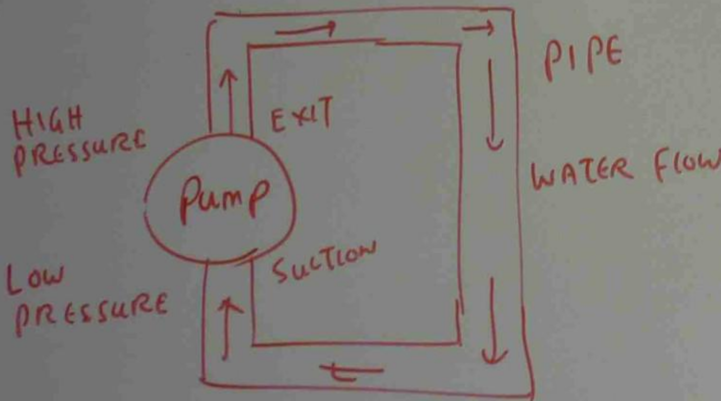
DC CIRCUITS

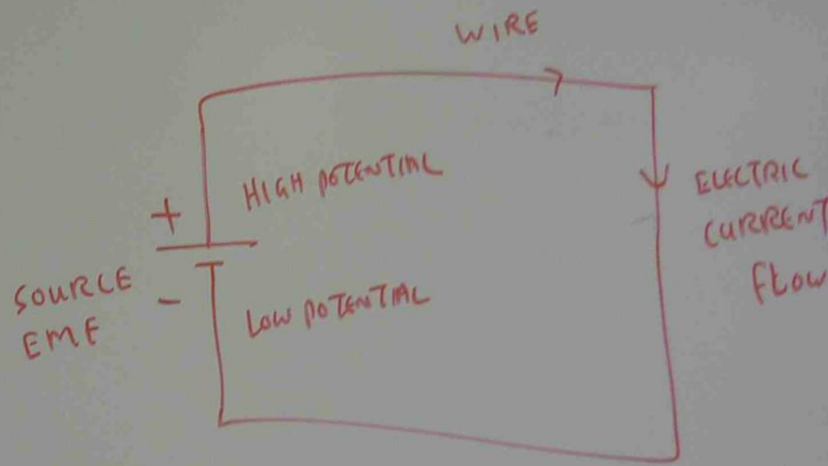
(E003 + E004)

1:30 → 3:30 THEORY (DC CIRCUIT E003 + E00

3:30 → 5:00 – PRACTICAL



HYDRAULIC SYSTEM



ELECTRIC SYSTEM

T(2)

OHM'S LAW

$$I = \frac{V}{R}$$

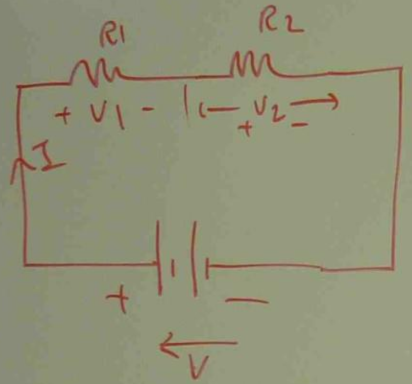
I = CURRENT

V = VOLTAGE

R = RESISTANCE

E004)

DC SERIES CIRCUITS



$$V = V_1 + V_2$$

$$R_T = R_1 + R_2$$

$$I = \frac{V_1}{R_1} = \frac{V_2}{R_2}$$

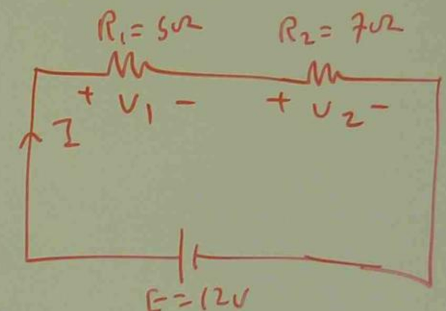
pb ①

RESISTORS OF 5Ω AND 7Ω ARE CONNECTED IN SERIES TO 12V SUPPLY. CALCULATE

(a) TOTAL RESISTANCE OF THE CIRCUIT

(b) CIRCUIT CURRENT

(c) POTENTIAL DIFFERENCE ACROSS EACH RESISTOR.



