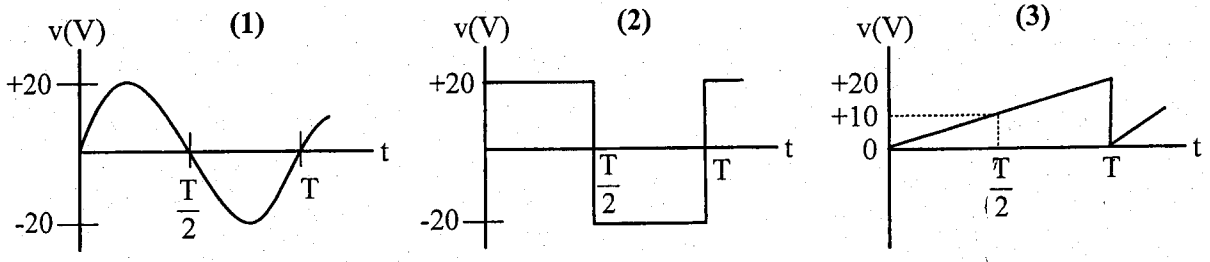
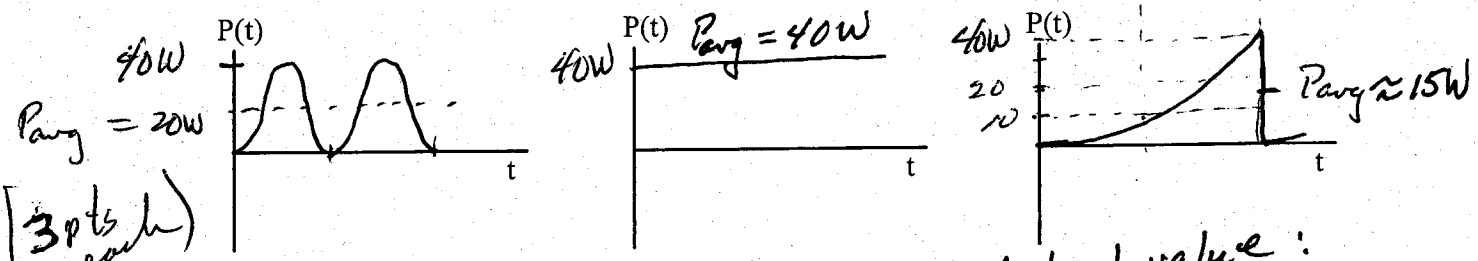
T. Trick

Problem 1 *(20 points)*

Below three periodic voltage waveforms are drawn. Sketch the instantaneous power in each case if these voltages are applied to a 10 Ω resistor. Clearly label the graphs and estimate P_{avg} in each case. It is not necessary to evaluate integrals. From your estimate of P_{avg}, calculate the rms value of the voltage in each case. Show your work!





(3 pts each)

$P_{avg} = \frac{V_{rms}^2}{10\Omega}$; $V_{rms} = \sqrt{10 \cdot P_{avg}}$

Actual value:

1) $P_{avg} = 20W$

$V_{rms} = \sqrt{200} = 14.1V$

2) $P_{avg} = 40W$

$V_{rms} = \sqrt{400} = 20V$

3) $P_{avg} = \frac{40W}{3} = 13.3W$

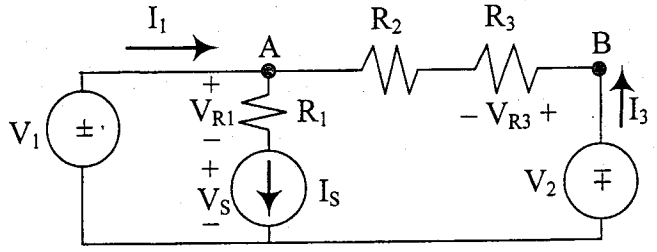
$V_{rms} = \sqrt{133} = 11.5V$

(2 pts each)

Acceptable range

P_{avg} = 20W	P_{avg} = 40W	P_{avg} = 10W to 15W	13.3W
V_{rms} = 14.1V	V_{rms} = 20V	V_{rms} = 10V to 12.25V	11.5V

Problem 2 *(20 points)*



This problem has no numerical value. **In your final answer to each part only use the circuit parameters (among V_1, V_2, I_S, R_1, R_2, R_3).** Show your work.

a) *(4 pts.)* Use KVL to find an expression for V_{AB} (in terms of the parameters!).

$$-V_1 - (R_2+R_3)I_3 - V_2 = 0$$

$$V_{AB} = -I_3(R_2+R_3)$$

$$V_{AB} = V_1 - (-V_2) = V_1 + V_2$$

$V_{AB} =$ $V_1 + V_2$

b) *(4 pts.)* Use the voltage divider rule to find an expression for V_{R3} (use part **a**)).

$$V_{R3} = \frac{R_3}{R_2+R_3} V_{BA} = \frac{-R_3}{R_2+R_3} V_{AB}$$

$V_{R3} =$ $\dfrac{-R_3(V_1+V_2)}{R_2+R_3}$

c) *(4 pts.)* Find an expression for I_3 (use part **b**)).

