

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! ☺

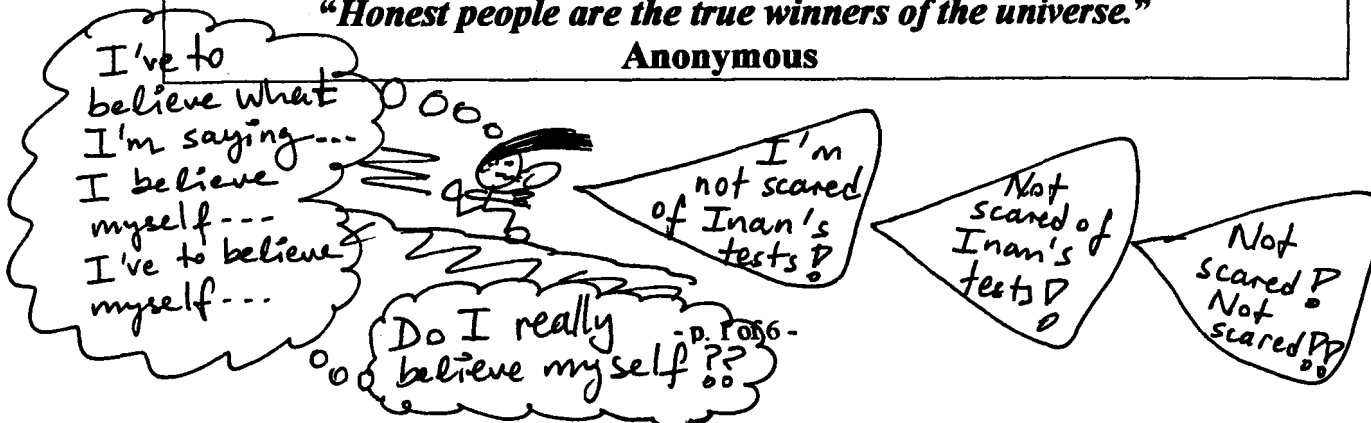
Signature:  ☺

***"An honest mind possesses a kingdom."***

**Lucius Annaeus Seneca (4B.C.-65A.D.)**

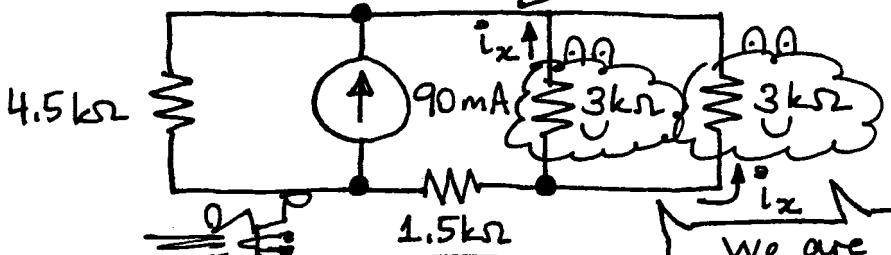
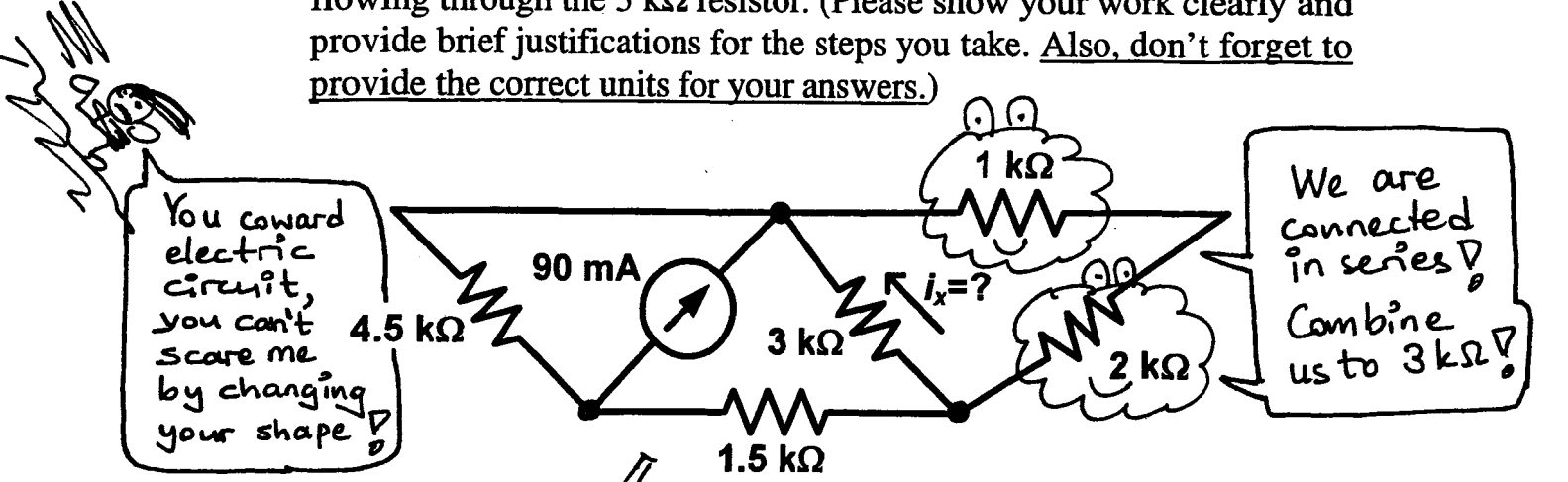
***"Honest people are the true winners of the universe."***