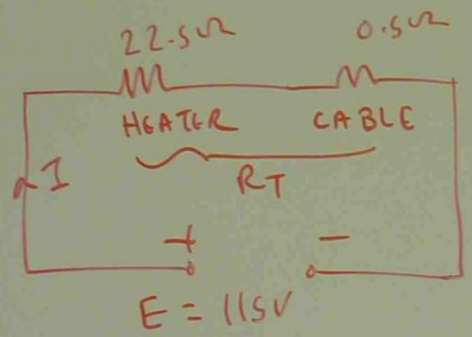
(a) TOTAL RESISTANCE $= R_1 + R_2 = 5 + 7 = 12\Omega$
R_T

(b) $I = \frac{E}{R_T} = \frac{12}{12} = 1$ Amp

(c) $V_1 = I R_1 = 1 \times 5 = 5V$, $V_2 = I \times R_2 = 1 \times 7 = 7V$

pb (2)

AN ELECTRIC HEATER OF RESISTANCE 22.5Ω IS CONNECTED TO A 115V SUPPLY THROUGH A CABLE OF TOTAL RESISTANCE 0.5Ω. CALCULATE THE CIRCUIT CURRENT AND THE POTENTIAL DIFFERENCE ACROSS THE HEATER.



$$R_T = 22.5 + 0.5 = 23\Omega$$

$$I = \frac{E}{R_T} = \frac{115}{23} = 5\text{ A}$$

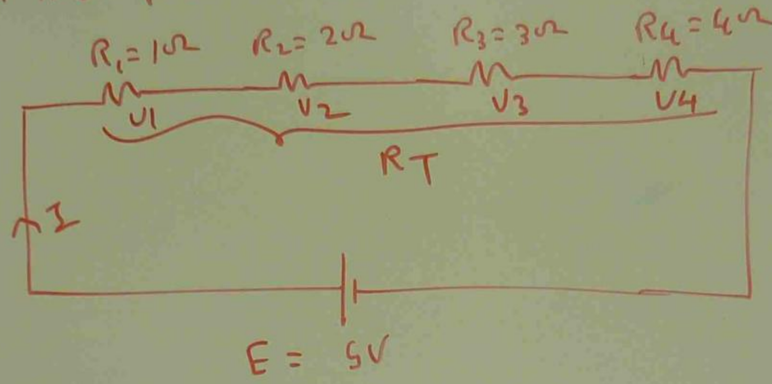
VOLTAGE ACROSS HEATER $= I\,R$

$$= 5 \times 22.5$$

$$= 112.5\text{V}$$

pb ③

FOUR RESISTORS OF VALUES 1Ω, 2Ω, 3Ω AND 4Ω ARE CONNECTED IN SERIES TO 5V SUPPLY. CALCULATE THE CIRCUIT CURRENT AND POTENTIAL DIFFERENCE ACROSS EACH RESISTOR.



