Han Yibei 519370910123

Question 24.11

Water has strong solubility, so it may erode the metal plate. Also, it's hard to keep water pure. Unpure water can conduct current since it contains ions.

Question 24.21

I think the electric field will decrease. The oil's dielectric contant k is bigger than 1, so the charge will be separate partially in the oil, thus causing the decrease in electric field.

Since $E = \frac{F}{q}$, we can measure the force a certain charge have in the electric field.

Question 25.11

(a) For a resistor $P = UI = \frac{U^2}{R}$ when $T\uparrow$, $R\uparrow$, since U is constant, we can found that P decrease.

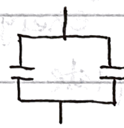
(b) For carbon. when $T\downarrow$, $R\uparrow$, also U is constant, so, we can found that P increase

Question 25.16

The light bulb in A will be much brighter. Since an ideal ammeter contain only a little resistor while an ideal voltmeter has large resistor. So the bulb in (A) has larger current, thus brighter

Problem 24.66

(a) This one is equal to these capacitors.



C_2.

$$C_2(Air) = \varepsilon_0 \frac{A}{d} = (8.85\times10^{-12}\ F/m) \times \frac{\left(\frac{12}{100}\right)\times\left(\frac{1}{2}\times\frac{12}{100}\right)m^2\ C_1}{\frac{4.5}{10000}\ m}$$

$$= 1.416\times10^{-11}\ F$$

$$C_1 = k\cdot\varepsilon_0\cdot\frac{A}{d} = k\cdot C_2 = (3.40)\times(1.416\times10^{-11}\ F) = 4.8144\times10^{-11}\ F.$$

$$C = C_1 + C_2 = 1.416\times10^{-11}\ F + 4.8144\times10^{-11}\ F = 6.23\times10^{-11}\ F$$

(b) $U = \frac{1}{2}CV^2 = \frac{1}{2}\times(6.23\times10^{-11}\ F)\times(18V)^2 = 1.01\times10^{-8}\ J$

(c)

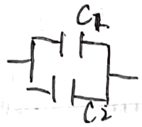
$C_1 = C_2$ $\quad C = C_1 + C_2 = 2\times1.416\times10^{-11}\ F = 2.83\times10^{-11}\ F.$

$U = \frac{1}{2}CV^2 = \frac{1}{2}\times(2.83\times10^{-11}\ F)\times(18V)^2 = 4.58\times10^{-9}\ J$

Han Yibei 5193702f10123

Question 24.72.

(a) $C = C_1 + C_2$.



$C_1 = \varepsilon_0 \frac{A}{d} = \varepsilon_0 \times \frac{L \times (L-x)}{D}$ $C_2 = K \cdot \varepsilon_0 \cdot \frac{A'}{d} = K \cdot \varepsilon_0 \cdot \frac{L \cdot x}{D}$.

$C = C_1 + C_2 = \varepsilon_0 \frac{L(L-x) + KLx}{D} = \frac{\varepsilon_0 L}{D}(L + (K-1)x)$

(b) $U = \frac{1}{2}CV^2 \Rightarrow U' = \frac{1}{2}V^2 C dx = \frac{1}{2}V^2 \frac{\varepsilon_0 (K-1)}{D} \Rightarrow \frac{dU}{dx} = \frac{V^2 \varepsilon_0 (K-1)}{2D}$

$\Rightarrow dU = + \frac{(K-1)\varepsilon_0 V^2 L}{2D} dx$

(c) $Q = CV = \frac{\varepsilon_0 L \cdot V}{D}(L + (K-1)x)$

$U = \frac{1}{2} \cdot \frac{Q^2}{C} = \frac{1}{2} \cdot \frac{\varepsilon_0 L V^2}{D}(L + (K-1)x)$

Also we can found that $F = -\frac{\varepsilon_0 L V^2}{2D}(K-1)$

So that the distance direction is opposite direction of the displacement

So it's repulsive force So energy is negative

$\Rightarrow -U' = \frac{1}{2}V^2 \frac{\varepsilon_0 (K-1)}{d} \Rightarrow dU = -\frac{(K-1)\varepsilon_0 V^2 L}{2D} dx$

(d) in (b) $U = Fx \Rightarrow dU = -F dx = -\frac{(K-1)\varepsilon_0 V^2 L}{2D}$, the force is in the opposite direction of x to make dU positive

So it's a force pushing it out.

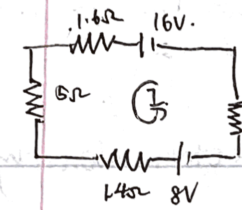
(e) Because when plates connect to the battery, the plate is not isolated. When the work done on the slow by the charges on the plate, energy of battery is also changed. But in part (c) the plate is isolated, the force is of the same distance as Fig. 24.16.

