Quiz 3

1. equipotential have no work on line
electric field represent gradient of energy
if ~~this~~ electric field have component on potential line
⇒ contradict

+2

2. electric energy in $\vec{E}$ field

4 2

3. 

$$V = \sum_i \frac{k q_i}{r_i} = 9\cdot 10^9 \times 4\times 10^{-6} C$$

4

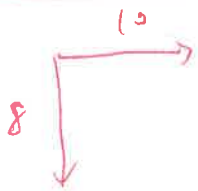
$$\sqrt{(10^{-2})^2 + (2\cdot 10^{-2})^2} + 10^{-2}$$

$$\approx \frac{9\cdot 10^9 \cdot (4+8)\cdot 10^{-6}}{\sqrt{5}\cdot (10^{-2})^2} \cong 4.8\cdot 10^6 \text{ V}$$

2

4

4. $\sqrt{10^2 + 8^2} = 12.8 N$ 4



$$\tan\frac{-8}{10} = -38.66^\circ$$

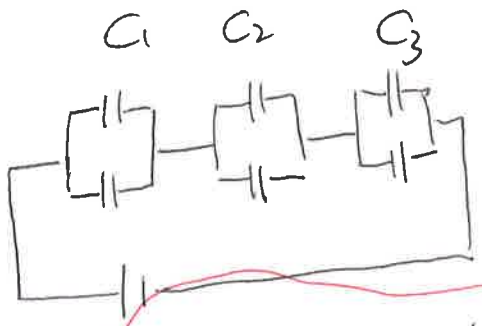
4 2

total = 24

Quiz 4

15 point total

(a)



$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ (3)

$C_1 = C_2 = C_3 = 10 + 5\ pF$ (3)

$\frac{1}{C_{tot}} = \frac{1}{15} + \frac{1}{15} + \frac{1}{15}$

$= \frac{3}{15} \Rightarrow C_{tot} = 5\ pF$ (1)

(b) $Q = CV = 5 \cdot 9 = 45\ pC$ (3) (1)

(c) $\frac{1}{2}CV^2 = \frac{1}{2} \cdot 5 \cdot 9^2$ (3)

$= 405\ pJ$ (1)

20 2.5

Q5

1. $V = IR + \frac{Q}{C} = R\frac{dQ}{dt} + \frac{Q}{C}$

inhomogeneous: $Q = at + b \Rightarrow V = aR + \frac{at+b}{C}$

③ $\Rightarrow a = 0,\ b = CV$

homogeneous: $0 = R\frac{dQ}{dt} + \frac{Q}{C} \quad Q = Ae^{\alpha t}$

③ $\Rightarrow \left(AR\alpha + \frac{A}{C}\right)e^{\alpha t} = 0$

$\Rightarrow \alpha = -\frac{1}{RC}$

$\Rightarrow Q(t) = Ae^{-\frac{t}{RC}} + CV$

$Q(0) = 0,\ I(0) = \frac{V}{R} \Rightarrow A = -CV$

② $\Rightarrow Q(t) = CV\left(1 - e^{-\frac{t}{RC}}\right)$

1. (a) $Q(t) = CV \cdot 0.9$ ①

$\Rightarrow 1 - e^{-\frac{t}{RC}} = 0.9,\ e^{-\frac{t}{RC}} = 0.1$

$t = 1.38 \cdot 10^{-7}\,s$ ①

(b) $I(t) = \frac{V}{R}e^{-\frac{t}{RC}}$ ④ $= \frac{12}{10} \cdot 0.1 = 0.12\,A$ ①

2. $F = q\vec{v} \times \vec{B} = ??$ $\quad I = \frac{\Delta Q}{\Delta t} \Rightarrow F = IBl$ ⑧

$F = 0.3 \cdot 0.5 \cdot 2 = 0.3\,N$ ①

Q7

1. (a) $\omega = \frac{1}{\sqrt{LC}} = 1.414 \cdot 10^5$ 4 1

(b) $U = \frac{Q^2}{2C} + \frac{1}{2}LI^2 = \frac{Q_{max}^2}{2C}(\cos \omega t)^2 + \dots$ 4 4

$Q_{max} = CV$

$\frac{1}{2}CV^2 = \frac{1}{2} \cdot 144 \cdot 5 \cdot 10^{-12}$ $3.6 \cdot 10^{-10}$ J 2

(c) $\frac{U\cos^2(\omega \cdot 5)}{U}$ 4

$\Rightarrow \cos^2(\omega t) = 0.94$ 1

$\omega \cdot 5 = \frac{5}{\sqrt{5 \cdot 10^{-11}}} = \sqrt{\frac{1}{5 \cdot 10^{-11}} \cdot 25 \cdot 5}$

$= \sqrt{5 \cdot 10^{11}}$

Xtra Q1

$\omega = \frac{1}{\sqrt{LC}} = 6 \cdot 10^4$ Hz

4 1

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$ (4)

$$X_L = \omega L \qquad X_C = \frac{1}{\omega C}$$ (4)

$$\phi = \tan^{-1}\left(\frac{(X_L - X_C)}{R}\right)$$

Q8

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = 8\,\Omega$$ (2)

ωL (4) $\frac{1}{\omega L}$

$\tan^{-1}\left(\frac{X_L - X_C}{R}\right)$ (4)

~~-0.11 rad~~ ~~0.82 rad~~ 0.0014 rad

~~$-47° - 63°$~~ $0.08°$ (2)

Q8 b:

(+4)

$$Z^2 = R^2 + (X_L - X_C)^2 \qquad \omega = 2\pi f$$

$$Z^2 - R^2 = \left(\omega L - \frac{1}{\omega C}\right)^2$$

$$\omega L = \sqrt{Z^2 - R^2} + \frac{1}{\omega C}$$

$$L = \frac{1}{\omega}\left(\sqrt{Z^2 - R^2} + \frac{1}{\omega C}\right) = 0.12\ \text{H}$$ (+1)

Q10 extra:

$d\theta \simeq (n+\frac{1}{2})\lambda$

(a) $d\theta \simeq \frac{1}{2}\lambda$ (4) $\theta = 325 \cdot 10^{-3}$ (1) $= 0.186^\circ$

(b) $d\theta \simeq \frac{5}{2}\lambda$ (1) (2) $\theta = 1625 \cdot 10^{-3}$ (1) $= 0.93^\circ$

Q10

1. $n_w \sin\theta_w = n_d \sin\theta_d$ (12)

$1.3 \sin 35^\circ = n_d \sin 12^\circ = 3.58$ (3)

2. $c = \lambda f$ (4) $\lambda = 500 \cdot 10^{-9}$

$f = \frac{3 \cdot 10^8}{500 \cdot 10^{-9}} = 6 \cdot 10^{14}\ Hz$ (1)