$$R_T = R_1 + R_2 + R_3 + R_4 = 1 + 2 + 3 + 4 = 10\Omega$$

$$I = \frac{E}{R_T} = \frac{5}{10} = 0.5\,A$$

$$V_1 = I R_1 = 0.5 \times 1 = 0.5V$$

$$V_2 = I R_2 = 0.5 \times 2 = 1V$$

$$V_3 = I R_3 = 0.5 \times 3 = 1.5V$$

$$V_4 = I R_4 = 0.5 \times 4 = 2V$$

CURRENT

$1\,kA = 1000\,A = 10^{3}\,A$

$1\,mA = \frac{1}{1000}\,A = 10^{-3}\,A$

$1\,\mu A = \frac{1}{1000{,}000}\,A = 10^{-6}\,A$

RESISTANCE

$1\,\Omega$

$1\,k\Omega = 1000\,\Omega = 10^{3}\,\Omega$

$1\,M\Omega = 1000{,}000 = 10^{6}\,\Omega$

VOLTAGE

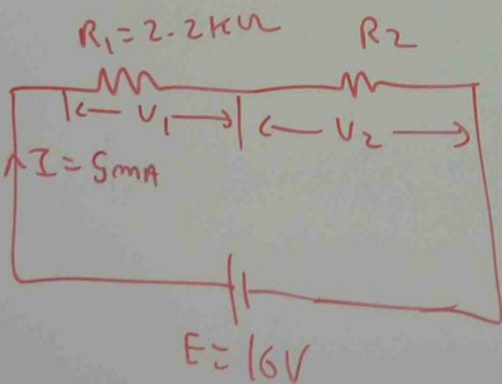
VOLT = 1V

$1\,kV = 1000\,V$

$1\,mV = 10^{-3}\,V$

$1\,\mu V = 10^{-6}\,V$

Pb④ A 2.2 kΩ RESISTOR IS CONNECTED IN SERIES WITH A RESISTOR OF UNKNOWN VALUE ACROSS A 16 V SUPPLY. IF THE CIRCUIT CURRENT FLOW IS 5 mA, CALCULATE THE VALUE OF THE UNKNOWN RESISTOR.



$V_1 = I R_1 = 5\times10^{-3} \times 2.2\times10^{3} = 11\,V$

$V_1 + V_2 = E$

$11 + V_2 = 16$

$V_2 = 16 - 11 = 5\,V$

$R_2 = \frac{V_2}{I}$

$= \frac{5}{5\times10^{-3}}$

$= 10^{3}\,\Omega$

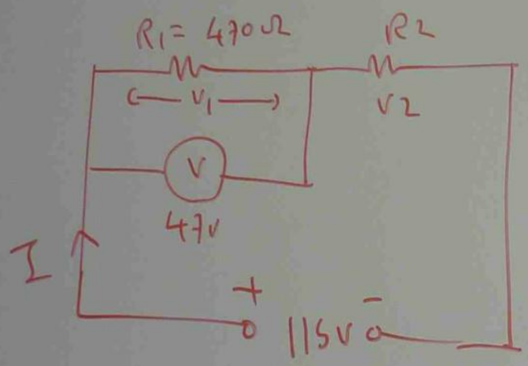
$= 1\,k\Omega$

pb (5)

TWO RESISTORS ARE CONNECTED IN SERIES TO A 115 V SUPPLY. ONE IS KNOWN TO HAVE A RESISTANCE OF 470Ω AND A VOLTMETER CONNECTED ACROSS IT SHOWS A READING OF 47 V.

CALCULATE (a) THE VALUE OF SECOND RESISTOR

(b) THE CIRCUIT CURRENT



$V_1 + V_2 = V_T = 115\ V$

$47 + V_2 = 115\ V$

$V_2 = 115 - 47 = 68\ V$

$I = I_1 = \dfrac{V}{R_1} = \dfrac{47}{470} = 0.1\ A$

$I = I_2 = 0.1\ A$

$R_2 = \dfrac{V_2}{I_2} = \dfrac{68}{0.1}$

$= 680\Omega$

EXERCISE

1. THE EFFECTIVE RESISTANCE OF A NUMBER OF RESISTORS CONNECTED IN SERIES IS
   - (a) THE SUM OF THE INDIVIDUAL RESISTANCE VALUES
   - (b) EQUAL TO THE RESISTANCE OF THE HIGHEST VALUE RESISTOR
   - (c) SMALLER THAN THE LOWEST INDIVIDUAL RESISTOR VALUE