~~$I_1 = I_S = I_3$~~

$$I_3 = \frac{V_{R3}}{R_3} = \frac{-(V_1+V_2)}{R_2+R_3}$$

$I_3 =$ $\dfrac{-(V_1+V_2)}{R_2+R_3}$

d) *(4 pts.)* Find an expression for I_1 (use part **c**)).

$$I_1 = I_S - I_3$$

$$= I_S + \frac{V_1+V_2}{R_2+R_3}$$

$I_1 =$ $I_S + \dfrac{V_1+V_2}{R_2+R_3}$

e) *(4 pts.)* Find an expression for V_S (you do not need the previous parts for this question).

$$-V_1 + R_1 I_S + V_S = 0$$

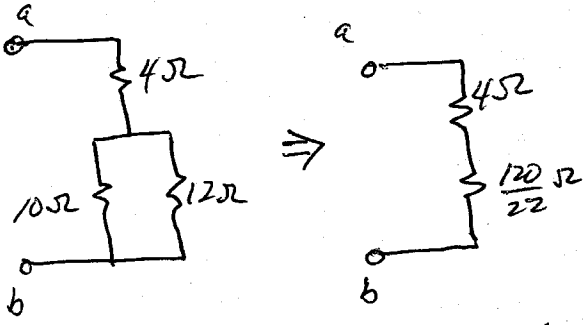
$$V_S = V_1 - R_1 I_S$$

$V_S =$ $V_1 - R_1 I_S$

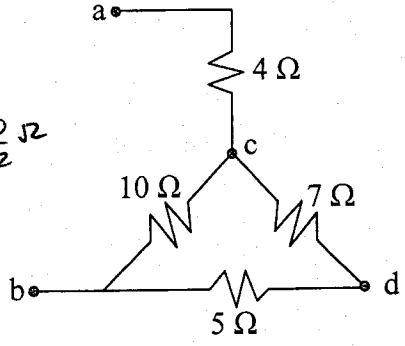
Problem 3 *(20 points)*

Find the equivalent resistance between terminals a-b in the following three cases. Show your work!

a)



(10pts)



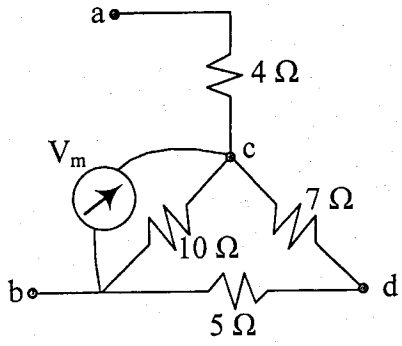
$R_{eq} = 4\Omega + 5.45\Omega = 9.45\Omega$

Req = 9.45Ω or $\frac{104}{11}\Omega$

b) An ideal voltmeter is connected between nodes c-b as shown.

(5pts) V_m has infinite resistance.

No change!

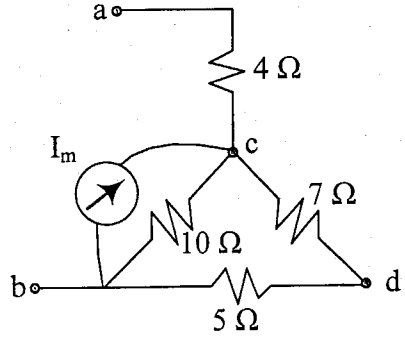


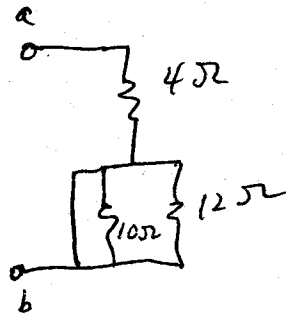
Req = 9.45Ω

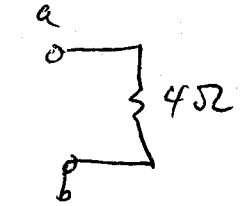
c) An ideal ammeter is connected between nodes c-b as shown.

(5pts) I_m has zero resistance.

