NAME: ______________________________ **KP UiTM:** _______________

Program: __________

QUIZ 2 – Sept 14th 2006

Answer ALL questions ON the question paper itself. DO NOT USE ADDITIONAL PAPERS.

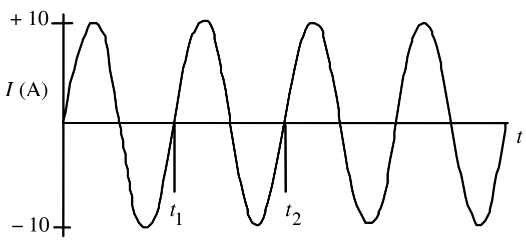
1. Complete the following statement: The electromotive force is
   (a) the maximum potential difference between the terminals of a battery.
   (b) the force that accelerates electrons through a wire when a battery is connected to it.
   (c) the force that accelerates protons through a wire when a battery is connected to it.
   (d) the maximum capacitance between the terminals of a battery.
   (e) the maximum electric potential energy stored within a battery.

2. The potential difference across the ends of a wire is doubled in magnitude. If Ohm's law is obeyed, which one of the following statements concerning the resistance of the wire is true?
   (a) The resistance is one half of its original value.
   (b) The resistance is twice its original value.
   (c) The resistance is not changed. *[resistance is a property of the material only]*
   (d) The resistance increases by a factor of four.
   (e) The resistance decreases by a factor of four.

3. The current through a certain heater wire is found to be fairly independent of its temperature. If the current through the heater wire is doubled, the amount of energy delivered by the heater in a given time interval will
   (a) increase by a factor of two..
   (b) decrease by a factor of two.
   (c) increase by a factor of four. *[Energy is the product of power & time and power is I^2R. Hence power and energy is $(2I)^2$ which means E_{new} is 4E.]*
   (d) decrease by a factor of four.
   (e) increase by a factor of eight.

Questions 4 and 5 pertain to the situation described below:

The figure shows variation of the current through the heating element with time in an electric iron when it is plugged into a standard 120 V, 60 Hz outlet.



4. What is the peak voltage?
   (a) 10 V
   (b) 60 V
   (c) 120 V
   (d) 170 V $V_{peak} = \sqrt{2}V_{rms} = \sqrt{2} \times 120V$
   (e) 240 V

5. What is the *rms* value of the current in this circuit?

(a) 1.4 A (c) 11 A (e) 18 A

(b) 7.1 A $I_{rms} = I_{peak}/\sqrt{2} = 10\ A/\sqrt{2}$ (d) 14 A

(5 marks)

6. In the circuit configuration below,

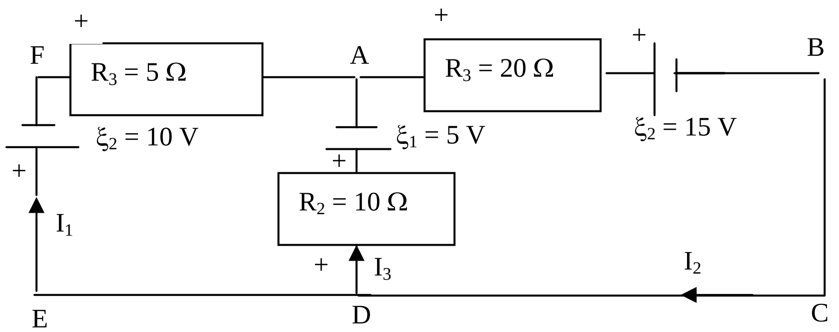
i) Label the '+' and '-' on the batteries and the resistors to show the high and low potential end.

ii) Apply Kirchoff's current rule at point A.

iii) Apply Kirchoff's voltage rule on loop ABCDA and on loop FADEF respectively.

iv) Solve the currents I_1, and I_2, and I_3 and determine the values and actual directions of the currents.

(24marks)



ii) At A: Current rule: $\sum I_{in} = \sum I_{out}$: $so, I_1 + I_3 = I_2$ *- eqn 1*

iii) Voltage rule: $\sum V_{drop} = \sum V_{rise}$. Follow the direction of the loop. Potential Drop is when we move from high potential (the positive end) to low potential (negative end). Potential rise is when we move from low potential (negative end) to high potential (positive end).

