3/1/2006

University of Portland
School of Engineering

EE 261-Electrical Circuits-3 cr. hrs.
Spring 2006

SOLUTIONS TO

Midterm Exam # 1

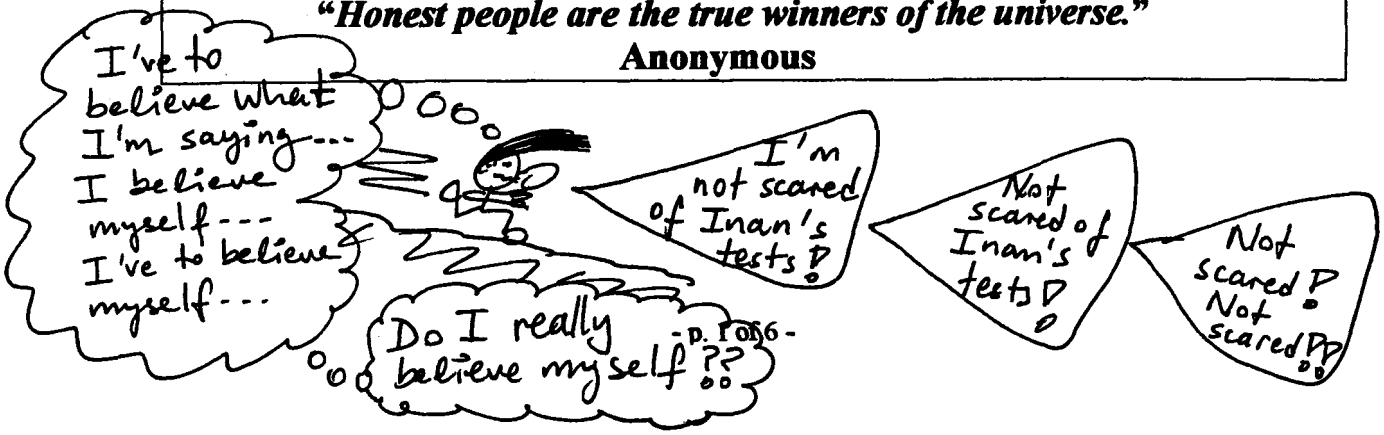
(Friday, February 17, 2006)
(Closed Book Exam, One Formula Sheet Allowed)
(Total Time: 55 minutes)

Name: SOLUTIONS!

Signature:

"An honest mind possesses a kingdom."
Lucius Annaeus Seneca (4B.C.–65A.D.)