$R_{eq} = 4\Omega + 0\Omega$



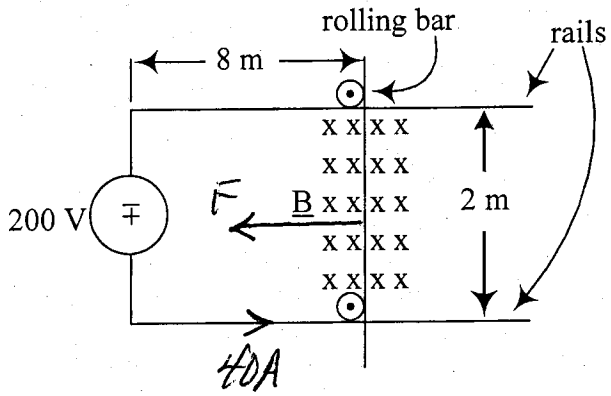




Req = [redacted] 4Ω

Problem 4 *(20 points)*

In the figure the rolling bar makes electrical contact to two rails completing the electrical circuit. The resistance of the circuit is 5 Ω and B = 0.3 T.



$$i = \frac{200V}{5\Omega} = 40A$$

a) The direction of the force on the bar is (circle one):

(10 pts)

down right (left) up zero

b) The magnitude of the force on the bar is

(10 pts)

$N=1,\ l=2m$
$B=0.3T$
$i=40A$

$F = NBil$

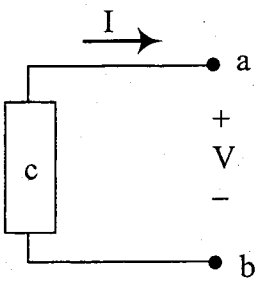
$= (0.3T)(40A)(2m)$

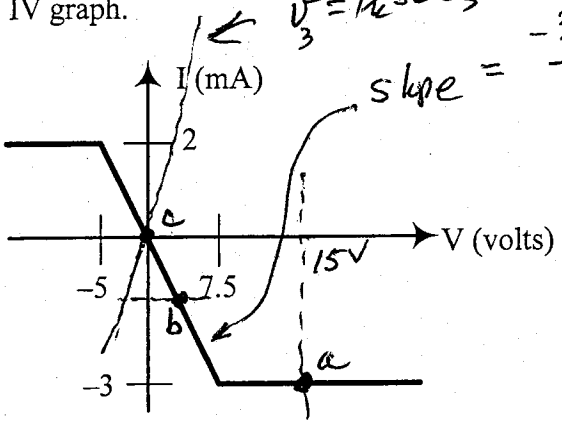
$= 24N$

F = 24 N

Problem 5 *(20 points)*

Consider the circuit below and its IV graph.





$v_3 = 1k\Omega\, i_3$

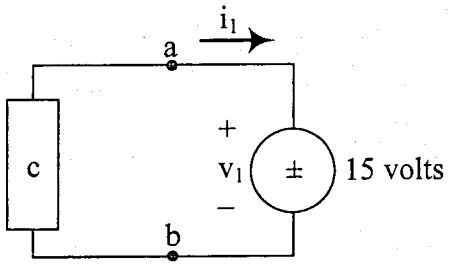
slope $= \dfrac{-3mA - 2mA}{7.5V - (-5V)} = \dfrac{-5}{12.5} \times 10^{-3}\ S$

$Req = \dfrac{12.5k\Omega}{5}$

$Req = 2.5k\Omega$

Find all the values of the current and voltage if the circuit is connected as shown in the three cases below. Show work for all answers. (Briefly explain how the values were found.)

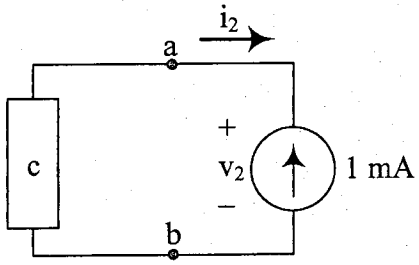
a)

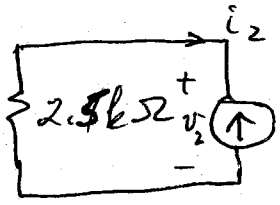


Point (a) on graph

$i_1 =$ −3mA $\quad v_1 =$ 15V

b)





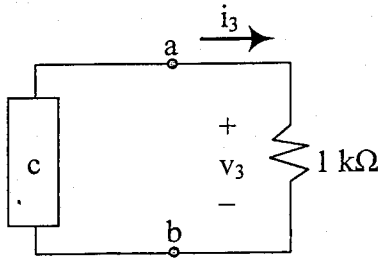
$v_2 = 2.5k\Omega\,(1mA)$

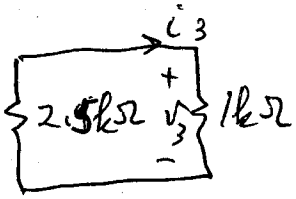
$= 2.5V$

Point (b) on graph

$i_2 =$ −1mA $\quad v_2 =$ 2.5V

c)





Point (c) on graph

$i_3 =$ 0 A $\quad v_3 =$ 0 V