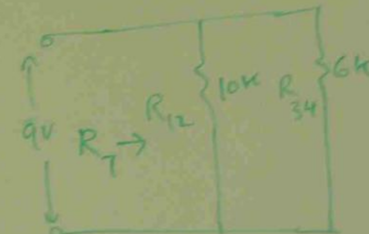
pb(2)

RESISTORS OF 2.2 kΩ AND 7.8 kΩ ARE CONNECTED IN SERIES AND IN PARALLEL ACROSS THEM IS A SECOND SERIES GROUP OF 3.3 kΩ AND 2.7 kΩ RESISTORS. THE COMPLETE CIRCUIT IS CONNECTED TO A 9V SUPPLY.

CALCULATE (a) THE TOTAL RESISTANCE OF THE CIRCUIT AND

(b) THE CURRENT FROM THE SUPPLY AND IN EACH RESISTOR.





$R_{12} = R_1 + R_2 = 2.2 + 7.8 = 10\,k\Omega$

$R_{34} = R_3 + R_4 = 3.3 + 2.7 = 6\,k\Omega$

$$R_T = \frac{R_{12} \times R_{34}}{R_{12} + R_{34}} = \frac{10 \times 6}{10 + 6} = \frac{60}{16} = 3.75\,k\Omega$$

$I_T = \frac{9V}{R_T} =$

$I_{12} = \frac{9}{R_{12}} =$

$I_{34} = \frac{9}{6K} =$

pb(3)

FIVE RESISTOR[S] ...

GROUPING TO A ...

CALCULATE

(a) ...

(b) ...

(c) ...

$$I_T = \frac{9V}{R_T} = \frac{9}{3.75K} = \frac{9}{3.75\times10^{3}} = 2.4\times10^{-3}A$$

$$= 2.4mA$$

$$I_{12} = \frac{9}{R_{12}} = \frac{9}{10K} = \frac{9}{10\times10^{3}} = 0.9\times10^{-3}A$$

$$= 0.9mA$$

$$I_{34} = \frac{9}{6K} = \frac{9}{6\times10^{+3}} = 1.5\times10^{-3} = 1.5mA$$

Pb(3)

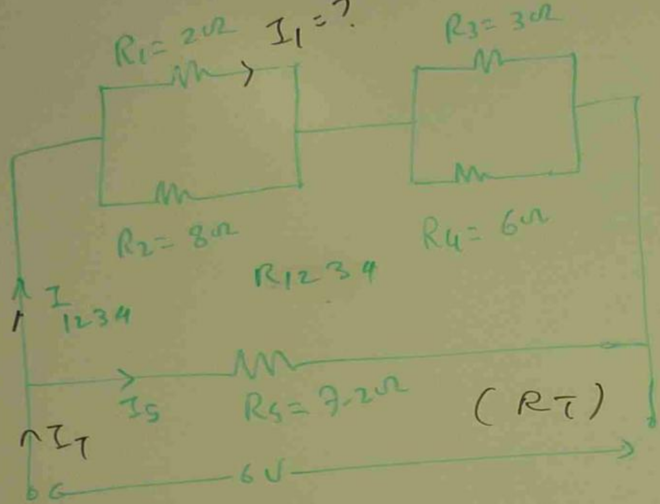
FIVE RESISTORS ARE CONNECTED IN SERIES - PARALLEL GROUPING TO A 6V SUPPLY AS SHOWN IN FIGURE

CALCULATE

(a) TOTAL RESISTANCE OF THE CIRCUIT

(b) THE CURRENT PROVIDED BY THE SUPPLY

(c) THE CURRENT FLOWING IN 2Ω RESISTOR.



$$R_{12} = \frac{2 \times 8}{2+8} = 1.6\ \Omega$$

$$R_{34} = \frac{3 \times 6}{3+6} = 2\ \Omega$$

$$R_{1234} = R_{12} + R_{34} = 1.6 + 2 = 3.6\ \Omega$$

(a)

$$R_T = \frac{R_{1234} \times R_5}{R_{1234} + R_5} = \frac{3.6 \times 7.2}{3.6 + 7.2} = \frac{3.6 \times 7.2}{10.8} = 2.4\ \Omega$$

(b)

$$I_T = \frac{V}{R_T} = \frac{6}{2.4} = 2.5A$$

$$I_{1234} = I_T \times \frac{R_5}{R_{1234} + R_5} = 2.5 \times \frac{7.2}{3.6 + 7.2} = 2.5 \times \frac{7.2}{10.8} = 1.66\ \text{Amp}$$