"Honest people are the true winners of the universe."
Anonymous



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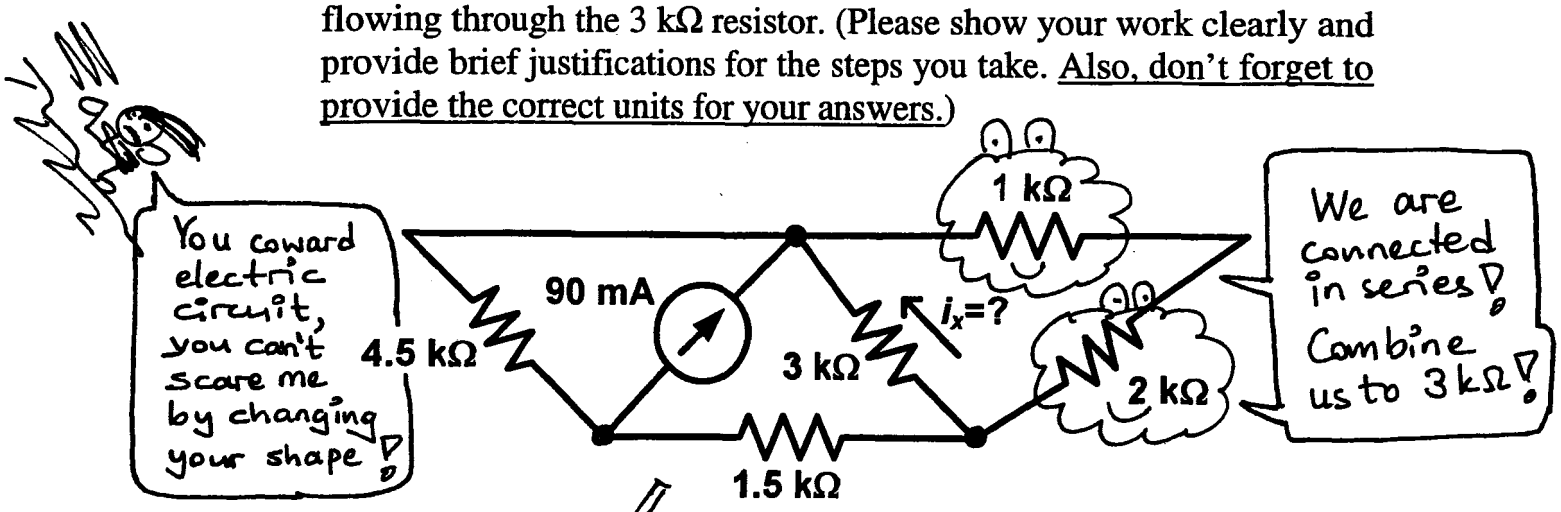
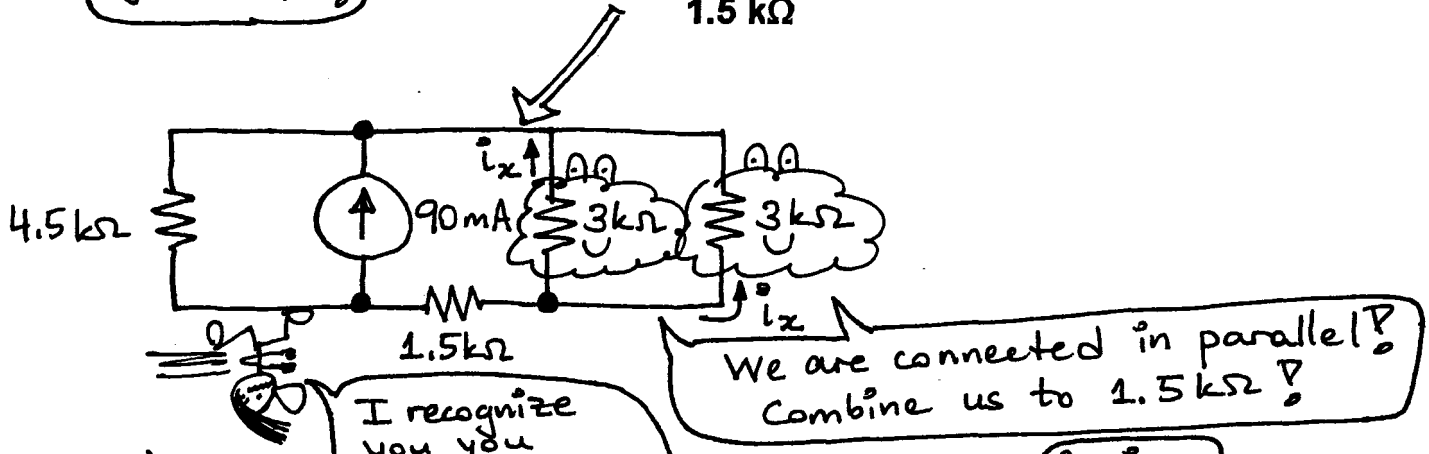
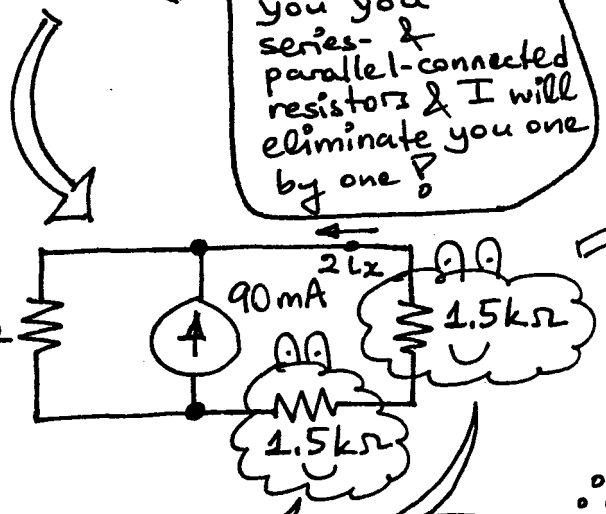