In opposite. in (c) $F = \frac{(K-1)\varepsilon_0 V^2 L}{2D}$, the force is in the same direction ~~of x~~

So it's a force pulling it in.

Han Yibei 519370910123

Question 25.33



(a) By applying KCL

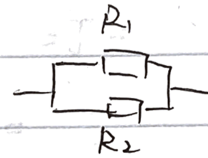
$8V + I\cdot(5\Omega + 1.4\Omega + 9\Omega + 1.6\Omega) = 16V.$

$\Rightarrow I = \frac{8}{17}A. = 0.47A.$ And it's counter clockwise

(b) $V_{ab} = 16V - 1.6\Omega \cdot 0.47A = 15.25V.$

Question 25.52

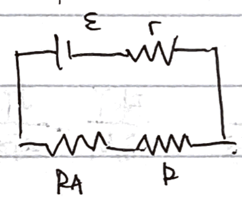
$R_1 = \frac{\rho L}{A} = \frac{\rho x}{A}$ $\quad R_2 = \frac{\rho L'}{A} = \frac{\rho(L-x)}{A}$ $\quad U = R_1 I_1 = R_2 I_2$



$(2.86A) \times \frac{\rho x}{\cancel{A}} = (1.65A) \times \frac{\rho(L-x)}{A}$ $\Rightarrow 2.86x = 1.65(2000m - x)$ $\Rightarrow x = 731.7m.$

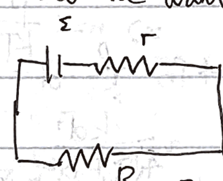
Question 26.67

(a).



$I_A = \frac{\varepsilon}{r + R_A + R}.$

what we want to measure:



$I = \frac{\varepsilon}{R + r}.$

$\frac{I}{I_A} = \frac{R + r + R_A}{R + r} = 1 + \frac{R_A}{R + r}$ R_A is smaller, $\frac{I}{I_A}$ is closer to 1. so that it's more ideal.

(b). $I_A = 0.99I.$ $\Rightarrow$ $\frac{1}{0.99} = 1 + \frac{R_A}{R + r}$ $\Rightarrow$ $R_A = (\frac{1}{0.99} - 1) \times (0.45\Omega + 3.80\Omega) = 0.43\Omega$

(c) $I - I_A = \frac{\varepsilon R_A}{(r+R)(r+R+R_A)} = \Delta I$ $\Rightarrow$ when $R_A \uparrow$, $\Delta I \uparrow$

if R_A bigger than 0.43Ω, ΔI will be bigger

so that $\frac{\Delta I}{I}$ will be bigger than 1% (in part (b)).

...an Jibei 519370910123

Essay Question I.

Mean free time = $\dfrac{\text{Mean free path}}{\text{average speed}}$

$$\lambda = \frac{1}{\sqrt{2}\pi n d^2}$$ (d = diameter of molecule, n = electron density)

$$V_{avg} = \sqrt{\frac{8RT}{\pi M}} \Rightarrow \tau = \frac{1}{\sqrt{2}\pi n d^2} \cdot \sqrt{\frac{M\pi}{8RT}}$$

$$\Rightarrow \tau = \frac{1}{\sqrt{2} \times 3.14 \times 8.5 \times 10^{28} \times (2.28 \times 10^{-10})^2} \times \sqrt{\frac{9.1 \times 10^{-31} \times 3.14}{8.314 \times 8 \times 237}}$$

$$= 6.39 \times 10^{-28}\ s$$

in the sound: $V = \sqrt{\dfrac{5kT}{3me}} \Rightarrow V^2 = \dfrac{5kT}{3me}$

$$P = nkT \Rightarrow n = \frac{P}{kT}$$

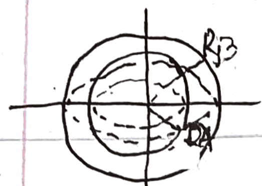
$$\Rightarrow \tau = \frac{1}{4\sqrt{\pi} \cdot \frac{P}{kT} \cdot d^2} \cdot \sqrt{\frac{M}{RT}} = \frac{k \cdot \sqrt{T} \cdot \sqrt{M}}{4\sqrt{\pi} \cdot P \cdot d^2 \cdot \sqrt{R}} = \frac{5kT}{3M} \cdot \frac{\sqrt{M} \cdot M \cdot 3}{4\sqrt{\pi} \cdot P \cdot d^2 \cdot \sqrt{R} \cdot \sqrt{T} \times 5}$$

$$= V_{sound}^2 \times \frac{1.54 \times 10^{-48}}{Pd^2}$$

Han Yibei 519370910123.

Essay question 2. (find the capacity per area for RA)

① concentric sphere.