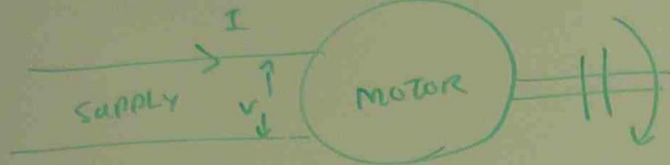
$$I_1 = I_{1234} \times \frac{R_2}{R_1 + R_2}$$

$$= 1.66 \times \frac{8}{2+8}$$

$$= 1.66 \times \frac{8}{10}$$

$$= 1.33\ \text{Amp.}$$

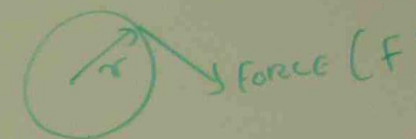
INPUT POWER + OUTPUT POWER + EFFICIENCY



$$\text{OUTPUT POWER} = \frac{2\pi N T}{60}$$

INPUT POWER = $V \times I$

T = TORQUE



T = FORCE × RADIUS

$T = F \times r$

$$\text{EFFICIENCY} = \frac{\text{OUTPUT POWER}}{\text{INPUT POWER}} \times 100$$

N = SPEED (RPM)

Pb(1) AN ELECTRIC MOTOR HAS A TOTAL POWER INPUT OF 1200 W AND AN OUTPUT OF 1000 W.
CALCULATE PER UNIT AND PERCENTAGE EFFICIENCIES.

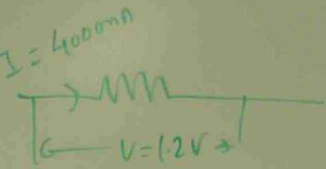
$$P.U\ (\text{PER UNIT})\ \text{EFFICIENCY} = \frac{\text{OUTPUT POWER}}{\text{INPUT POWER}}$$

$$= \frac{1000}{1200} = 0.833$$

$$\%\ \text{EFFICIENCY} = \frac{\text{OUTPUT POWER}}{\text{INPUT POWER}} \times 100$$

$$= \frac{1000}{1200} \times 100 = 83.3\%$$

Pb 2 A RESISTOR HAS A VOLTAGE OF 1.2V ACROSS IT AND CARRIES A CURRENT OF 400mA. IF THE RESISTOR HAS A POWER RATING OF 0.5W, IS IT OPERATION LIKELY TO BE SATISFACTORY?



$$\text{POWER} = V \times I = 1.2 \times 400 \times 10^{-3}$$

$$= 0.48\ \text{WATT}$$

ACTUAL POWER 0.48W IS LESS THAN RATED POWER OF RESISTOR, THE RESISTOR WILL NOT BE OVER HEATED AND IT'S OPERATION IS SATISFACTORY

Pb 3 THE VOLTAGE ACROSS A 12Ω RESISTOR IS 0.8V, CALCULATE THE POWER DISSIPATED IN IT.

$$P = \frac{V^2}{R} = \frac{(0.8)^2}{12} = 0.0533\,W$$

$$= 53.3\,mW$$

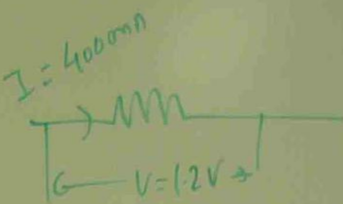
$$\text{P.U (PER UNIT) EFFICIENCY} = \frac{\text{OUTPUT POWER}}{\text{INPUT POWER}}$$

$$= \frac{1000}{1200} = 0.833$$

$$\text{\% EFFICIENCY} = \frac{\text{OUTPUT POWER}}{\text{INPUT POWER}} \times 100$$

$$= \frac{1000}{1200} \times 100 = 83.3\%$$

Pb (2) A RESISTOR HAS A VOLTAGE OF 1.2V ACROSS IT AND CARRIES A CURRENT OF 400mA. IF THE RESISTOR HAS A POWER RATING OF 0.5W, IS IT OPERATION LIKELY TO BE SATISFACTORY?



$$\text{POWER} = V \times I = 1.2 \times 400 \times 10^{-3}$$

$$= 0.48 \text{ WATT}$$

ACTUAL POWER 0.48W IS LESS THAN RATED POWER OF RESISTOR, THE RESISTOR WILL NOT BE OVER HEATED AND IT'S OPERATION IS SATISFACTORY