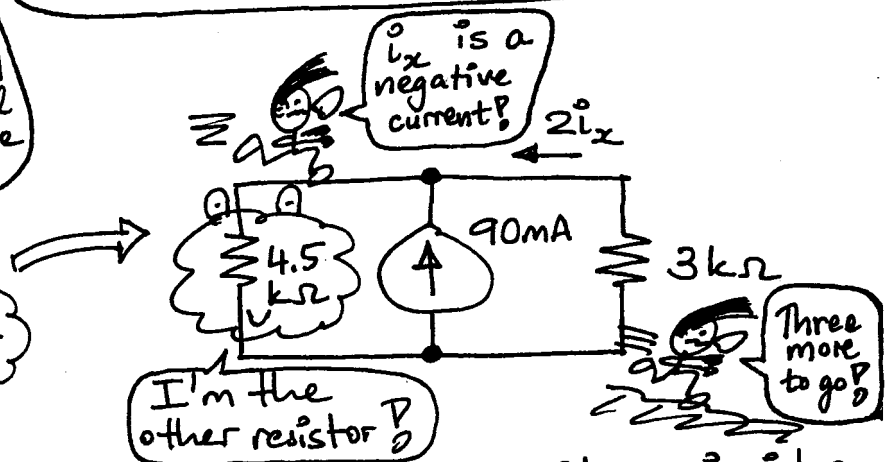
NOTE: On all the problems, please show your work clearly, and provide the appropriate units for your answers. Also mark on the schematic to show any current or voltage that you define in your solution.