**Anonymous**



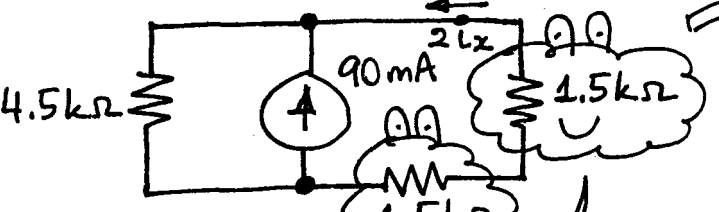
**NOTE:** On all the problems, please show your work clearly, and provide the appropriate units for your answers. Also mark on the schematic to show any current or voltage that you define in your solution.

1. (25 points) In the circuit shown, find the value of the current  $i_x$  flowing through the  $3\text{ k}\Omega$  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.)



We are connected in parallel! Combine us to  $1.5\text{ k}\Omega$ !

I recognize you you series- & parallel-connected resistors & I will eliminate you one by one!



$i_x$  is a negative current!

I'm the other resistor!

Three more to go!

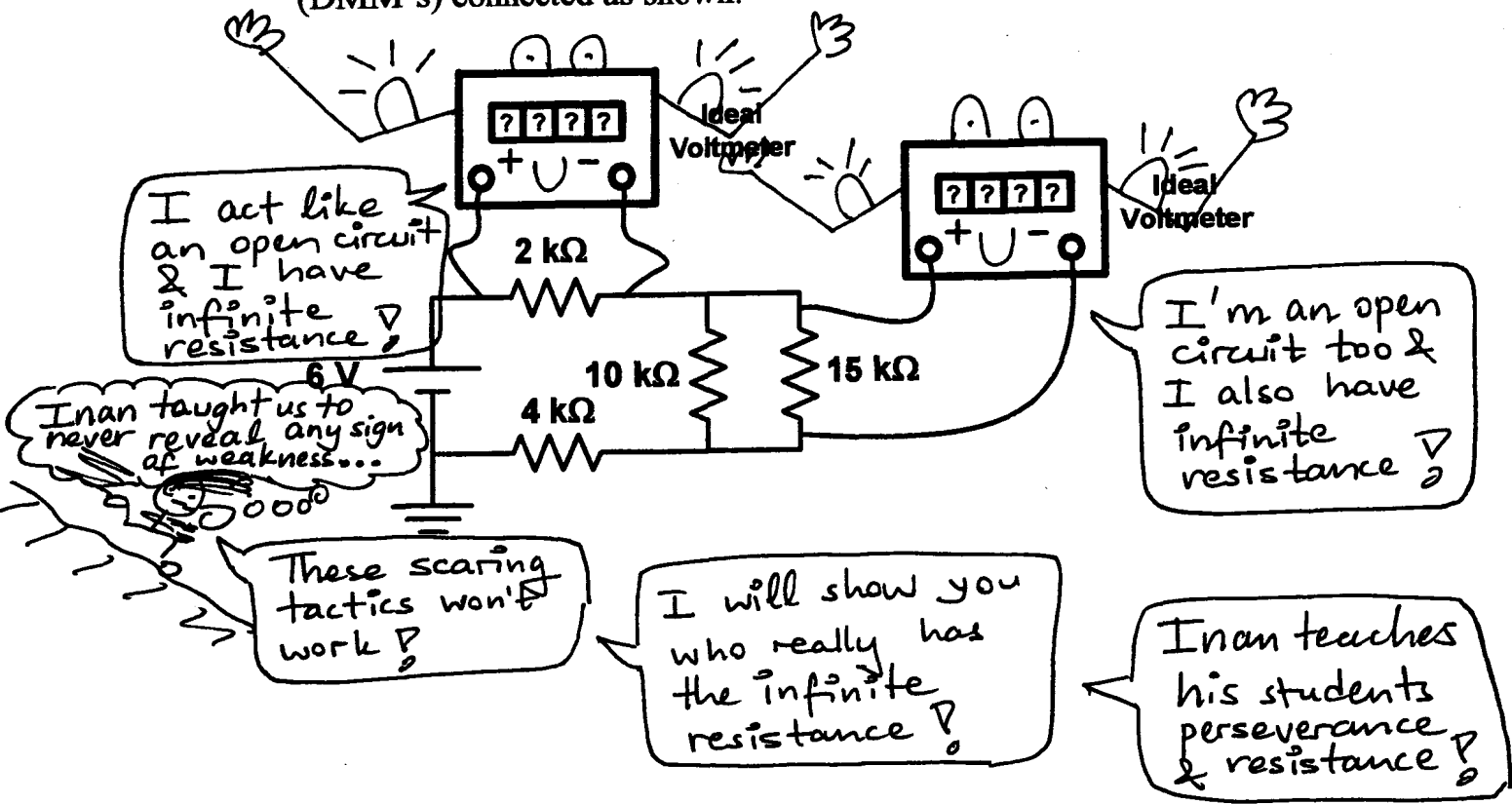
We are connected in series! Combine us to  $3\text{ k}\Omega$ !

