Midterm 7/5-09: LF

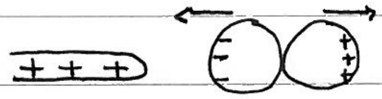
① $V(x) = 50\,V + (15\,\frac{V}{m})x$

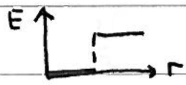
$\Rightarrow \vec{E} = -\nabla V = -\hat{x}\,\frac{dV}{dx} = \underline{\underline{-(15\,\frac{V}{m})\hat{x}}}$ Ⓓ

② $\vec{E} = \pm \frac{\sigma}{2\varepsilon_0}\,\hat{x}$ ⇒ lineart avtagende V i begge retninger

⇒ Ⓐ

③ Sammenhengende leder = ekvipotensial ⇒ Ⓑ

④  ⇒ neg. ladn. til venstre ⇒ Ⓐ

⑤ $E(r) = -\partial V/\partial r$ ⇒  5 ⇒ Ⓓ

⑥ Før: ΔV_0 Etter: $\frac{2}{3}\Delta V_0$ ⇒ $C_1 = \frac{q}{\frac{2}{3}\Delta V_0} = \frac{3}{2}\,\frac{q}{\Delta V_0} = \frac{3}{2}C_0$ ⇒ Ⓒ

⑦ $\vec{D}$ og $\vec{E}$ stopper ikke ytterst på plasten ⇒ feltl. for $\vec{P}$ ⇒ Ⓒ

⑧ metall = ekvipot. ⇒ $V_1 = V_2 = V_3$ ⇒ Ⓑ

⑨ $U = \sum_{i<j} U_{ij} = \frac{q^2}{4\pi\varepsilon_0 a}\left\{-4 + \frac{2}{\sqrt{2}}\right\} = \frac{9^2\cdot 10^{-12}\cdot 9\cdot 10^{9}}{5\cdot 10^{-2}}\left\{-4+\sqrt{2}\right\}$ J

$= (81\cdot 9/5)\cdot 10^{-1}\cdot\{-4+\sqrt{2}\}$ J $\simeq 160\cdot(-2.6)/10 \simeq \underline{-38\,J}$ ⇒ Ⓓ

⑩ Gauss' lov ⇒ $-Q$ på indre flate av midtkula

⇒ $-Q$ på ytre —"— ⇒ Ⓐ

⑪ $\vec{F} = I\vec{L}\times\vec{B}$; høyre leder: $IL\,\hat{y}\times B\hat{z} \sim \hat{x}$

venstre —"— : $IL(-\hat{y})\times B\hat{z} \sim -\hat{x}$ } ⇒ kraftpar 1 ⇒ Ⓐ

12 uten avbøyning: $\vec{F}_e + \vec{F}_m = 0$

$\vec{F}_e = q\vec{E} = qE_0\hat{y}$, $\quad \vec{F}_m = q\vec{v}\times\vec{B} = qvB_0\,\hat{x}\times\hat{z} = -qvB_0\hat{y}$

$\Rightarrow v = E_0/B_0 = 10^4/(50\cdot 10^{-3})\ \frac{m}{s} = 2\cdot 10^5\ m/s = \underline{200\ km/s} \quad \Rightarrow$ D

13 $R_{tot} = \left\{\frac{1}{R} + \frac{1}{R+(1/R+1/R)^{-1}}\right\}^{-1} = \left\{\frac{3}{3R} + \frac{2}{3R}\right\}^{-1} = \frac{3R}{5}$

strøm totalt: $I_{tot} = V_0/(3R/5) = 5V_0/3R$

øverst: $V_0/R \Rightarrow 2V_0/3R$ nederst $\Rightarrow \underline{I} = V_0/3R \quad \Rightarrow$ B

[evt mer direkte: nederst: $R + R/2 = 3R/2 \Rightarrow I = \frac{1}{2}\cdot\frac{V_0}{(3R/2)} = V_0/3R$]

14 $C = Q/V_0 \Rightarrow Q = V_0 C \quad \Rightarrow$ A

15 $C_{tot} = \left\{\frac{1}{C} + \frac{1}{C+3C}\right\}^{-1} = \frac{4C}{5}$

$\Rightarrow Q = \frac{3}{4}\cdot V_0\cdot\frac{4C}{5} = 3V_0C/5 \quad \Rightarrow$ C

16 $\tau = RC = 10\cdot 10^{-3}\,s = 0.01\,s = 10\,ms$

$\Rightarrow t \sim$ "noen τ" som ~~tilsier~~ betyr at 30 ms må være svaret $\Rightarrow$ B