1. (25 points) In the circuit shown, find the value of the current i_x flowing through the 3 kΩ resistor. (Please show your work clearly and provide brief justifications for the steps you take. Also, don't forget to provide the correct units for your answers.)









∴ Using the current divider principle:

$$2i_x = -(90\text{mA})\frac{4.5\text{k}\Omega}{3\text{k}\Omega + 4.5\text{k}\Omega}$$

$$\therefore i_x = -27\text{mA}$$

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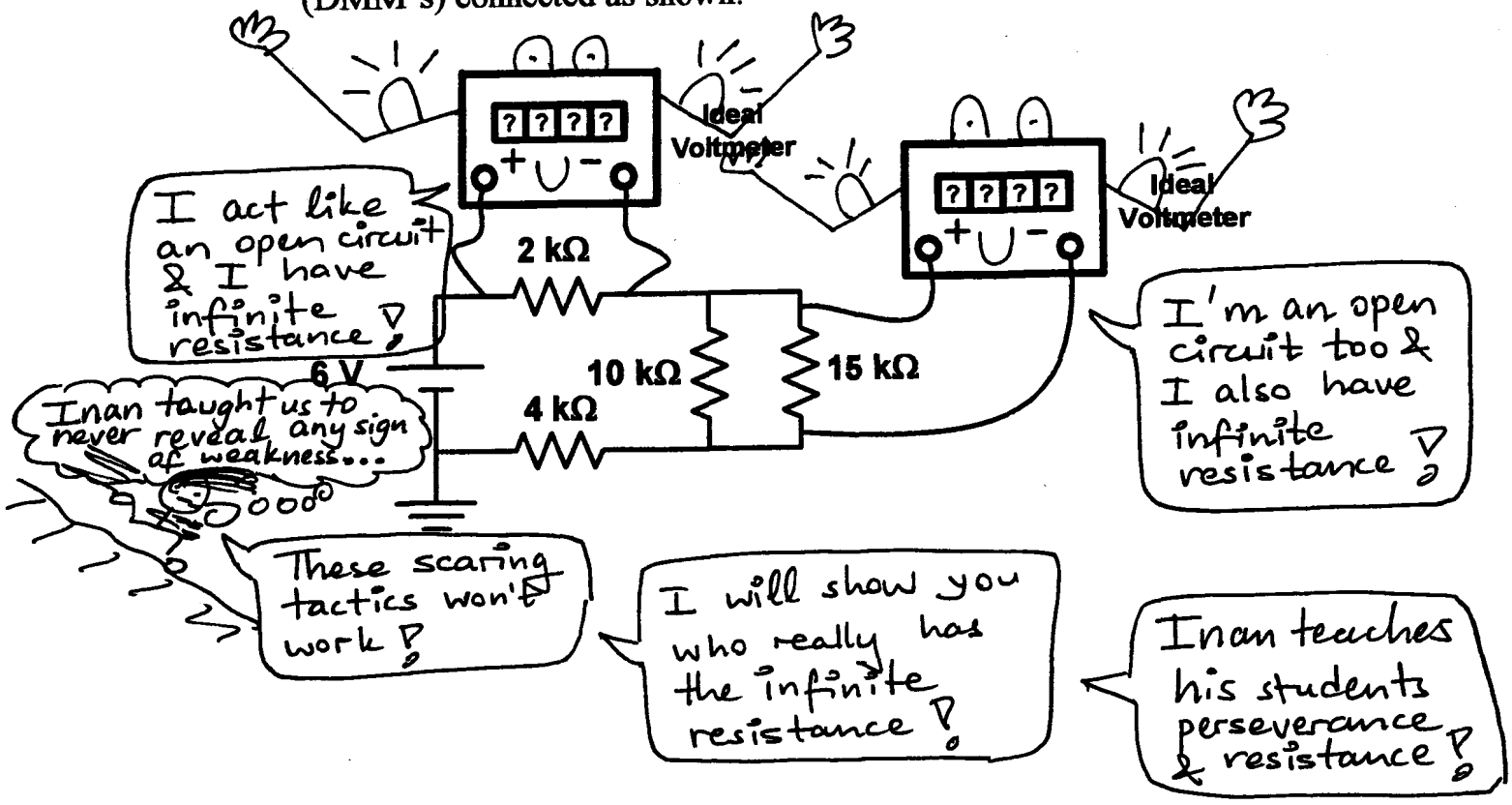
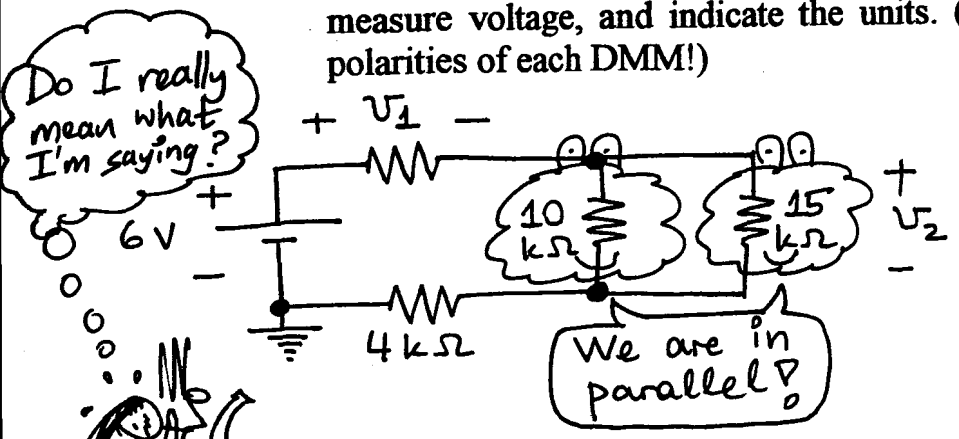
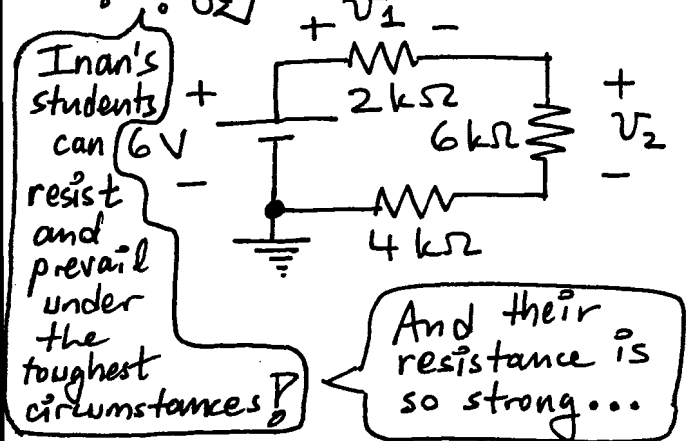
2. (Total: 25 Points) Consider the circuit with two digital multi-meters (DMM's) connected as shown.