Using the current divider principle:

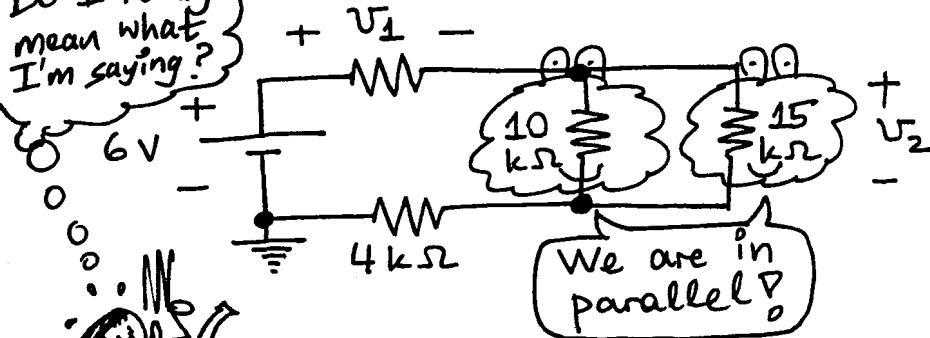
$$2i_x = -(90\text{ mA}) \frac{4.5\text{ k}\Omega}{3\text{ k}\Omega + 4.5\text{ k}\Omega}$$

$i_x = -27\text{ mA}$

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!)