Mer presist: $Q(t) = V_0C\left(1-e^{-t/RC}\right) = 0.95V_0C$

$\Rightarrow 0.05 = e^{-t/RC} \Rightarrow \frac{t}{RC} = \ln 20 \Rightarrow t = 10\,ms\cdot\ln 20 = \underline{30\,ms}$

17 $I(t) = \frac{V_0}{R}e^{-t/RC} \Rightarrow I(0^+) = V_0/R = \frac{3}{10}A = \underline{0.30A} \quad \Rightarrow$ B

18 $d\vec{p} = \hat{z}\cdot dq\cdot 2|z(x)| = \hat{z}\cdot\sigma\cdot dy\cdot R\,d\theta\cdot 2\sqrt{R^2-x^2}$

$x = R\cos\theta \Rightarrow$ ~~$dx = -R\sin\theta\,d\theta$~~, $\sqrt{R^2-x^2} = R\sin\theta$

$\Rightarrow \vec{p} = \hat{z}\,\sigma R^2\cdot\int_0^L dy\cdot 2\int_0^\pi \sin\theta\,d\theta = \hat{z}\cdot 2L\sigma R^2\Big|_0^\pi -\cos\theta = \hat{z}\cdot 4L\sigma R^2$

$\Rightarrow \vec{p}/L = 4\sigma R^2\hat{z}$

$\Rightarrow$ B

Evt: $\pm Q = \pm\sigma\cdot\pi R\cdot L$; $\langle\Delta\vec{z}\rangle \overset{(\gtrsim?)}{\simeq} \hat{z}\cdot R \Rightarrow \vec{p}/L \overset{(>?)}{\approx} \pi R^2\sigma \Rightarrow$ B...

(19) For rett leder: $R = \frac{\ell}{\sigma A}$ ($\Rightarrow G = \sigma A/\ell$)

$\Rightarrow$ For sylinderskall med radius r, tykkelse dr, lengde L:

$$dR = dr/(\sigma \cdot 2\pi r \cdot L) = \frac{1}{2\pi\sigma L}\frac{dr}{r}$$

$$\Rightarrow R = \int dR = \frac{1}{2\pi\sigma L}\int_a^b \frac{dr}{r} = \frac{1}{2\pi\sigma L}\ln b/a$$

(Seriekobling!)

$\Rightarrow G = 2\pi\sigma L / \ln(b/a) \quad \Rightarrow$ D

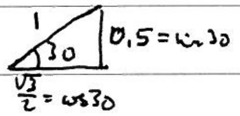
(20) Sirkelbevegelse, med radius bestemt ved at

$$mv^2/r = qvB \quad \Rightarrow r = mv/qB$$

Her er $v = \sqrt{v_0^2 + v_0^2} = \sqrt{2}\, v_0 \Rightarrow r = \sqrt{2}\, m v_0/qB \quad \Rightarrow$ B

(21) $B = \mu_0 n I = 4\pi\cdot 10^{-7}\cdot\frac{2000}{0.3142}\cdot 2 \text{ T} = 16\cdot 10^{-3}\text{ T} = 16\text{ mT} \quad \Rightarrow$ B

(22)



$\Rightarrow$ areal: $A = 1\cdot\sqrt{3} + \frac{1}{2}\cdot\sqrt{3} = \frac{3}{2}\sqrt{3}\text{ cm}^2 \simeq 2.6\text{ cm}^2$

$\Rightarrow |\vec{m}| = I\cdot A \simeq \underline{2.6\text{ A cm}^2} \quad \Rightarrow$ C

(23) $Z_C = 1/\omega C = \frac{1}{10^6\cdot 200\cdot 10^{-9}} = \frac{1000}{200} = \underline{5\,\Omega} \quad \Rightarrow$ D

(24) $Z_L = \omega L = 10^6\cdot 200\cdot 10^{-12}\,\Omega = 2\cdot 10^{-4}\,\Omega = 0.2\text{ m}\Omega \quad \Rightarrow$ A

(25) $I(t) = \frac{V_0}{R}(1 - e^{-t/\tau})$ der $\tau = L/R = \frac{10^{-6}}{10^{-3}}\text{ s} = 10^{-3}\text{ s} = 1\text{ ms}$

$\Rightarrow \frac{V_0}{R}(1 - e^{-t/\tau}) = 0.8\frac{V_0}{R} \Rightarrow e^{-t/\tau} = 0.2 \Rightarrow e^{t/\tau} = 5$

$\Rightarrow t = \tau\cdot\ln 5 \simeq 1.6\tau = \underline{1.6\text{ ms}} \quad \Rightarrow$ B