(a) (12.5 points) Find the DMM readings if both of them are set to measure voltage, and indicate the units. (Note: Pay attention to the polarities of each DMM!)



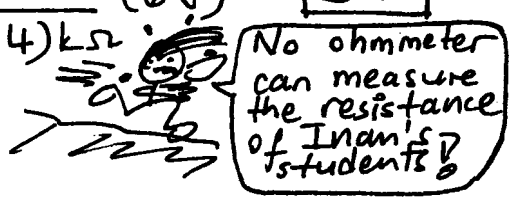
$$\frac{(10\,k\Omega)(15\,k\Omega)}{10\,k\Omega + 15\,k\Omega} = 6\,k\Omega\ \Omega$$



∴ Using the voltage divider principle:

$$V_1 = \frac{2\,k\Omega}{(2+6+4)\,k\Omega}(6V) = \boxed{1\,V}$$

$$V_2 = \frac{6\,k\Omega}{(2+6+4)\,k\Omega}(6V) = \boxed{3\,V}$$



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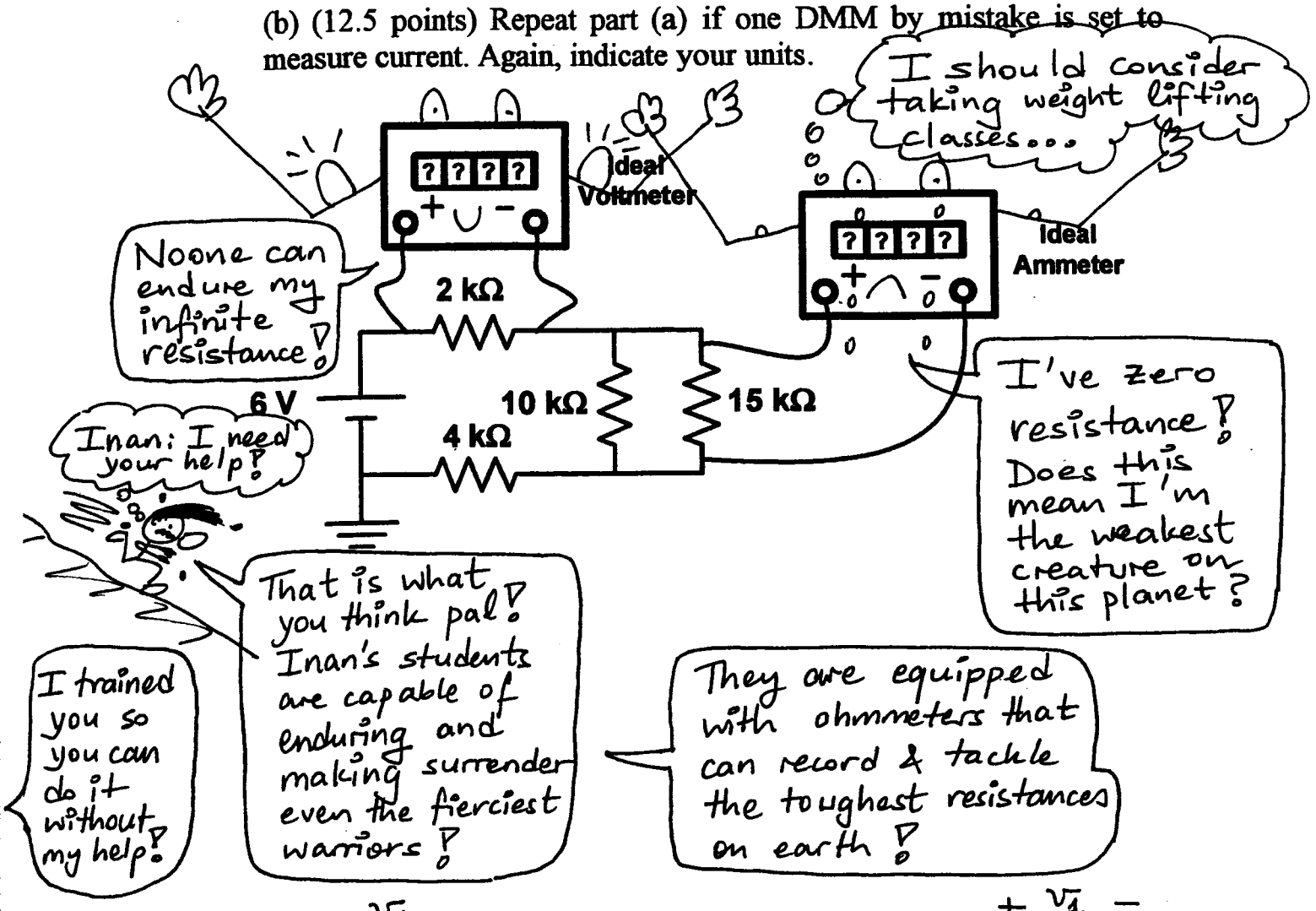
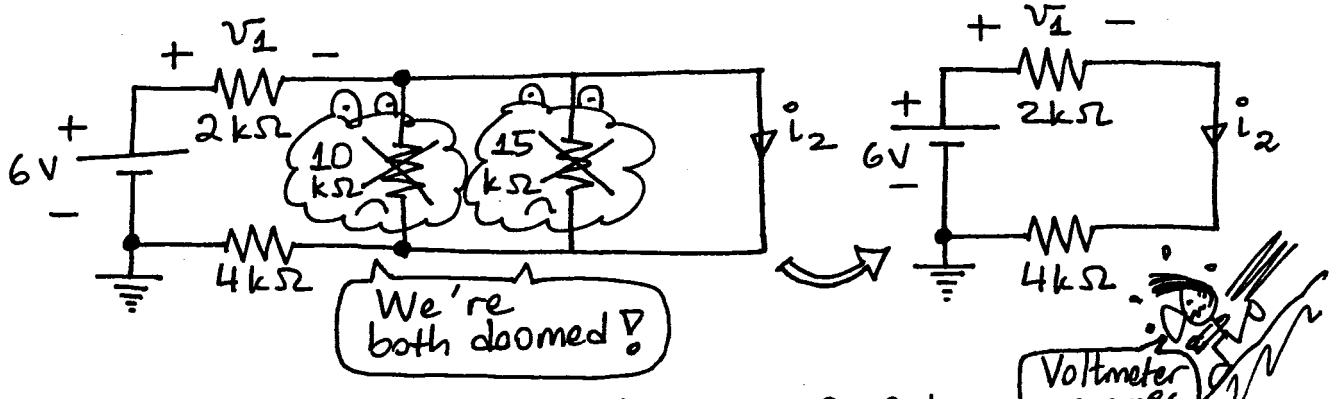
(b) (12.5 points) Repeat part (a) if one DMM by mistake is set to measure current. Again, indicate your units.

