Chapter 15

Electrostatic Potential and Capacitance

1. Answer (3)

Q =
$$100e = -100 \times 1.6 \times 10^{-10} = -1.6 \times 10^{-17}C$$

 $\Delta V = -14 V$
 $\therefore W = Q\Delta V = 14 \times 1.6 \times 10^{-17} = 2.24 \times 10^{-16} J$

Answer (1)

W_{*} = - q (V₇ - V₃) It depends on initial and final point only, because electrostatic field is a conservative field.

3. Answer (4)

$$U = \frac{q^2}{2C} = \frac{(q_0)^2}{2C} e^{-2t/RC} = U_0 e^{-2t/RC}$$

$$q = q_0 e^{-t/RC}$$

When charge becomes $\frac{1}{4}$ times, energy becomes

So, t_1 = one half life, while t_2 = 4 half lives

- 4. Answer (2)
- 5. Answer (2)

For this, charge must be same $Q = C_1V_1 = C_2V_2$ $\Rightarrow 120C_1 = 200C_2$ $\Rightarrow 3C_1 = 5C_2$

6. Answer (4)

$$V = \int \frac{kdq}{L + x}$$

$$V = \frac{kQ}{L} \int_{0}^{L} \frac{dL}{L + x} = \frac{kQ}{L} \ln 2$$

$$V = \frac{Q}{4\pi\epsilon_0 L} \ln 2$$

7. Answer (3)

$$dV = -E \cdot \overline{dx}$$

$$\int_{0}^{\infty} dV = -\int_{0}^{2} 30x^{2}dx$$

$$V_A - V_O = -[10x^3]_0^2 = -80 \text{ J}$$

8. Answer (1)

$$E = \frac{\sigma}{K\epsilon_0}$$

$$\sigma = K \epsilon_0 E$$

9. Answer (3, 4)

$$V_0 = k \frac{Q}{R}$$

$$V_i = \frac{kQ}{3Q^3}(3R^2 - r^2)$$

$$V = \frac{3}{5}V_0 \Rightarrow R_1 = 0$$

$$\frac{5}{4} \frac{kQ}{R} = kQ \frac{(3R^2 - r^2)}{2R^3}$$

$$\Rightarrow R_2 = \frac{R}{\sqrt{2}}$$

$$\frac{3}{4}\frac{kQ}{R} = \frac{kQ}{R^3}$$

$$\Rightarrow R_3 = \frac{4R}{3}$$

$$\frac{1}{4}\frac{kQ}{R} = \frac{kQ}{R_4}$$

$$\Rightarrow R_s = 4R \Rightarrow R_s > 2R$$

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JS Bruner

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