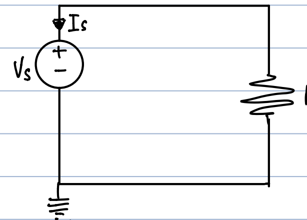
Shivani Patel 3033800943 EE16a Homework #7

1a)



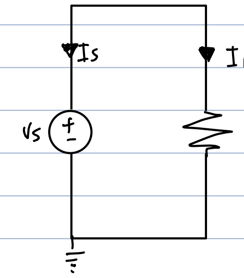
$R_b + R_t = R$

1b) $R_{touch1} = \rho t_1 \cdot \frac{L}{A}$

$= \rho t_1 \cdot \frac{L}{w \cdot t}$

$= 0.5\,\Omega m \left(\frac{80 \times 10^{-3} m}{90 \times 10^{-3} m \cdot 1 \times 10^{-3} m} \right)$

$R_{touch1} = 800\,\Omega$



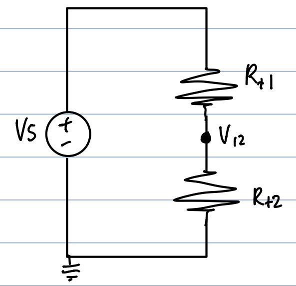
$I_S - I_{R_1} = 0$

$I_S = -I_{R_1}$

$I_R = \frac{V_S}{R_{touch1}} = \frac{5}{800} A$

$I_S = \boxed{6.25mA}$

1c)



$V_{12} = V_S \left(\frac{R_{t2}}{R_{t1} + R_{t2}} \right) = V_S \frac{y_2}{L}$.

$= 5 \cdot \frac{3}{4} V \rightarrow \boxed{3.75V}$

$R_{t1} = \rho t_1 \cdot \frac{L - y_2}{wt}$ $\quad R_{t2} = \rho t_1 \cdot \frac{y_2}{wt}$

1d) $V_{ab} = V_{x_1 y_1} - V_{x_2 y_2}$

$= V_S \cdot \frac{R_{b1}}{R} - V_S \cdot \frac{R_{b2}}{R}$

$= \frac{V_S}{R} (R_{b1} - R_{b2})$

$= V_S \left(\frac{R_{b1}}{R} - \frac{R_{b2}}{R} \right)$

$= V_S \left(\frac{y_1}{L} - \frac{y_2}{L} \right)$

$= 5 \left(\frac{30}{80} - \frac{60}{80} \right)$

$= 5 \left(\frac{-3}{8} \right)$

$= \frac{-15V}{8} = -1.875V$

$|V_{ab}|$ = Absolute Value = 1.875 V

1e) $V_{ab} = V_{x_1 y_1} - V_{x_2 y_1}$ since both the points are at the same vertical position

$= V_S \left(\frac{R_{b1}}{R} - \frac{R_{b2}}{R} \right)$ $\quad \frac{R_{b1}}{R} = \frac{R_{b2}}{R} = \frac{y_1}{L}$

$\frac{R_{b1}}{R} - \frac{R_{b2}}{R} = 0$

$\boxed{V_{ab} = 0}$

1f) $V_{ab} = V_{x_1 y_1} - V_{x_2 y_2}$

$= V_S \left(\frac{R_{b1}}{R} - \frac{R_{b2}}{R} \right)$

$= V_S \left(\frac{y_1}{L} - \frac{y_2}{L} \right)$

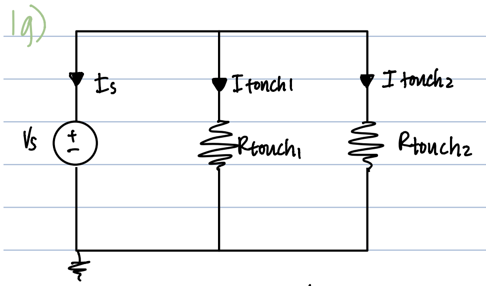
$= \frac{V_S}{L} (y_1 - y_2)$

$= \frac{5}{80} (30 - 60)$

$= -1.870V$

Absolute value $= |V_{ab}| = \boxed{1.875V}$

1g)



1h) $I_s + I_{Rtouch1} + I_{Rtouch2} = 0$

$I_S = -(I_{touch1} + I_{touch2})$

$I_S = \left(\frac{V_S}{R_{touch1}} + \frac{V_S}{R_{touch2}} \right)$

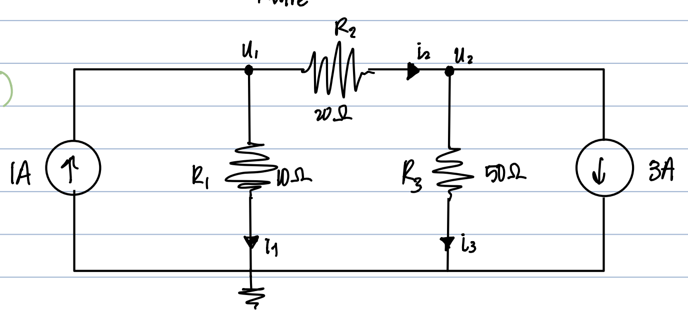
$R_{touch2} = \left(\frac{80 \times 10^{-3} m}{70 \times 10^{-3} m \cdot 1 \times 10^{-3} m} \right)$