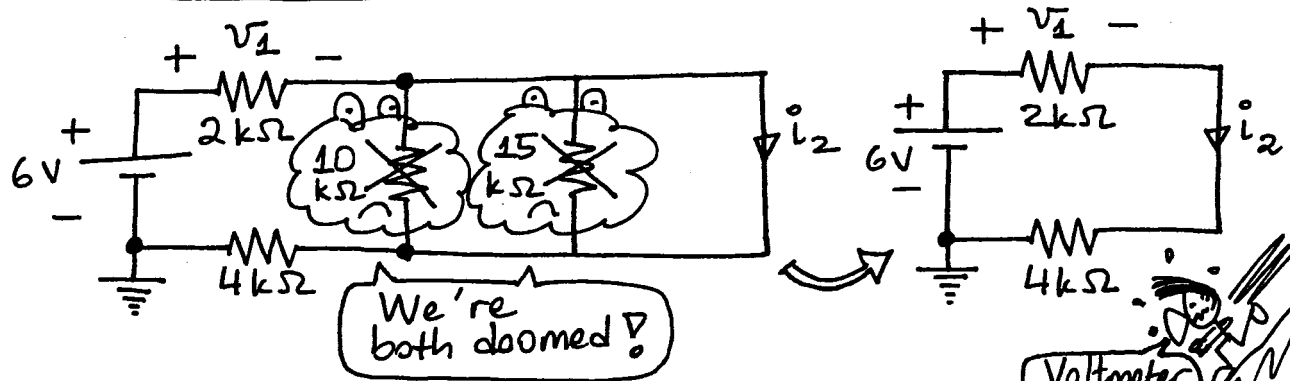
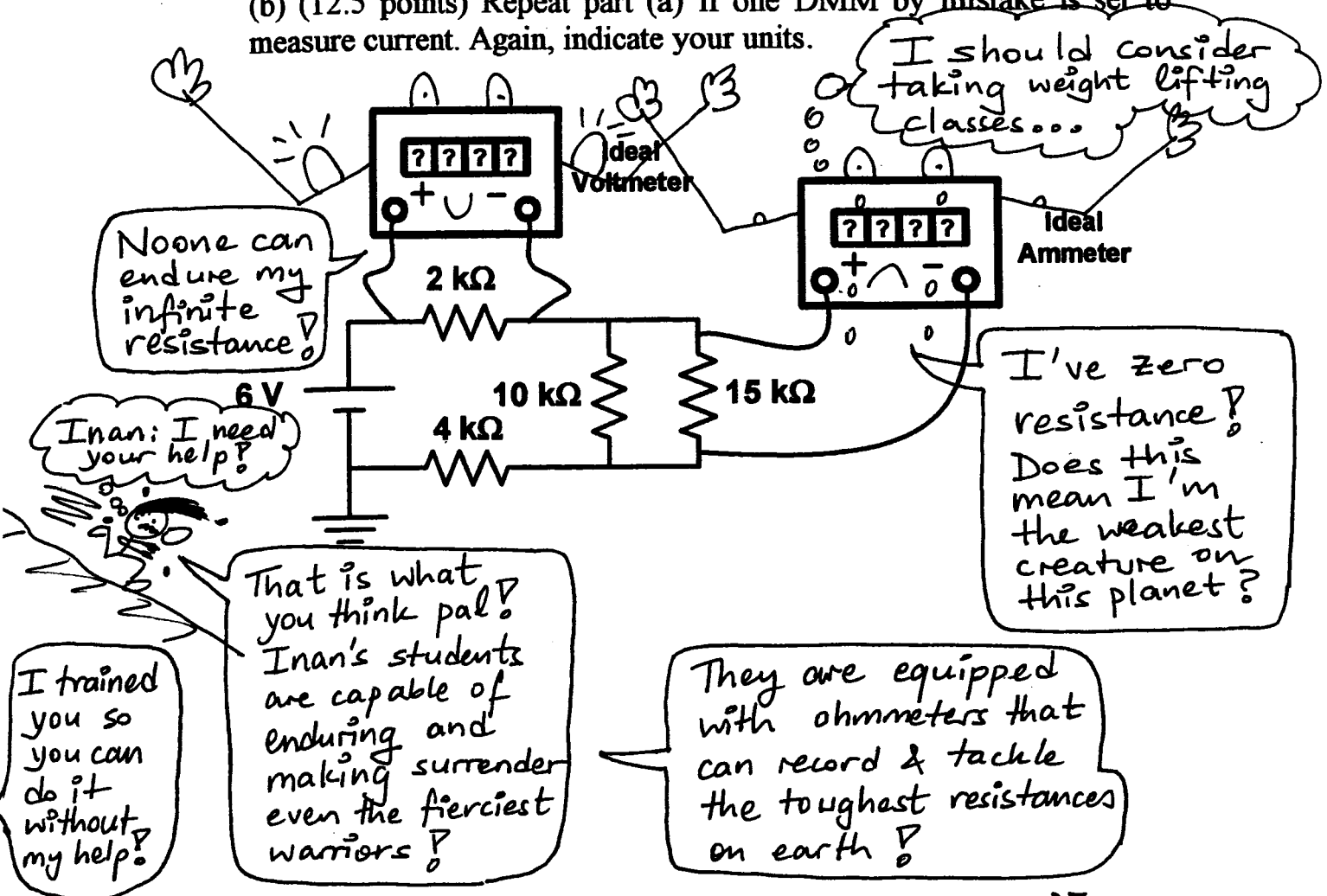
$$\frac{(10\text{ k}\Omega)(15\text{ k}\Omega)}{10\text{ k}\Omega + 15\text{ k}\Omega} = 6\text{ k}\Omega \text{ ?}$$

∴ Using the voltage divider principle:

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

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

(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:

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

Using Ohm's law, we have

$$i_2 = \frac{V_1}{2k\Omega} = \frac{2V}{2k\Omega} = \boxed{1mA}$$

Voltmeter measures  $V_1$  & ammeter measures  $i_2$

Two more to go. Inan's fighters are unstoppable!

