

第二十一章：电场 (2003年 - 2017年)

选择题:

①
$$\Delta E = \frac{Qq}{4\pi\epsilon_0 r_f} - \frac{Qq}{4\pi\epsilon_0 r_i}$$

$$= \frac{Qq}{4\pi\epsilon_0} \left(\frac{1}{r_f} - \frac{1}{r_i} \right)$$

$$= \frac{5 \times 10^{-6} \times 2 \times 10^{-2}}{4\pi\epsilon_0} \left(\frac{1}{5} - \frac{1}{10} \right)$$

$$= -89.87 \text{ J} \#$$

D.

②
$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C} = \frac{1}{10} + \frac{1}{10}$$

$$C = 5 \text{ MF}$$

$$E = \frac{1}{2} CV^2$$

$$= \frac{1}{2} \times 5 \times 10^{-6} \times 12^2$$

$$= 3.6 \times 10^{-4} \text{ J} \#$$

D.

③ C.

④ 电场强度
$$= \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{Ze}{4\pi\epsilon_0 r^2} \#$$

A.

⑤
$$C = \frac{Q}{V}$$

$$Q = CV$$

$$C_1 V_1 = C_2 V_2$$

$$V_1 + V_2 = 100$$

$$V_2 = 100 - V_1$$

$$12 \times 10^{-6} V_1 = 4 \times 10^{-6} (100 - V_1)$$

$$V_1 = 25 \text{ V} \#$$

C.

⑥
$$E_{AT} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{4 \times 10^{-6}}{4\pi\epsilon_0 \times 0.1^2}$$

$$= 3.595 \times 10^6 \text{ NC}^{-1}$$

$$E_{BT} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{6 \times 10^{-6}}{4\pi\epsilon_0 \times 0.1^2}$$

$$= 5.393 \times 10^6 \text{ NC}^{-1}$$

$$E_T = \sqrt{[(3.595 \times 10^6 \times \cos 45) + (5.393 \times 10^6 \times \cos 45)]^2 + [(5.393 \times 10^6 \times \sin 45) - (3.595 \times 10^6 \times \sin 45)]^2}$$

$$= 6.481 \times 10^6 \text{ NC}^{-1}$$

C.

⑦ C

⑧
$$V = \frac{E}{q}$$

$$= \frac{3.94 \times 10^{-19}}{e}$$

$$= 2.46 \text{ V} \#$$

C.

⑨ A

⑩
$$E = \frac{V}{d}$$

$$= \frac{50}{0.02}$$

$$= 2500 \text{ NC}^{-1}$$

$$F = qE$$

$$= 6 \times 10^{-6} \times 2500$$

$$= 0.015 \text{ N} \#$$

B.

⑪
$$C = \frac{Q}{V}$$

$$= \frac{80 \times 10^{-12}}{20}$$

$$= 4 \text{ pF} \#$$

A.

⑫ B

⑬
$$F = \frac{Qq}{4\pi\epsilon_0 r^2}$$
 漏电前

$$kx_1 = \frac{2Q}{4\pi\epsilon_0 (l_0 + x_1)^2}$$

$$kx_2 = \frac{Q}{4\pi\epsilon_0 x_1 (l_0 + x_1)^2}$$

$$F = \frac{Qq}{4\pi\epsilon_0 r^2}$$
 漏电后

$$kx_2 = \frac{Q}{4\pi\epsilon_0 (l_0 + x_2)^2}$$

$$k = \frac{4\pi\epsilon_0 x_2 (l_0 + x_2)^2}{Q}$$

$$\frac{4\pi\epsilon_0 x_1 (l_0 + x_1)^2}{4\pi\epsilon_0 x_2 (l_0 + x_2)^2}$$

$$x_1 (l_0 + x_1)^2 = 4x_2 (l_0 + x_2)^2$$

$$x_2 = \frac{x_1}{4} \times \frac{(l_0 + x_1)^2}{(l_0 + x_2)^2}$$

C.

