ELECTRICAL ENERGY IN THE HOME QUIZ

1. A conductor has a resistance of 20Ω. Given that its length is doubled and the radius of its cross-sectional area is also doubled, what is its new resistance? (3 marks)

$R_{orig} = \frac{L}{A} = \frac{L}{\pi r^2} = 20\,\Omega$

$R_{new} = \frac{2L}{\pi(2r)^2}$

$= \frac{2L}{4\pi r^2}$

$= \frac{1}{2} \cdot R_{orig}$

$= \frac{1}{2} \times 20$

$= 10\,\Omega$ #

2. A current of 3A flows for a period of 1.5seconds. How many coulombs of charge and hence how many electrons pass a given point in this time? (2 marks)

$I = 3A$
$t = 1.5$ seconds
$q = ?$
$n = ?$
$e = 1.6 \times 10^{-19}\,C$

$I = \frac{q}{t}$

$q = It$

$= 3 \times 1.5$

$= 4.5\,C$ #

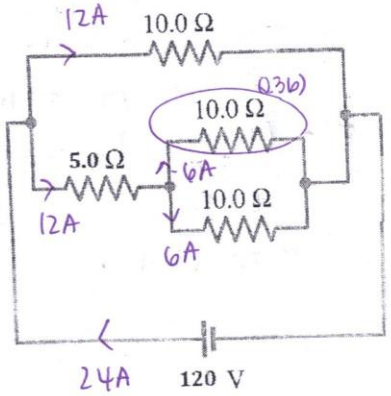
$q = ne$

$n = \frac{q}{e}$

$= \frac{4.5}{1.6 \times 10^{-19}}$

$= 2.8 \times 10^{19}\,e^-$ #

3.



a) Calculate the total resistance of the circuit (2 marks)

$\frac{1}{R_p} = \frac{1}{10} + \frac{1}{10}$

$= \frac{2}{10}$

$R_p = 5\,\Omega$

$R_S = R_p + 5$

$= 5 + 5$

$= 10\,\Omega$

$\therefore \frac{1}{R_T} = \frac{1}{10} + \frac{1}{10}$

$= \frac{2}{10}$

$R_T = 5\,\Omega$

b) Calculate the current and hence the voltage drop across the 10Ω resistor which is connected in parallel. (3 marks) ↓ marked on diagram.

$R_T = 5\,\Omega$
$V_T = 120V$

$I_T = \frac{V_T}{R_T}$

$= \frac{120}{5}$

$= 24A$

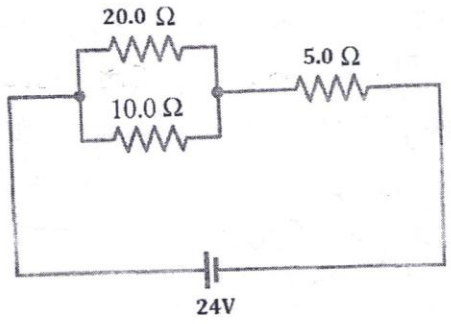
$I_{10\Omega} = 6A$ #

$V_{10\Omega} = I_{10\Omega} R_{10\Omega}$

$= 6 \times 10$

$= 60V$ #

4.



Calculate:

a) The total resistance and the total current (2 marks)

$\frac{1}{R_p} = \frac{1}{20} + \frac{1}{10}$

$= \frac{3}{20}$

$R_p = \frac{20}{3}\,\Omega$

$R_T = R_p + 5$

$= \frac{20}{3} + 5$

$= \frac{35}{3}\,\Omega$ #

$R_T = \frac{35}{3}\,\Omega$

$V_T = 24V$

$I_T = \frac{V_T}{R_T}$

$= \frac{24}{\frac{35}{3}}$

$= \frac{72}{35}\,A$ #

b) The current and the voltage drop of the 5Ω resistor (2 marks)

5Ω is connected in series so

$I_{5\Omega} = I_T = \frac{72}{35}$ A.