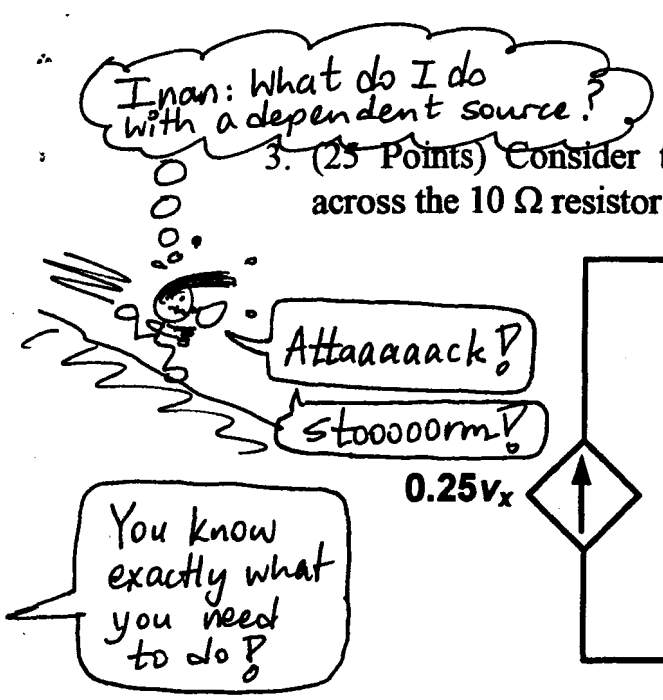




Again, using the voltage divider principle:

$$v_1 = \frac{2\,k\Omega}{2k\Omega + 4k\Omega}(6V) = \boxed{2V}$$

Using Ohm's law, we have $i_2 = \frac{v_1}{2k\Omega} = \frac{2V}{2k\Omega} = \boxed{1\,mA}$



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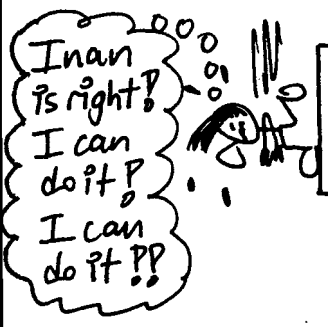
3. (25 Points) Consider the circuit shown. Determine the voltage v_x across the 10 Ω resistor. Please show your work step by step.

Note that based on KVL, the voltage across the 20 Ω resistor is $(8+v_x)$. Using Ohm's law, we can write the currents i_1 and i_2 in terms of voltage v_x as

