

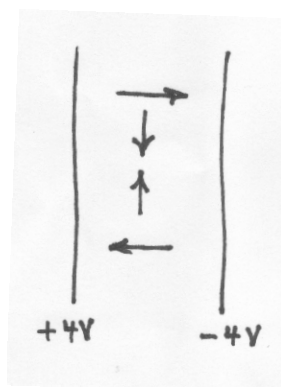
*The whole of science is nothing more than a refinement of everyday thinking.*

Albert Einstein

All answers must be accompanied by clear and concise explanations, appropriate calculations, and diagrams. Where appropriate, physical units must included in answers. Partial credit can be earned if correct reasoning is clearly expressed.

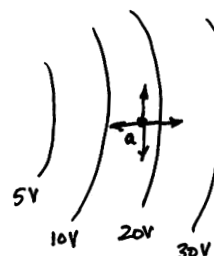
**Shorter Questions (each worth 5 points)**

- 1 Two large metal plates are fixed parallel to each other as shown. Each plate has the electric potential indicated. Circle the vector that best describes the electric field between the plates.



- 2 A proton is accelerated from rest through a potential difference of 64 Volts. What is the final speed of the proton?

- 3 Equipotentials in a particular region of space are shown to the right. An electron is placed at the point *a* and released. Circle the arrow that best describes the direction the electron will move.

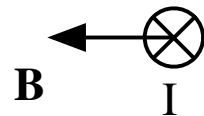


4 A capacitor has a charge  $5\mu\text{C}$  and its potential difference is measured to be  $50\text{V}$ . What is the capacitance?

5 A  $100\Omega$  resistor is connected to a  $12\text{V}$  battery. How much charge flows through the battery in  $1.0$  minutes?

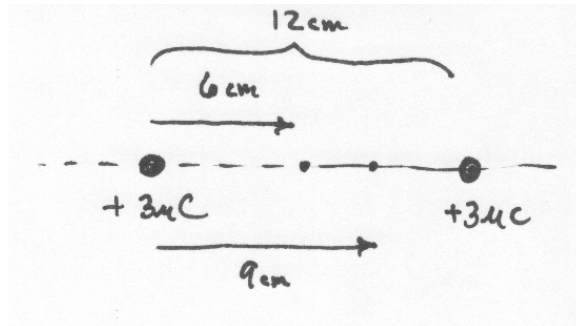
6 A  $100\text{W}$  light bulb is connected to a  $120\text{ V}$  (rms) alternating voltage source. What is the peak current through the bulb?

7 A wire carries a current of  $1.5\text{A}$  and is  $2\text{m}$  long. It is in a magnetic field of  $1\text{ Tesla}$ . The directions of the current and magnetic field are shown to the right. What is the magnetic force (direction and magnitude) on the wire?



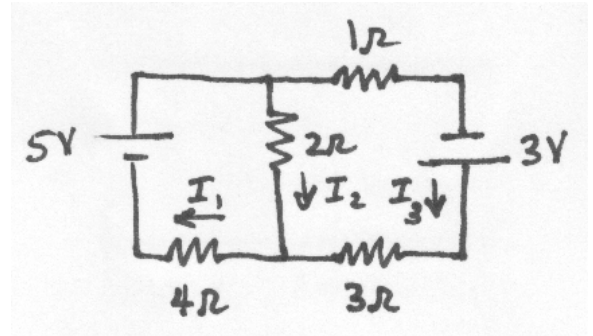
### Longer Questions

- 8 (15 points) Two charges, each  $+3\mu\text{C}$ , are separated by a distance of 12cm. Take the potential at infinity to be equal to zero.

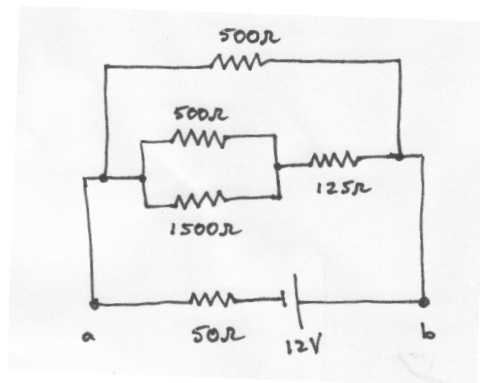


- What is the electric potential at the point midway between the charges?
- What is the electric potential at the point 9cm from the left charge?
- How much work is required to move a third charge of  $10\mu\text{C}$  from the midpoint of the two charges to the point 9cm from the left charge?

- 9 (10 points) Using the currents labeled in the circuit shown, write down 3 equations needed to determine the currents.



10 (15 points) Consider the following circuit:



- a ) What is the current through the battery?
- b ) What is the voltage difference between the points *b* and *a*?
- c ) What is the current through the 125Ω resistor?
- d ) What is the voltage drop across the 1500Ω resistor?

## Useful Information

$$KE = \frac{1}{2}mv^2$$

$$\Delta PE = q\Delta V$$

$$V_{tot} = \sum V_i$$

$$E = \frac{V}{d}$$

$$P = \frac{W}{t} = IV$$

$$P = \frac{V^2}{R}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

$$\langle P \rangle = \frac{1}{2}I_0V_0$$

$$\sum \Delta V_i = 0$$

$$e = 1.6 \times 10^{-19}\text{C}$$

$$PE_b - PE_a = -W_E$$

$$E = -\frac{\Delta V}{\Delta x}$$

$$Q = CV$$

$$I = \frac{\Delta Q}{\Delta t}$$

$$P = IV$$

$$V(t) = V_0 \sin \omega t$$

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$R_{eq} = R_1 + R_2 + R_3 + \dots$$

$$I_{in} = I_{out}$$

$$m_e = 9.11 \times 10^{-31}\text{kg}$$

$$PE = k\frac{qQ}{r}$$

$$V = k\frac{q}{r}$$

$$C = \epsilon_0\frac{A}{d}$$

$$V = IR$$

$$P = I^2R$$

$$I_0 = \frac{V_0}{R}$$

$$\langle P \rangle = I_{rms}V_{rms}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

$$F = I\ell B \sin \theta$$

$$m_p = 1.67 \times 10^{-27}\text{kg}$$