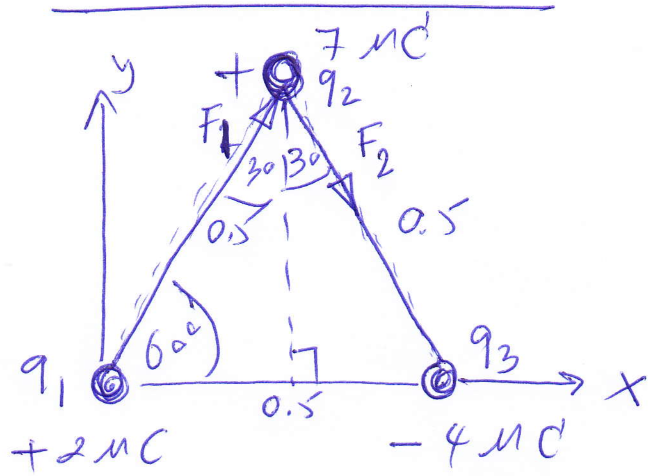
เฉลย ไฟฟ้าสถิต

1



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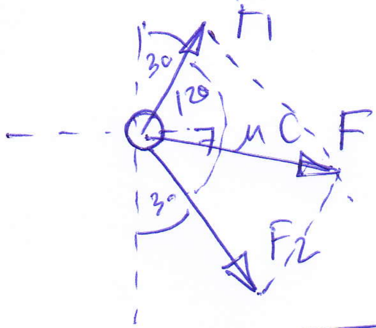

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos 120^\circ}$$

$$F_1 = \frac{kq_1q_2}{r_{12}^2} = \frac{9\times10^9 \times (2\times10^{-6})(7\times10^{-6})}{(0.5)^2} \quad — ①$$

$$F_2 = \frac{kq_2q_3}{r_{23}^2} = \frac{9\times10^9 \times (7\times10^{-6})(4\times10^{-6})}{(0.5)^2} \quad — ②$$

$$\cancel{F = \sqrt{(9\times10^9 \times 2\times10^{-6} \times}}$$

$$F_1 = 0.504 \text{ N} \quad , \quad F_2 = 1.008 \text{ N}$$

$$F = \sqrt{(0.504)^2 + (1.008)^2 - \frac{2}{2}(0.504)(1.008)}$$

$$= 0.873 \text{ N}$$

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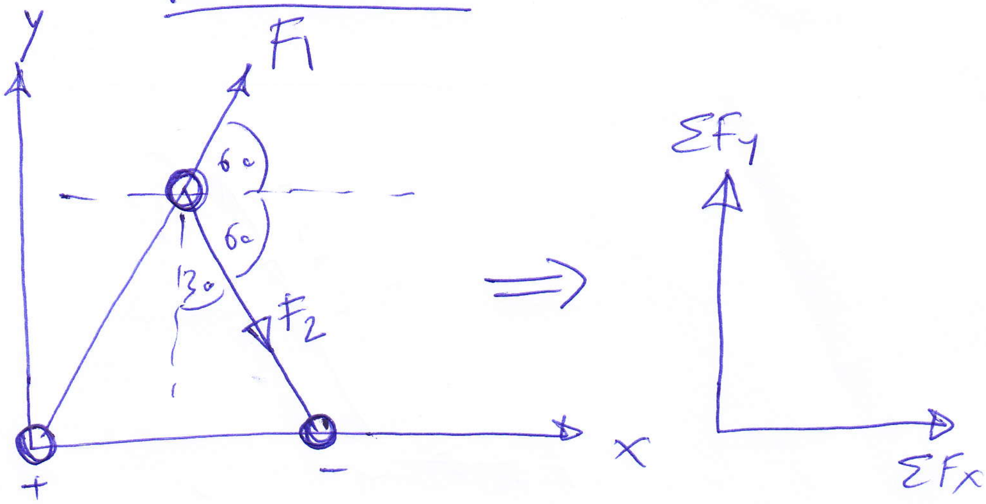


$$\Sigma F_x = F_1 \cos 60^\circ + F_2 \cos 60^\circ$$

$$= [F_1 + F_2] \cos 60^\circ = (0.504 + 1.008)\frac{1}{2}$$

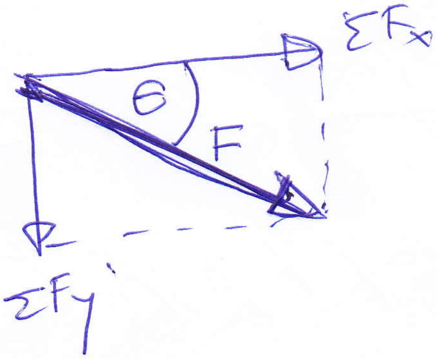
$$= 0.756 \text{ N}$$

$$\Sigma F_y = F_1 \sin 60^\circ - F_2 \sin 60^\circ$$

$$= [F_1 - F_2] \sin 60^\circ$$

$$= (0.504 - 1.008)\frac{\sqrt{3}}{2} = -0.436 \text{ N}$$

$\Rightarrow$



$$F = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$$

$$= \sqrt{(0.756)^2 + (+0.436)^2}$$

$$= 0.873 \text{ N}$$

$$\tan\theta = \left|\frac{\Sigma F_y}{\Sigma F_x}\right| = \frac{0.436}{0.756} = 0.577$$