2. INDICATE WHICH OF THE FOLLOWING STATEMENTS DOES NOT APPLY TO RESISTORS CONNECTED IN SERIES
   - (a) THEY ALL CARRY THE SAME CURRENT
   - (b) THE TOTAL CIRCUIT RESISTANCE IS EQUAL TO THE SUM OF THE INDIVIDUAL RESISTOR VALUES
   - (c) THE SUPPLY VOLTAGE IS EQUAL TO THE SUM OF THE INDIVIDUAL RESISTOR VOLTAGE DROPS
   - (d) THE CURRENT IN EACH RESISTOR IS DIFFERENT

3. THE POTENTIAL DIFFERENCE ACROSS A RESISTOR WHICH IS CONNECTED IN SERIES OF OTHERS IS
   - (a) EQUAL TO SUPPLY VOLTAGE
   - (b) NEGLIGIBLE
   - (c) MUST BE LESS THAN THE SUPPLY VOLTAGE
   - (d) HIGHER THAN SUPPLY VOLTAGE.

(4) THE CURRENT FLOWING IN A RESISTOR CONNECTED IN SERIES WITH ANOTHER WILL BE

(a) THE SAME AS THAT IN THE OTHER RESISTOR

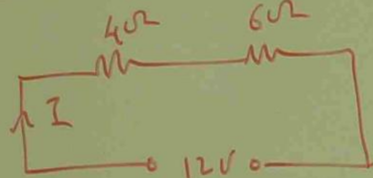
(b) DEPENDENT ONLY ON THE SUPPLY VOLTAGE AND IT'S RESISTANCE VALUE

(c) UNRELATED TO THAT IN THE OTHER RESISTOR

(d) THE SMALLER OF THE TWO CURRENTS

(5) THE CURRENT IN THE FIGURE WILL BE

(a) 1.2A (b) 3A (c) 0.2A (d) 2A

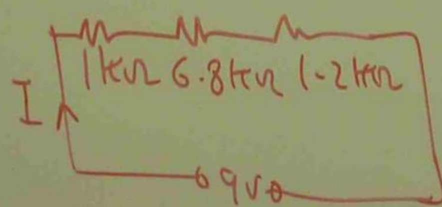


(6) THE POTENTIAL DIFFERENCE ACROSS 6Ω RESISTOR IN ABOVE FIGURE WILL BE

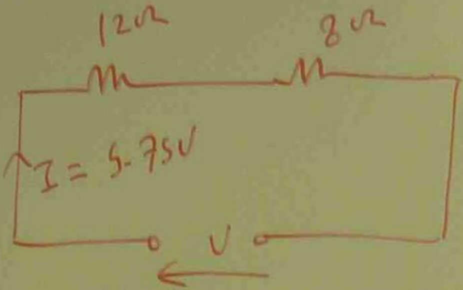
(a) 12V (b) 6V (c) 4.8V (d) 7.2V

(7) THE CURRENT FLOWING IN THE CIRCUIT OF FIGURE BELOW WILL BE

(a) 1A (b) 1mA (c) 9mA (d) 1.32mA



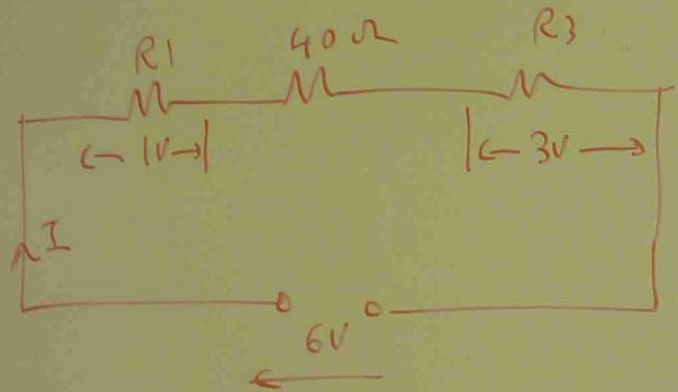
(8) THE SUPPLY VOLTAGE OF THE FIGURE BELOW WILL BE .



