

Problems for chapter 7.

Revision

$$\mathbf{a} = \frac{q}{m} \mathbf{E}$$

$$\frac{1}{2} m v_-^2 - \frac{1}{2} m v_+^2 = qEX = q(V_+ - V_-)$$

$$E = \frac{V_+ - V_-}{X} \quad \text{Positive charges move towards negative potential regions.}$$

$$I = \frac{q}{t} \quad V = IR$$

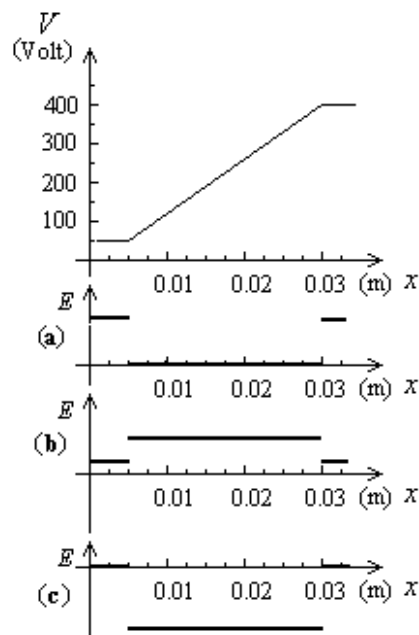
$$P = I^2 R = IV = \frac{V^2}{R}$$

- 1.* Show that the units for the electrostatic field E can be N C^{-1} or V m^{-1} or $\text{J C}^{-1} \text{m}^{-1}$.
2. Show that the units of power are $\text{kg m}^2 \text{s}^{-3}$.
- 3.* A charge of $q = 1.0 \times 10^{-12} \text{ C}$ and $m = 4.0 \mu\text{g}$ (this is $10^{-6} \times 10^{-3} \text{ kg}$) is placed in a vacuum with a uniform electrostatic field of $1.20 \times 10^6 \text{ N C}^{-1}$. If the charge is released from rest, what is its initial acceleration, what is its speed after it has travelled $2.0 \times 10^{-2} \text{ m}$?
4. A charge of $q = -2.0 \times 10^{-12} \text{ C}$ and $m = 5.0 \mu\text{g}$ (this is 10^{-9} kg) is placed in a vacuum with a uniform electrostatic field of $2.20 \times 10^6 \text{ N C}^{-1}$. If the charge is released from rest, what is its initial acceleration, what is its speed after it has travelled $2.0 \times 10^{-2} \text{ m}$?
- 5.* How long would the charge take to travel the 2 cm in problem 3 and problem 4 above?
6. According to the theory of relativity an electron cannot exceed the speed of light, $c = 3.00 \times 10^8 \text{ m s}^{-1}$, through what potential difference should an electron pass if its speed is to approach that of light? ($q_e = -1.60 \times 10^{-19} \text{ C}$ and $m_e = 9.11 \times 10^{-31} \text{ kg}$)
7. According to the theory of relativity a proton cannot exceed the speed of light, $c = 3.00 \times 10^8 \text{ m s}^{-1}$, through what potential difference should a proton pass if its speed is to approach that of light? ($q_p = 1.60 \times 10^{-19} \text{ C}$ and $m_p = 1.67 \times 10^{-27} \text{ kg}$)

8.* How many electrons are needed to provide a charge of 1 C? If these electrons were in a metal they would be about 0.40 nm apart, what volume would they occupy? If this volume was squeezed down a wire of $(1.0 \text{ mm})^2$ or $1.0 \times 10^{-6} \text{ m}^2$ cross-section what length of wire would they occupy? If a current of 1.0 A of electrons was running along the wire, what is the effective speed of the electrons?

9. What is the total charge and volume of one mole, that is 6.02×10^{23} of the electrons described in question 8. (these are 0.40 nm apart)? If this volume was squeezed down a wire of $(\pi(0.50 \times 10^{-3})^2) \text{ m}^2 = 7.85 \times 10^{-7} \text{ m}^2$ cross-section, what length of wire would they occupy? What is the average current if they all pass through the wire in 2.5 s?

10.*



Which of the E against x graphs best represents the uniform field between $x = 0.005 \text{ m}$ and $x = 0.030 \text{ m}$ as defined by the top V against x graph? What is the strength of the uniform field?

Would a positive charge released at $x = 0.02 \text{ m}$ move in a positive or negative x -direction? If a mass of 0.050 kg with a charge of +2.5 C was released from rest at $x = 0.02 \text{ m}$ what would be its speed after it has travelled 0.010 m?

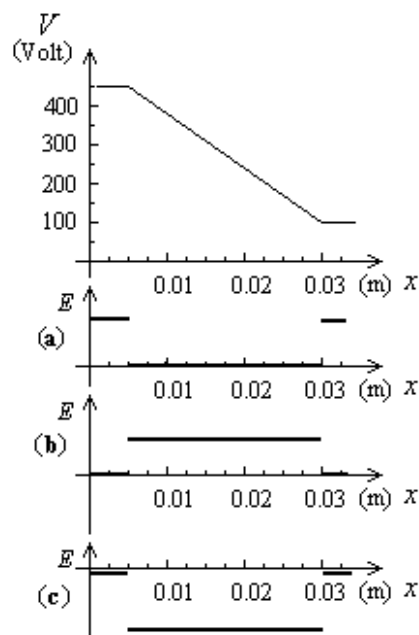
11.* If a resistor has a value of 2.40 k Ω (this is 2 400 Ω) and a voltage of 48.0 V across it, how much charge will flow through this resistor in 2.0 s?

12. If a resistor has a value of 96.0 k Ω and a voltage of 48.0 V across it, how much charge will flow through this resistor in 0.60 s?

13.* If a $10.0\ \Omega$ resistor has $500\ \text{mA}$ flowing through it, what is the voltage across this resistor? How much power is lost in the resistor? As all this power is dissipated as heat energy how much energy is released in $15.0\ \text{s}$?

14. If a $10.0\ \text{k}\Omega$ resistor has $50.0\ \text{mA}$ flowing through it, what is the voltage across this resistor? How much power is lost in the resistor? As all this power is dissipated as heat energy how much energy is released in $8.00\ \text{s}$?

15.



Which of the E against x graphs best represents the uniform field between $x = 0.005\ \text{m}$ and $x = 0.030\ \text{m}$ as defined by the top V against x graph? What is the strength of the uniform field?

Would a positive charge released at $x = 0.02\ \text{m}$ move in a positive or negative x -direction? If a mass of $0.025\ \text{kg}$ with a charge of $+2.5\ \text{C}$ was released from rest at $x = 0.02\ \text{m}$ what would be its speed after it has travelled $0.010\ \text{m}$?