14) B

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}$$

$$\frac{1}{C} = \frac{1}{10\mu} + \frac{1}{10\mu} + \dots + \frac{1}{10\mu}$$

$$C = 1 \times 10^{-6} F$$

$$E = \frac{1}{2} CV^2$$

$$= \frac{1}{2} \times 1 \times 10^{-6} \times 10^3$$

$$= 5 \times 10^{-5} J \xrightarrow{\text{每-1}} 5 \times 10^{-6} J$$

B.

16) D.

$$U_A = U_B + K_E$$

$$k \frac{q_1 q_2}{a} = k \frac{q_1 q_2}{b} + \frac{1}{2} m v^2$$

$$\frac{1}{2} m v^2 = k \frac{q_1 q_2}{a} - k \frac{q_1 q_2}{b}$$

$$\frac{1}{2} m v^2 = k q_1 q_2 \left(\frac{1}{a} - \frac{1}{b} \right)$$

$$\frac{1}{2} m v^2 = \frac{k q_1 q_2 (b-a)}{ab}$$

$$V = \sqrt{\frac{2k q_1 q_2 (b-a)}{mab}}$$

b.

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$100 = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$E = \frac{Q}{4\pi\epsilon_0 \left(\frac{r}{2}\right)^2} \times 2$$

$$= 8 \times \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= 800 \text{ NC}^{-1}$$

D.

19) C

$$T \sin 30 = Eq$$

$$\frac{mg}{\cos 30} \sin 30 = Eq$$

$$E = \frac{mg \tan 30}{q}$$

$$T \cos 30 = mg$$

$$T = \frac{mg}{\cos 30}$$

A.

$$\frac{1}{2} m u^2 + V_p q = \frac{1}{2} m v^2 + V_0 q$$

$$\frac{1}{2} m_e (7 \times 10^6)^2 - 120e = \frac{1}{2} m_e v^2 + 0e$$

$$V = 2.61 \times 10^6 \text{ ms}^{-1}$$

A.

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

$$= \frac{600}{0.04}$$

$$= 1.5 \times 10^4 \text{ NC}^{-1}$$

D.

23) A.

作答题:

$$\textcircled{1} \text{ (a) (i)} \quad V_p = \frac{Q_A}{4\pi\epsilon_0(AP)} + \frac{Q_B}{4\pi\epsilon_0(BP)}$$

$$= \frac{5 \times 10^{-6}}{4\pi\epsilon_0(AP)} = \frac{5 \times 10^{-6}}{4\pi\epsilon_0(BP)} \quad AP = BP$$

$$= 0V$$

$$\text{(ii)} \quad E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{5 \times 10^{-6}}{4\pi\epsilon_0 (5^2 \cdot 15^2)}$$

$$= 898.755 \text{ NC}^{-1}$$

$$E_p = 2E \cos 45^\circ$$

$$= 2 \times 898.755 \times \cos 45^\circ$$

$$= 1.271 \times 10^3 \text{ NC}^{-1} \quad (\text{与AOB平行, 向右})$$

$$\text{(b) (i)} \quad \frac{Q}{V}$$

$$20 \times 10^{-6} = \frac{Q_A}{20}$$

$$Q_A = 4 \times 10^{-4} C$$

$$\text{(ii)} \quad C = C_A + C_B$$

$$= 20\mu + 10\mu$$

$$= 30 \times 10^{-6} F$$

$$C = \frac{Q}{V}$$

$$30 \times 10^{-6} = \frac{4 \times 10^{-4}}{V}$$

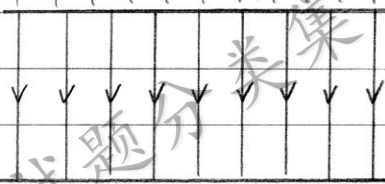
$$V = 13.33V$$

$$C = \frac{Q}{V}$$

$$10 \times 10^{-6} = \frac{Q}{13.33}$$

$$Q = 1.33 \times 10^{-4} \text{ C}$$

② (a) (i)