$$i_1 = \frac{v_x}{10} \quad \text{and} \quad i_2 = \frac{8+v_x}{20}$$

Applying KCL at the bottom node, we can write



$$0.25v_x = i_1 + i_2 = \frac{v_x}{10} + \frac{8+v_x}{20}$$

$$5v_x = 2v_x + 8 + v_x \rightarrow \boxed{v_x = 4\text{V}}$$

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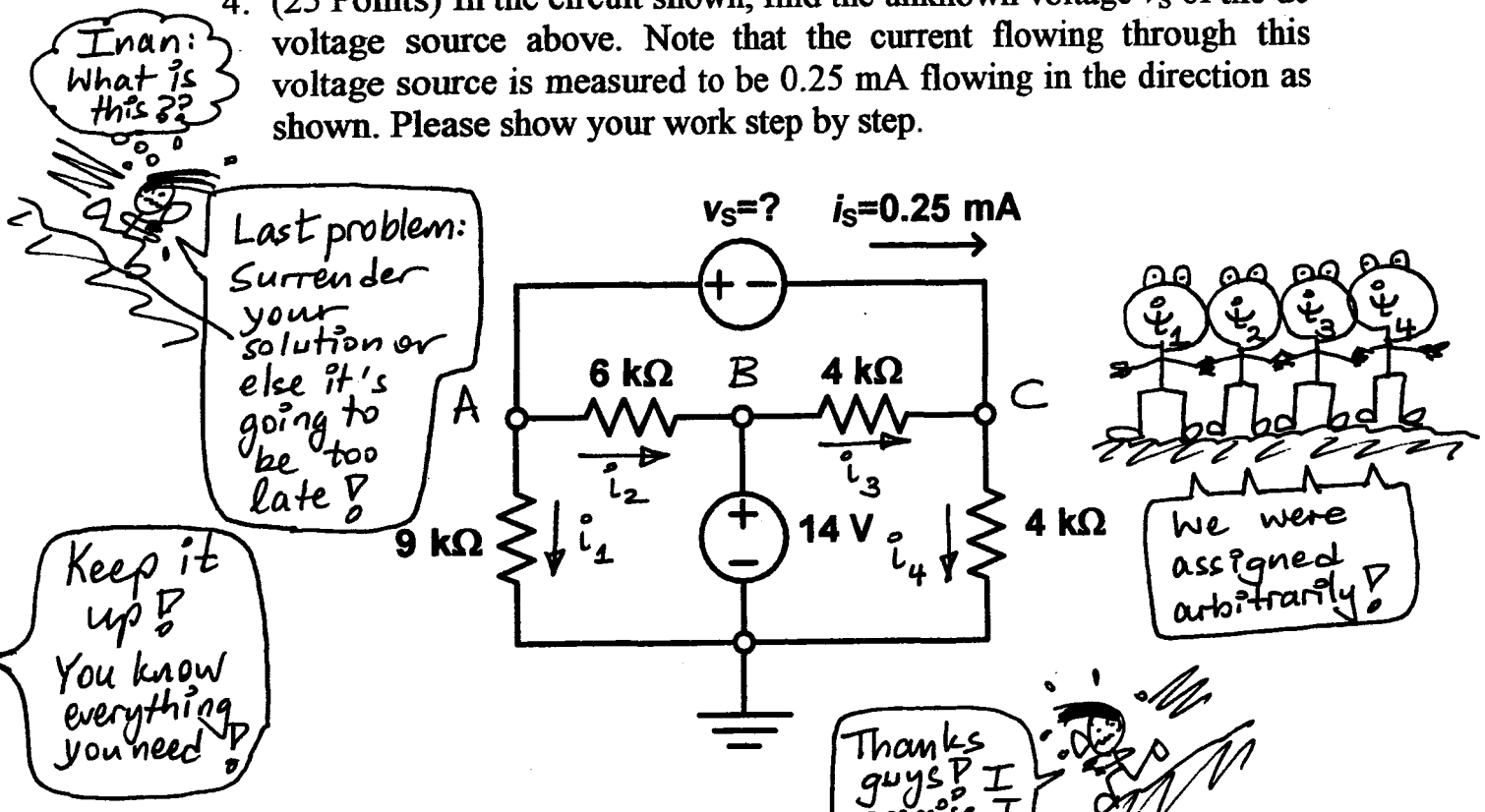
4. (25 Points) In the circuit shown, find the unknown voltage v_S of the dc voltage source above. Note that the current flowing through this voltage source is measured to be 0.25 mA flowing in the direction as shown. Please show your work step by step.



Note that $v_B = 14$ V.

Applying KCL at node A yields

$$i_S + i_1 + i_2 = 0 \rightarrow 0.25\text{mA} + \frac{v_A}{9\text{k}\Omega} + \frac{v_A - 14}{6\text{k}\Omega} = 0$$

$$\rightarrow 4.5 + 2v_A + 3v_A - 42 = 0 \rightarrow v_A = 7.5\text{ V}$$

Applying KCL at node C yields

$$i_S + i_3 = i_4 \rightarrow 0.25\text{mA} + \frac{14 - v_C}{4\text{k}\Omega} = \frac{v_C}{4\text{k}\Omega}$$

I can't believe what I'm saying!

$$\rightarrow 1 + 14 - v_C = v_C \rightarrow v_C = 7.5\text{ V}$$

$$\therefore v_S = v_A - v_C = 7.5 - 7.5 = \boxed{0}$$

This is fun! Give me more problems! I want to solve more problems!

Thanks Inan for teaching us to stand on our feet ourselves!