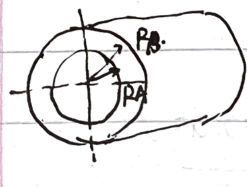
$E = k \cdot \frac{q}{R_A^2} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R_A^2}$

$\Delta V = \int_{RA}^{RB} \vec{E}\, d\vec{r} = \frac{q}{4\pi\varepsilon_0} \cdot \int_{RA}^{RB} \frac{dr}{r^2} = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{RA} - \frac{1}{RB}\right).$

$C = \frac{q}{V} = 4\pi\varepsilon_0 \cdot \left(\frac{RA\,RB}{d}\right).$ capacity per unit area:

$\frac{C}{A} = \frac{\varepsilon_0}{d} + \frac{\varepsilon_0}{RB}$

② concentric cylonders.



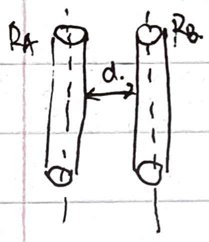
$E = \oint \vec{E}\, d\vec{A} = E \cdot 2\pi r \cdot L = \frac{Q_{enc}}{\varepsilon_0} = \frac{q}{\varepsilon_0}.$

$\Rightarrow E = \frac{q}{2\pi\varepsilon_0 \cdot rL}.$

$V = \int_{RA}^{RB} \frac{q}{2\pi\varepsilon_0 rL} dr = \frac{q}{2\pi\varepsilon_0 \cdot L} \int_{RA}^{RB} \frac{dr}{r} = \frac{q}{2\pi\varepsilon_0 \cdot L} \cdot \ln\left(\frac{RB}{RA}\right)$

$\Rightarrow C = \frac{q}{V} = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{RB}{RA}\right)}$ $\quad \frac{C}{A} = \frac{\varepsilon_0}{RA \cdot \ln\left(\frac{RB}{RA}\right)}$

③ Parallel cylinder:



$V = -\int_{rA}^{d-rA} E\, d\vec{r}$

$E = \frac{q}{2\pi\varepsilon_0 r \cdot L} + \frac{q}{2\pi\varepsilon_0 r \cdot L}$

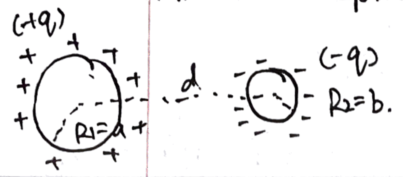
$\Rightarrow V = \frac{q}{2\pi\varepsilon_0 L} \cdot \ln\left(1 + \frac{d}{rA}\right) \Rightarrow C = \frac{q}{V} = \frac{2\pi\varepsilon_0 \cdot L}{\ln\left(1 + \frac{d}{RA}\right)}$

$\Rightarrow \frac{C}{A} = \frac{\varepsilon_0}{RA \cdot \ln\left(1 + \frac{d}{RA}\right)}$

↗ next page

Hanyibei 5193707(10r2)

④. ~~not~~ concentrated sphere.



$$\vec{E} = \vec{E}_A + \vec{E}_B = \frac{q}{4\pi\varepsilon_0 r^2} + \frac{q}{4\pi\varepsilon_0 (d-r)^2}$$

$$-\int_{V_A}^{V_B} dV = \frac{q}{4\pi\varepsilon_0}\int_a^{d+a} \left(\frac{1}{r^2} + \frac{1}{(d-r^2)}\right) dr.$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{a} - \frac{1}{d+a}\right).$$

$$= \frac{q}{4\pi\varepsilon_0 a} - \frac{1}{4\pi\varepsilon_0 (d+a)}$$

$$C = \frac{q}{V} = \frac{2\pi\varepsilon_0 R_A^2}{d} + 2\pi\varepsilon_0 R_A.$$

$$\frac{C}{A} = \frac{\varepsilon_0}{2d} + \frac{\varepsilon_0}{2R_A}$$

⑤ Parallel Plate.

$$E = \frac{q}{A\varepsilon_0}$$

$$\int_0^d \vec{E}\, d\vec{r} = \frac{qd}{A\varepsilon_0}$$

$$= \int_0^d \frac{q}{A\varepsilon_0} =$$

$$C = \frac{q}{V} = \frac{A\varepsilon_0}{d} \Rightarrow \frac{C}{A} = \frac{\varepsilon_0}{d}.$$

Capacity per area for "A" object

① $\frac{\varepsilon_0}{d} + \frac{\varepsilon_0}{R_A}$ ② : $\frac{\varepsilon_0}{R_A \cdot \ln(\frac{R_B}{R_A})}$ ③ $\frac{\varepsilon_0}{R_A \cdot \ln(1+\frac{d}{R_A})}$ ④ : $\frac{\varepsilon_0}{2d} + \frac{\varepsilon_0}{2R_A}$ ⑤ $\frac{\varepsilon_0}{d}$.

① have the greatest capacity per unit area.