(ii) $E = \frac{V}{d}$

$$= \frac{100}{0.02}$$

$$= 5000 \text{ NC}^{-1}$$

(iii) $qE = ma$

$$5000e = me a$$

$$a = 8.79 \times 10^{14} \text{ ms}^{-2}$$

(iv) $qV = \frac{1}{2}mv^2$

$$100e = \frac{1}{2}me v^2$$

$$V = 5.93 \times 10^6 \text{ ms}^{-1}$$

(b) 水平方向

$$t = \frac{s}{V}$$

$$= \frac{0.06}{1.5 \times 10^7}$$

$$= 4 \times 10^{-9} \text{ s}$$

竖直方向

$$t = 4 \times 10^{-9}$$

$$u = 0$$

$$a = 8.79 \times 10^{14}$$

$$s = ?$$

$$s = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2} \times 8.79 \times 10^{14} \times (4 \times 10^{-9})^2$$

$$= 7.032 \times 10^{-3} \text{ m}$$

③ (a) $V = \frac{Q}{4\pi\epsilon_0 r}$

$$= \frac{2 \times 10^{-12}}{4\pi\epsilon_0 \times 0.1}$$

$$= 0.18 \text{ V}$$

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{2 \times 10^{-12}}{4\pi\epsilon_0 \times 0.1^2}$$

$$= 1.8 \text{ NC}^{-1}$$

(b) (i) $\frac{1}{2}mu^2 - \frac{1}{2}mv^2 = \frac{Qq}{4\pi\epsilon_0 r}$

$$\frac{1}{2} \times 1.67 \times 10^{-27} [(5 \times 10^6)^2 - (2 \times 10^6)^2] = \frac{2 \times 10^{-12} \times e}{4\pi\epsilon_0 r}$$

$$r = 1.64 \times 10^{-7} \text{ m}$$

(ii) $F = \frac{Qq}{4\pi\epsilon_0 r^2}$

$$\frac{mv^2}{r} = \frac{Qq}{4\pi\epsilon_0 r^2}$$

$$\frac{1.67 \times 10^{-27} (2 \times 10^6)^2}{r} = \frac{2 \times 10^{-12} e}{4\pi\epsilon_0 (1.64 \times 10^{-7})^2}$$

$$r' = 6.26 \times 10^{-8} \text{ m}$$

④ (a) $V = \frac{Q}{4\pi\epsilon_0 r}$

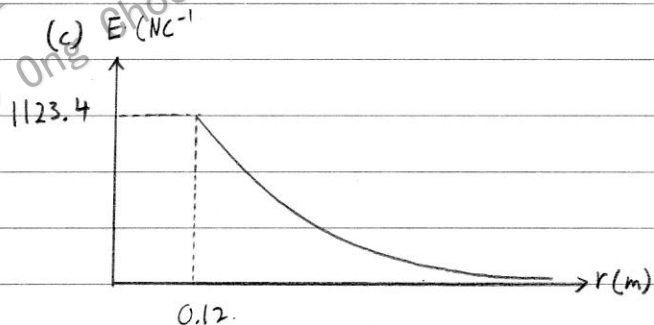
$$= \frac{1.8 \times 10^{-9}}{4\pi\epsilon_0 \times (0.12)}$$

$$= 134.81 \text{ V}$$

(b) $E = \frac{Q}{4\pi\epsilon_0 r^2}$

$$= \frac{1.8 \times 10^{-9}}{4\pi\epsilon_0 \times (0.12)^2}$$

$$= 1123.4 \text{ NC}^{-1} \text{ (沿半径向外)}$$



$$(d)(i) \quad Q = 1.8 \times 10^{-9} - 9 \times 10^{-10}$$

$$Q_A + Q_B = 9 \times 10^{-10}$$

$$V_A = V_B$$

$$\frac{Q_A}{4\pi\epsilon_0 \times 0.12} = \frac{Q_B}{4\pi\epsilon_0 \times 0.06}$$