$V_{5\Omega} = I_{5\Omega} R_{5\Omega} = \frac{72}{35} \times 5 = \frac{72}{7}$ V #

c) The current and voltage drop of the 10Ω resistor (2 marks)

Method 1: Ratios

$I_{10\Omega} = \frac{2}{3} \times I_T = \frac{2}{3} \times \frac{72}{35} = \frac{48}{35}$ A #

$V_{10\Omega} = I_{10\Omega} R_{10\Omega} = \frac{48}{35} \times 10 = \frac{96}{7}$ V #

Method 2: Kirchoff's Law

$V_{10\Omega} + V_{5\Omega} = 24$V

$V_{10\Omega} = 24 - V_{5\Omega} = 24 - \frac{72}{7} = \frac{96}{7}$ V #

$I_{10\Omega} = \frac{V_{10\Omega}}{R_{10\Omega}} = \frac{\frac{96}{7}}{10} = \frac{48}{35}$ A #

d) The current and the voltage drop of the 20Ω resistor (2 marks)

Method 1: Ratios

$I_{20\Omega} = \frac{1}{3} \times I_T = \frac{1}{3} \times \frac{72}{35} = \frac{24}{35}$ A #

$V_{20\Omega} = I_{20\Omega} R_{20\Omega} = \frac{24}{35} \times 20 = \frac{96}{7}$ V #

Method 2: Kirchoff's Law

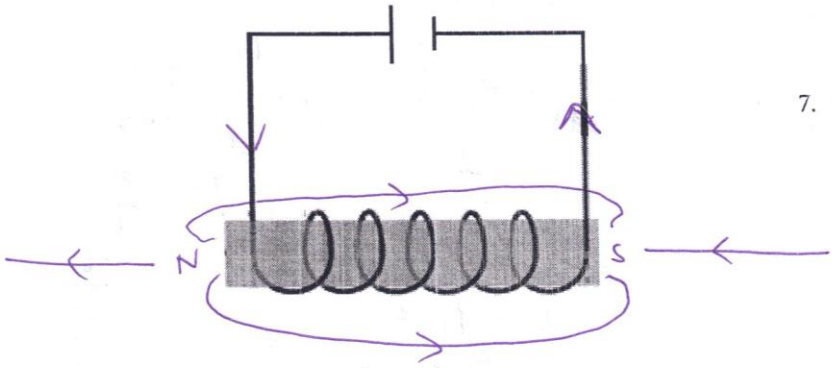
$V_{20\Omega} = V_{10\Omega}$ (connected in parallel)

$= \frac{96}{7}$ V #

$I_{20\Omega} = \frac{V_{20\Omega}}{R_{20\Omega}} = \frac{\frac{96}{7}}{20} = \frac{48}{35}$ A #

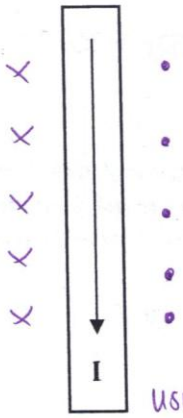
5. Sketch the magnetic field surrounding the following: (2 marks each)

a)



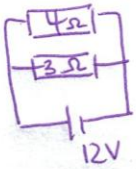
Using Right Hand Coil Rule

b)



Using Right Hand Grip Rule

6. Two resistors R1=4Ω and R2=3Ω are connected in parallel t a 12V power supply. What is the power generated by the power supply and the power dissipated in each resistor? (3 marks)



$\frac{1}{R_T} = \frac{1}{3} + \frac{1}{4} = \frac{7}{12}$

$R_T = \frac{12}{7}\Omega$

$P_T = V_T I_T = V_T \cdot \frac{V_T}{R_T} = \frac{V_T^2}{R_T} = \frac{12^2}{\frac{12}{7}} = 84$W #

$P_{4\Omega} = \frac{V_{4\Omega}^2}{R_{4\Omega}} = \frac{12^2}{4} = 36$W #

$P_{3\Omega} = \frac{V_{3\Omega}^2}{R_{3\Omega}} = \frac{12^2}{3} = 48$W #

7. How much energy (in kWh) does a 5kW heater use in 6 hours? (1 mark)

$E = Pt$

$= 5 \times 6$

$= 30$ kWh.

$\begin{cases} P = 5\text{kW} \\ t = 6\text{hrs} \end{cases}$