(a) 69V (b) 20V (c) 115V

(d) 46V

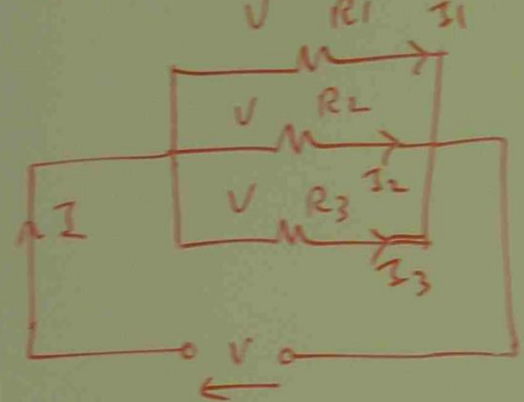
(9) THE CURRENT FLOWING IN THE CIRCUIT BELOW WILL BE



(a) 50mA (b) 6.7 A (c) 3mA (d) 150mA

DC PARALLEL CIRCUITS

PARALLEL CONNECTION OF RESISTORS



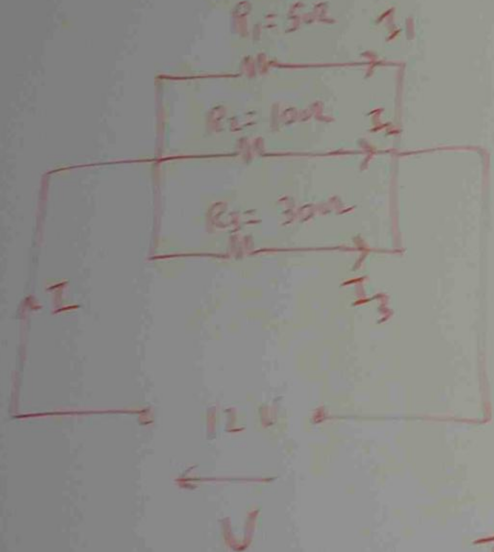
$$I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2}, \quad I_3 = \frac{V}{R_3}$$

$$I = I_1 + I_2 + I_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Pb ①

RESISTORS OF 5Ω, 10Ω AND 30Ω ARE CONNECTED IN PARALLEL TO A 12V SUPPLY. CALCULATE THE SUPPLY CURRENT



$$I_1 = \frac{V}{R_1} = \frac{12}{5} = 2.4\text{ A}$$

$$I_2 = \frac{V}{R_2} = \frac{12}{10} = 1.2\text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{12}{30} = 0.4\text{ A}$$

$$I = I_1 + I_2 + I_3$$

$$= 2.4 + 1.2 + 0.4$$

$$= 4\text{ A}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_T} = \frac{R_2R_3 + R_1R_3 + R_1R_2}{R_1 R_2 R_3}$$

3 RESISTORS ∥l

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

4 RESISTORS ∥l

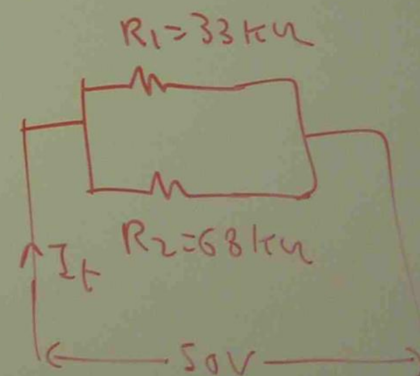
$$R_T = \frac{R_1 R_2 R_3 R_4}{R_1R_2R_3 + R_2R_3R_4 + R_3R_4R_1 + R_2 R_4 R_1}$$

Pb(2) RESISTORS OF 33KΩ AND 68 KΩ ARE CONNECTED IN PARALLEL TO A 50V SUPPLY. CALCULATE

(a) TOTAL CIRCUIT RESISTANCE

(b) TOTAL CIRCUIT CURRENT

(c) INDIVIDUAL BRANCH CURRENTS.