$$0.06 Q_A = 0.12 Q_B$$

$$0.06 Q_A = 0.12 (9 \times 10^{-10} - Q_A)$$

$$0.06 Q_A = 1.08 \times 10^{-10} - 0.12 Q_A$$

$$Q_A = 6 \times 10^{-10} \text{ C} \#$$

$$Q_B = 3 \times 10^{-10} \text{ C} \#$$

$$(ii) \quad V_{AB} = \frac{Q}{4\pi\epsilon_0 r}$$

$$= 9 \times 10^9 \times 3.2 \times 10^{-6} \div 0.4$$

$$= 7.2 \times 10^4 \text{ V}$$

$$V_{CB} = \frac{Q}{4\pi\epsilon_0 r}$$

$$= 9 \times 10^9 \times 1.6 \times 10^{-6} \div 0.1$$

$$= 1.44 \times 10^5 \text{ V}$$

$$V_B = 1.44 \times 10^5 + 7.2 \times 10^4$$

$$= 2.16 \times 10^5 \text{ V} \#$$

$$(ii) \quad F = \frac{Qq}{4\pi\epsilon_0 r^2}$$

$$= \frac{6 \times 10^{-10} \times 3 \times 10^{-10}}{4\pi\epsilon_0 \times (0.3)^2}$$

$$= 1.8 \times 10^{-8} \text{ N} \#$$

$$(iii) \quad F = qE$$

$$= 4.8 \times 10^{-6} \times 1.26 \times 10^6$$

$$= 6.048 \text{ N (向左)} \#$$

$$(5) \quad E_{AP} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{2 \times 10^{-8}}{4\pi\epsilon_0 \times 0.15^2}$$

$$= 7.989 \times 10^3 \text{ N C}^{-1}$$

$$E_{BP} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= \frac{2.5 \times 10^{-9}}{4\pi\epsilon_0 \times (0.05)^2}$$

$$= 8.988 \times 10^3 \text{ N C}^{-1}$$

$$E = 8.988 \times 10^3 - 7.989 \times 10^3$$

$$= 9.98 \times 10^2 \text{ N C}^{-1} \# \quad (\text{向左})$$

$$(6) (a)(i) \quad E_{AB} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= 9 \times 10^9 \times 3.2 \times 10^{-6} \div (0.4)^2$$

$$= 1.8 \times 10^5 \text{ N C}^{-1}$$

$$E_{CB} = \frac{Q}{4\pi\epsilon_0 r^2}$$

$$= 9 \times 10^9 \times 1.6 \times 10^{-6} \div (0.1)^2$$

$$= 1.44 \times 10^6 \text{ N C}^{-1}$$

$$E = 1.44 \times 10^6 - 1.8 \times 10^5$$

$$= 1.26 \times 10^6 \text{ N C}^{-1} \quad (\text{向左}) \#$$

$$E = qV$$

$$= 4.8 \times 10^{-6} \times 2.16 \times 10^5$$

$$= 1.037 \text{ J} \#$$

$$(b)(b)(i) \quad W = -qV_{CB}$$

$$= -e (V_C - V_B)$$

$$= -e \left(\frac{Q}{4\pi\epsilon_0 r_C} - \frac{Q}{4\pi\epsilon_0 r_B} \right)$$

$$= \frac{-8 \times 10^{-6} e}{4\pi\epsilon_0} \left(\frac{1}{0.5} - \frac{1}{0.4} \right)$$

$$= +5.76 \times 10^{-15} \text{ J} \#$$

$$(ii) \quad W = \frac{1}{2} m v^2$$

$$5.76 \times 10^{-15} = \frac{1}{2} m v^2$$

$$v = 1.12 \times 10^8 \text{ m s}^{-1} \#$$