Pb (3) THE VOLTAGE ACROSS A 12 Ω RESISTOR IS 0.8V, CALCULATE THE POWER DISSIPATED IN IT.

$$P = \frac{V^2}{R} = \frac{(0.8)^2}{12} = 0.0533\,W$$

$$= 53.3\,mW$$

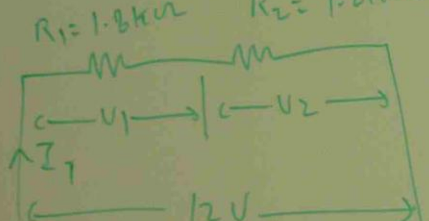
pb 4

A 47 kΩ RESISTOR IS CARRYING A CURRENT OF 6mA. CALCULATE THE POWER DISSIPATED.

$$P = I^2 R = (6\times10^{-3})^2 \times 47\times10^3 = 36\times10^{-6}\times47\times10^3 = \frac{36\times47}{1000} = 1.69\,W$$

pb 5

A CIRCUIT HAS RESISTORS OF 1.8 kΩ AND 1.2 kΩ CONNECTED IN SERIES TO A 12V SUPPLY. CALCULATE THE POWER DISSIPATED IN EACH RESISTOR AND TOTAL CIRCUIT POWER.



$$R_T = R_1 + R_2 = 1.8 + 1.2 = 3\,k\Omega$$

$$I_T = \frac{V}{R_T} = \frac{12}{3\times10^3} = 0.4\times10^{-3}\ \text{Amp}$$

$$P_1 = I_T^2 \times R_1 = (0.4\times10^{-3})^2 \times 1.8\times10^3$$

$$= 0.16\times10^{-6}\times1.8\times10^3 = 0.0288\,W$$

(OR)

28.8mW

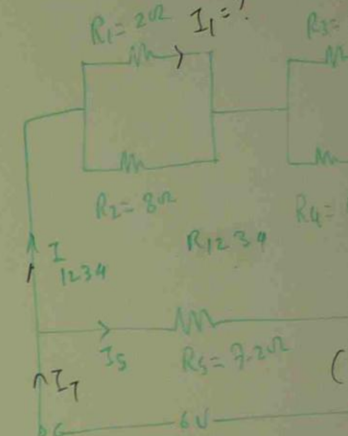
$$P_2 = I_T^2 \times R_2 = (0.4\times10^{-3})^2 \times 1.2\times10^3$$

$$= 0.16\times10^{-6}\times1.2\times10^3 = 0.0192\,W$$

(OR)

19.2mW

$$P_T = P_1 + P_2$$
$$= 28.8 + 19.2$$
$$= 48\,mW$$



$$R_{12} = \frac{2\times8}{2+8} = 1.6\,\Omega$$

$$R_{34} = \frac{3\times6}{3+6} = 2\,\Omega$$

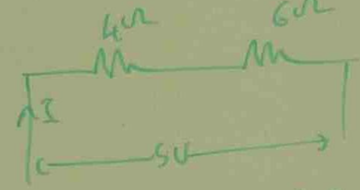
$$R_{1234} = R_{12} + R_{34} = 1.6 + 2$$

(a) $$R_T = \frac{R_{1234}\times R_5}{R_{1234} + R_5}$$

(b) $$I_T = \frac{V}{R_T} = \frac{6}{2.4} = 2$$

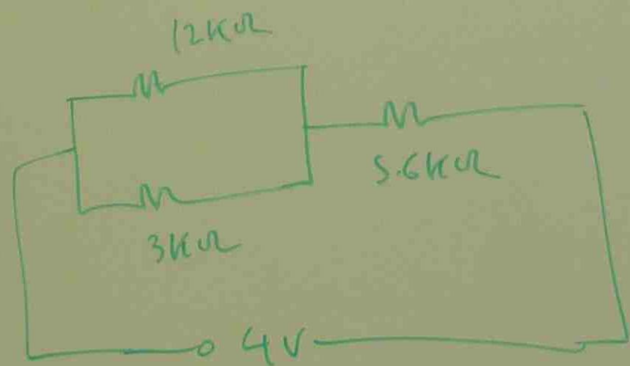
EXERCISE

1. THE POWER DISSIPATED IN 4Ω RESISTOR OF THE CIRCUIT IS



(a) 0.1W (b) 2.5W (c) 1.5W (d) 1W

2. THE POWER DISSIPATED IN $12\,k\Omega$ RESISTOR IS



(a) 1.4 mW (b) $120\,\mu W$ (c) $75\,\mu W$ (d) 2 mW