$R_{touch2} = 457.142857\,\Omega$

$I_S \approx -(6.25mA + 10.94mA) = -17.19mA$

1g) $I_{wire} = \frac{V_{12\,touch1} - V_{22\,touch2}}{R_{wire}} = \boxed{0}$

2)

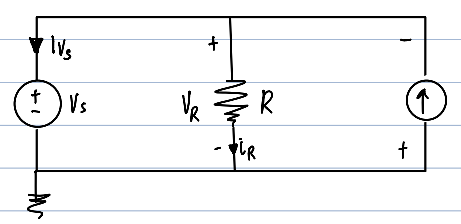


$i_1 = \frac{-10V}{10\Omega} = -1A$

$i_2 = \frac{-10V - (-50V)}{20\Omega} = 2A$

$i_3 = \frac{-50V}{50\Omega} = -1A$

3a)



$i_R = \frac{V_S}{R}$

$i_V = I - \frac{V_S}{R}$

$V_1 = -V_S$

$V_R = V_S$

$P_{V_S} = V_S i_V = IV_S - \frac{V_S^2}{R}$

$R_I = I V_1 = -IV_S$

$P_R = i_R v_R = \frac{V_S^2}{R}$

$\Big\} = 0$

3b) $P_{VS} = (0.005A)(5V) - \frac{(5V)^2}{5000\Omega} = \boxed{0.02W}$

$P_I = -(0.005A)(5V) = \boxed{-0.025W}$

$P_R = \frac{5V^2}{5000\Omega} = \boxed{0.005W}$

3c) $P_I = 40mW$

$P_{VS} = (-0.008A)(5V) - \frac{(5V)^2}{5000\Omega} = \boxed{-0.045W}$

$P_I = -(-0.008A)(5V) = \boxed{0.04W}$

$P_R = \frac{(5V)^2}{5000\Omega} = \boxed{0.005W}$

$P_{VS} + P_I + P_R = 0$

4a) Time required for the battery to discharge under typical usage conditions

$= \frac{\text{Battery rating}}{\text{current delivered}} = \frac{2770}{\left(\frac{0.5}{3.8}\right)\times 10^{+3}} = \boxed{35.04}$

4b) charge stored in the battery when it is fully charged = ?

From the battery rating of 2770mAh

we have $i = 1{,}000mA = 1A$

$t = 2.77 \text{ hrs} = 9972 \text{ sec}$

we know $q = it$ (coulomb)

where q = charge stored

i = value of current

t = time

$\therefore q = 1\times 9972 = \boxed{9972 \text{ coulomb}}$

4c) When the battery is completely recharged the energy stored in the battery is given by

$E = p\times t$

given $p = 3.8W$

$t = 2.77$ hours

$\therefore E = 3.8\times 2.77 = 10.526 \text{ W-h}$

$\therefore E = 10.526\times 3600$ Joules

$\therefore E = 37893.6$ Joules

4d) For 1 full charge

energy consumption $= \frac{(Ah)\times V}{1000}$ unit

$= \frac{2.77\times 3.8}{1000} = 0.010526 \text{ kWh}$

so for 31 days energy consumed

$= 31 \times 0.010526$ kWh

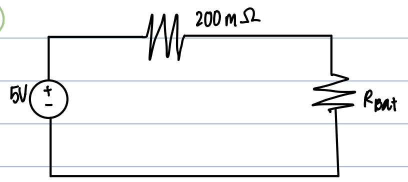
$= 0.326306$ kWh

cost of electricity = 0.12 \$/kWh

cost of recharging = 0.326306 × \$0.12

$= \boxed{\$0.039}$

4e)