(a) $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{33 \times 68}{33 + 68}$$

$$= \frac{33 \times 68}{101}$$

$$= 22.2\,k\Omega$$

(c) $I_1 = \frac{V}{R_1} = \frac{50}{33 \times 10^3} = 1.5\,mA$

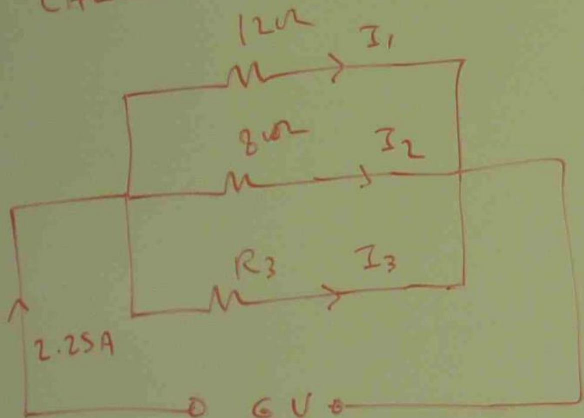
$$I_2 = \frac{V}{R_2} = \frac{50}{68 \times 10^3} = 0.74\,mA$$

(b) $I_T = I_1 + I_2 = 1.5 + 0.74$

$$= 2.24\,mA$$

pb ③

RESISTORS OF VALUES 12Ω AND 8Ω ARE CONNECTED IN PARALLEL WITH A RESISTOR R_3 OF UNKNOWN VALUE ACROSS A 6V SUPPLY. WHEN THE CURRENT FROM THE SUPPLY IS FOUND TO BE 2.25 A, CALCULATE (a) THE VALUE OF R_3 AND (b) THE CURRENT FLOWING IN R_3



$$I_1 = \frac{V}{R_1} = \frac{6}{12} = 0.5\,A$$

$$I_2 = \frac{V}{R_2} = \frac{6}{8} = 0.75\,A$$

$$I_1 + I_2 + I_3 = I_T = 2.25$$

$$0.5 + 0.75 + I_3 = 2.25$$

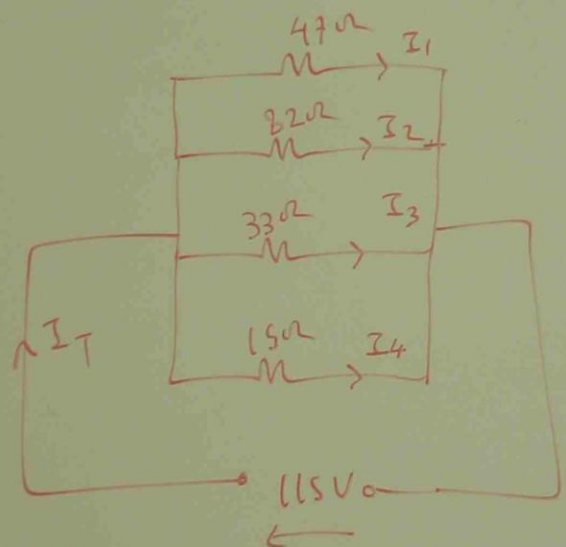
$$I_3 = 2.25 - (0.5 + 0.75)$$

$$= 2.25 - 1.25 = 1\,A$$

$$R_3 = \frac{V}{I_3} = \frac{6}{1} = 6\,\Omega$$

Pb 4.

FOUR RESISTORS OF INDIVIDUAL VALUES 47 Ω, 82 Ω, 33 Ω AND 15 Ω ARE CONNECTED IN PARALLEL WITH EACH OTHER AND CONNECTED TO A 115 V SUPPLY. CALCULATE THE CURRENT PROVIDED TO THEM BY THE SUPPLY.