Loop ABCDA: $20\,\Omega I_2 + 15V + 10\,\Omega I_3 + 5V = 0$ *- eqn 2a* ***OR***

$20\,\Omega I_2 + 10\,\Omega I_3 = -5V - 15V = -20V$ *- eqn 2a.*

Loop FADEF: $5\,\Omega I_1 + 10V = 5V + 10\,\Omega I_3$ *- eqn 2b.* ***OR***

$5\,\Omega I_1 - 10\,\Omega I_3 = 5V - 10V = -5V$ *- eqn 2b*

iv) Now, we <u>eliminate</u> I_3 from equation 2a and equation 2b by replacing I_3 from equation 1. Hence,

$20\,\Omega I_2 + 10\,\Omega(I_2 - I_1) = -20V$ OR $30\,\Omega I_2 - 10\,\Omega I_1 = -20V$ *- eqn 2a-1*

$5\,\Omega I_1 - 10\,\Omega(I_2 - I_1) = -5V$ OR $-10\,\Omega I_2 - 15\,\Omega I_1 = -5V$ *- eqn 2b-1*

Multiply eqn2b-1 by 3: $-30\,\Omega I_2 - 45\,\Omega I_1 = -15V$ eqn 2b-2.

Now add eqn2b-2 to eqn 2a-1. $-55\,\Omega I_1 = -35V$. Then $I_1 = \dfrac{-35V}{-55\,\Omega} = 0.795\ A$.

$$-30\,\Omega I_2 - 45\,\Omega I_1 = \frac{-15V + (45\,\Omega \times 0.795\ A)}{-30\,\Omega} = -0.693\ A .$$

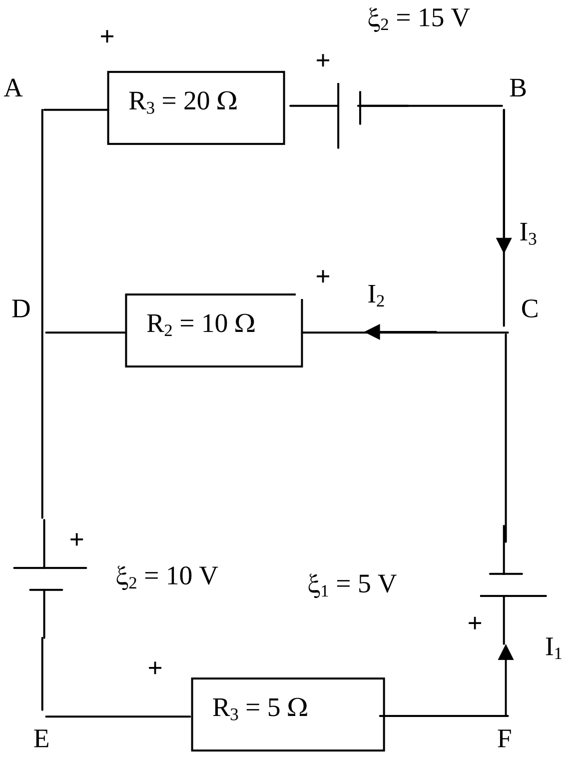
Substitute into eqn 1. Then $I_3 = I_2 - I_1 = 1.488A$. Negative I_2 means the current actually flows opposite the direction we had actually chosen.

Supplementary Question

In the circuit configuration below,

i) Label the '+' and '-' on the batteries and the resistors to show the high and low potential end.
ii) Apply Kirchoff's current rule at point C.
iii) Apply Kirchoff's voltage rule on loop DABC and on loop DEFC respectively.
iv) Solve the currents I_1, and I_2, in terms of I_3. DO NOT CALCULATE.

(6+3+3+4=16 marks)



(i) As shown in the figure:

(ii) At C: Current rule:
$\sum I_{in} = \sum I_{out}$: so, $I_1 + I_3 = I_2$ - eqn 1

iii) Voltage rule: $\sum V_{drop} = \sum V_{rise}$. Follow the direction of the loop. Potential Drop is when we move from high potential (the positive end) to low potential (negative end). Potential rise is when we move from low potential (negative end) to high potential (positive end).

Loop DABCD:
$20\,\Omega I_3 + 15V + 10\,\Omega I_2 = 0$ - eqn 2
loop DEFCD: $10V + 5\Omega I_1 + 5V + 10\Omega I_2 = 0$ - eqn 3

(iv) *Eliminate I_2: eqn 1 minus eqn 2*
$20I_3 + 15 - 15 + 10I_2 - 10I_2 + 5I_1 = 0$
$20I_3 + 5I_1 = 0$. So, $I_1 = -4I_3$,
Then, using eqn 1,
$I_2 = I_3 - I_1 = I_3 + 4I_3 = 5I_3$. *Substituting I_2 into eqn 2,* $20\,\Omega I_3 + 15V + 10\,\Omega \times 5I_3 = 0$.
Then $70\Omega I_3 = -15V$. Hence,
$I_3 = -15V/70\Omega = -0.214A$.
$I_1 = -4I_3 = 4 \times 0.214A = 0.856A$
$I_1 = 5I_3 = -5 \times 0.214A = -0.856A = -1.07A$

Negative I_3 & I_1 means the current actually flows opposite the direction we had actually chosen.