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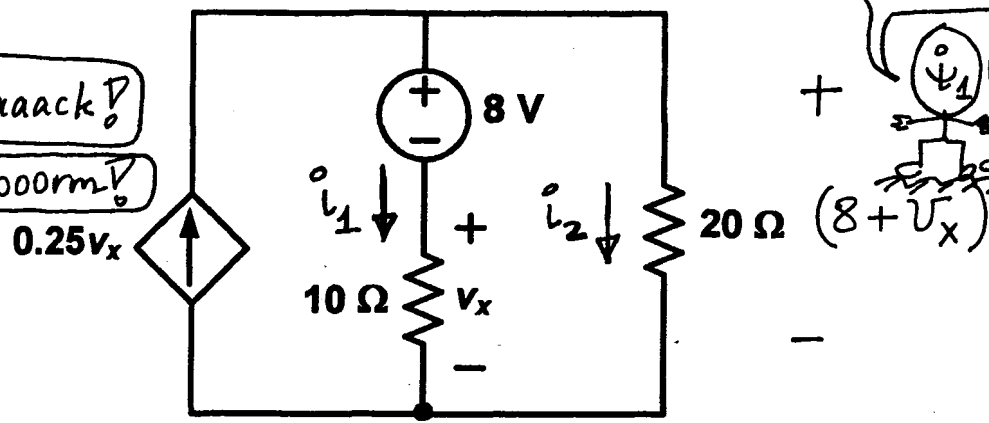
Inan: What do I do with a dependent source?

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

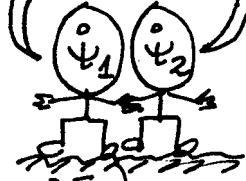


Attaaaaack!  
Stooooorm!

You know exactly what you need to do?



We were assigned arbitrarily



Note that based on KVL, the voltage across the  $20 \Omega$  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

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

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

Inan is right!  
I can do it!  
I can do it??



Haiiiii!  
Inan's merciless warriors are coming!

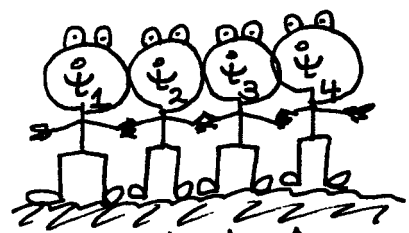
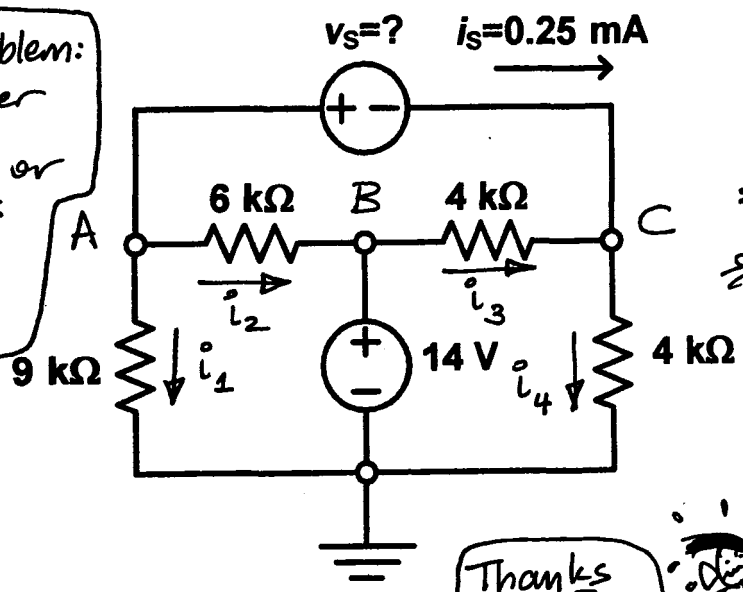
And no electric circuit problem can withstand their power!

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.

Inan: What is this??

Last problem: Surrender your solution or else it's going to be too late!

Keep it up! You know everything you need!



We were assigned arbitrarily!

Thanks guys! I promise I will spare your lives!

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

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

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

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

I can't believe what I'm saying!

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

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