$$I_1 = \frac{V}{R_1} = \frac{115}{47} = 2.45\text{ A}$$

$$I_2 = \frac{V}{R_2} = \frac{115}{82} = 1.4\text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{115}{33} = 3.48\text{ A}$$

$$I_4 = \frac{V}{R_4} = \frac{115}{15} = 7.67\text{ A}$$

$$I_T = I_1 + I_2 + I_3 + I_4$$

$$= 2.45 + 1.4 + 3.48 + 7.67$$

$$= 15\text{ A}$$

EXERCISE

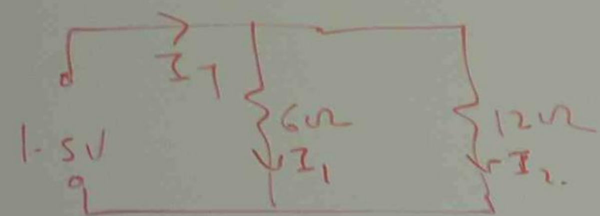
① WHEN THE RESISTORS ARE CONNECTED IN PARALLEL

(a) THEY EACH HAVE THE SUPPLY VOLTAGE CONNECTED DIRECTLY ACROSS THEM

(b) THE SUM OF THE VOLTAGE ACROSS EACH RESISTOR WILL SUM TO THE SUPPLY VOLTAGE

(c) THERE WILL BE NO VOLTAGE ACROSS THEM

② THE EFFECTIVE RESISTANCE OF THE GROUP OF PARALLEL RESISTORS IN GIVEN FIGURE IS



(a) 18Ω (b) 3Ω

(c) 4Ω (d) 0.25Ω

③ IN ABOVE FIGURE THE CORRECT CURRENTS ARE

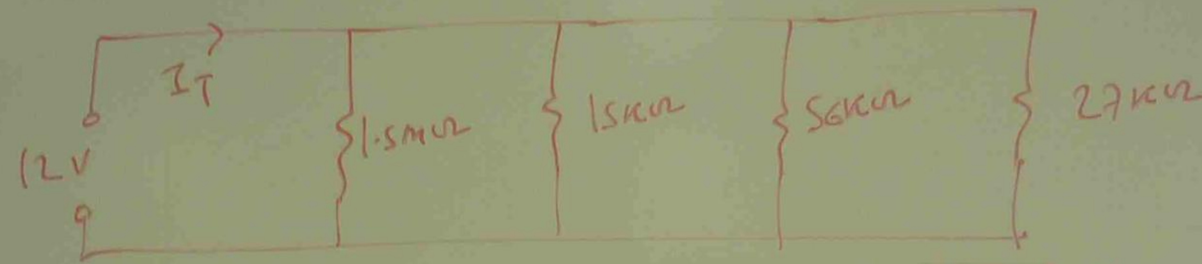
(a) $I_1 = 0.25A$ $I_2 = 0.125A$ $I_T = 0.375A$

(b) $I_1 = 0.25A$ $I_2 = 0.5A$ $I_T = 0.75A$

(c) $I_1 = 0.25A$ $I_2 = 0.125A$ $I_T = 0.125A$

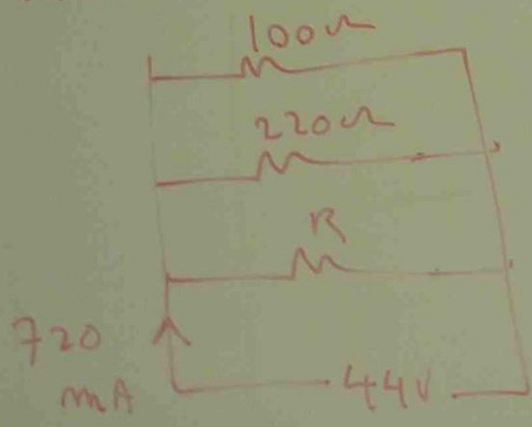
(d) $I_1 = 2.5A$ $I_2 = 1.25A$ $I_T = 3.75A$

4. THE SUPPLY CURRENT IN THE FOUR BRANCH RESISTIVE CIRCUIT OF THE DIAGRAM BELOW IS



(a) 800 μA (b) 0.8 mA (c) 14.7 mA (d) 1.47 mA

5. THE VALUE OF THE UNKNOWN RESISTOR IN FIGURE BELOW IS



(a) 320Ω

(b) 550Ω

(c) 68.7Ω

(d) 61.1Ω