For $R_{bat} = 1m\Omega$

$I = \frac{5}{1.2} = 4.167$ Amp

so power dissipated across R_{bat}

$= I^2R$

$= (4.167)^2 \times 1 \cdot W$

For $R_{bat} = 1\Omega$

$I = \frac{5}{201\times 10^{-3}}$

$I = 24.87A$

the power supplied to phone battery while charging $= I^2R$

$= \boxed{17.3638\ W}$

time taken by battery to charge $= \frac{2.77}{4.367}$ hours

$= \boxed{0.66 \text{ hours}}$

For $R_{bat} = 10k\ \Omega$

$I = \frac{5}{10,000 \cdot 2} = 4.99 \times 10^{-4} A$

$I = 0.499\ mA$

so the power is dissacipated across R_{bat}

$= I^2 R$

$(4.99 \times 10^{-4})^2 \times 10,000$

$= \boxed{2.499 \times 10^{-3}\ W}$

time taken by the battery to charge

$= \frac{2.77}{4.99 \times 10^{-4}}$

$= \boxed{5551.10 \text{ hours}}$

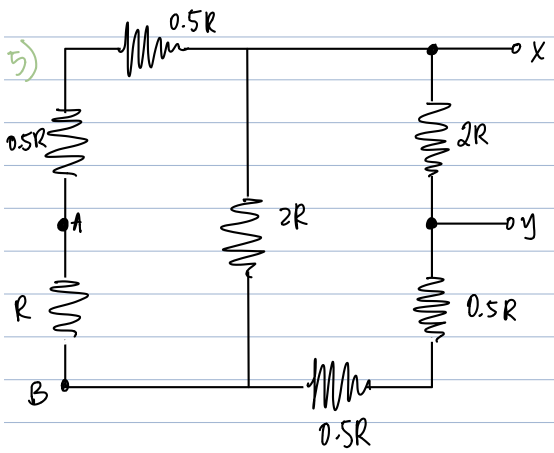
$= (24.87)^2 \times (1 \times 10^{-3})\ W$

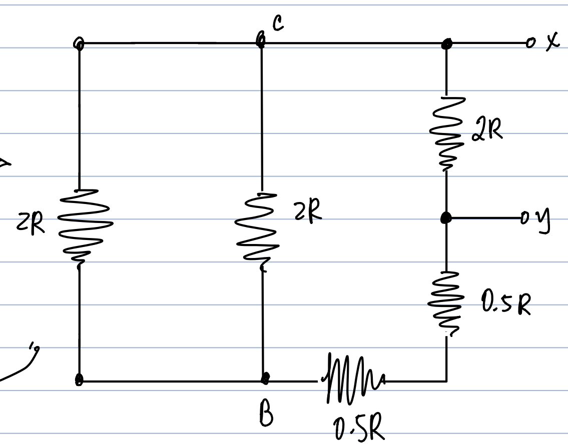
$\boxed{= 0.618\ W}$

time taken by battery to charge

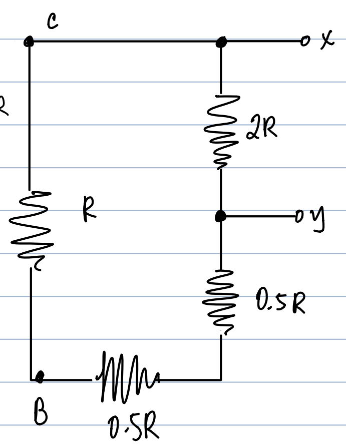
$= \frac{\text{Battery A-h}}{\text{charging current}} = \frac{2.77}{24.87} h = \boxed{0.11 \text{ hours}}$

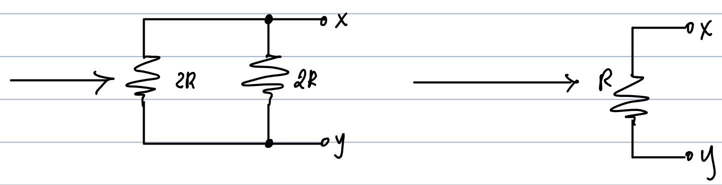
5)





$R + 0.5R + 0.5R = 2R$



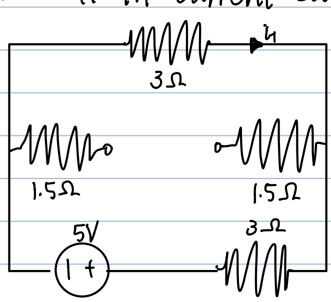


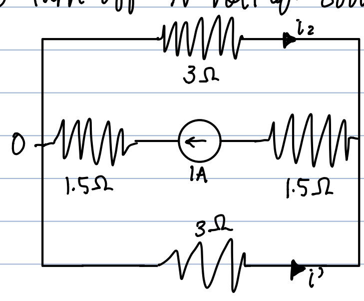
$\boxed{R_{xy} = R}$

6) $i = 1/3 A$

① turn off 1A current source

② turn off 5V voltage source





$1 - i_2 - i' = 0$

$i_2 = 1/2 A$

$i = i_1 + i_2 = -5/6 A + \frac{1}{2} A = -\frac{1}{3} A$

7) the I_s current flowing through C_1 is also the same flowing through C_2. $V_{out}(0)=0$

$$I_s = C_2 \frac{dV_{out}(t)}{dt} \Rightarrow V_{out}(t) = \int \frac{I_s}{C_2}\,dt$$

$$= \frac{I_s t}{C_2} + V_{out}(0)$$

$$= \frac{I_s t}{C_2}$$

8) I worked with Sadia Qureshi (3034541667), 6 hours