$$\theta = \tan^{-1}(0.577) = 30^\circ$$

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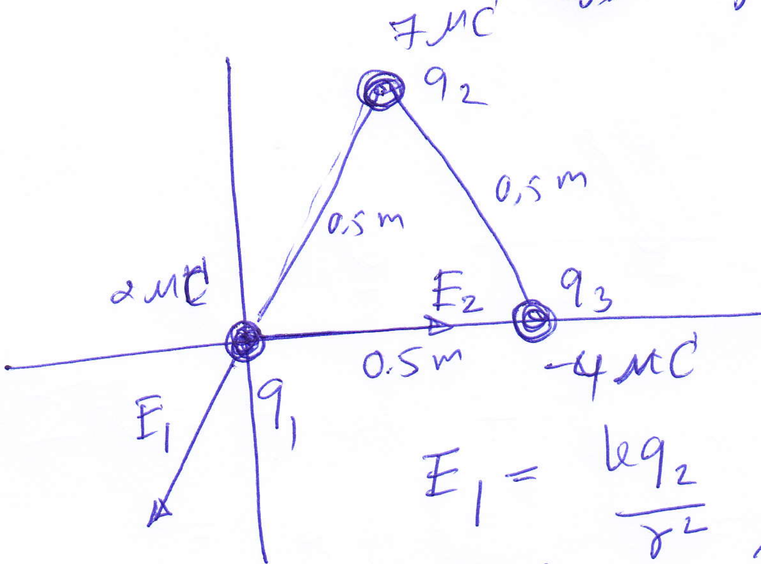
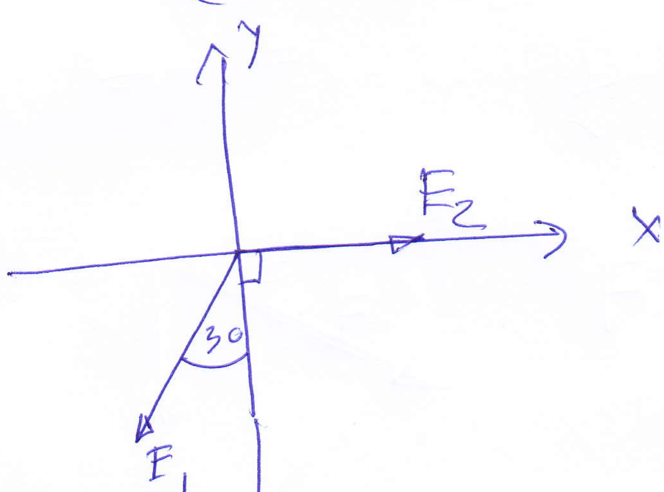
(b) حل $E = \frac{kq}{r^2}$



$$E_1 = \frac{kq_2}{r^2}, \quad E_2 = \frac{kq_3}{r^2}$$

$$E_1 = \frac{9\times10^{9}\times7\times10^{-6}}{(0.5)^2} = 252,000 \text{ N/C}$$

$$E_2 = \frac{9\times10^{9}\times4\times10^{-6}}{(0.5)^2} = 144,000 \text{ N/C}$$

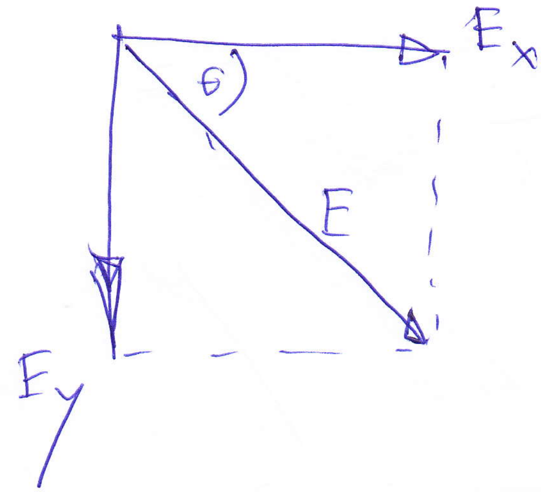


$$E_x = E_2 - E_1\sin30^\circ = 144,000 - 252,000\times\frac{1}{2}$$

$$= 144,000 - 126,000 = 18,000 \text{ N/C}$$

$$E_y = -E_1\cos30^\circ = -252,000\times\frac{\sqrt{3}}{2} \text{ N/C}$$

$$= -218,238.4 \text{ N/C}$$



$$E = \sqrt{E_x^2 + E_y^2} = \sqrt{(18{,}000)^2 + (218{,}238.4)^2}$$

$$= 218{,}979.4 \ N/C$$

$$\tan\theta = \left|\frac{E_y}{E_x}\right| = \frac{218{,}238.4}{18{,}000} = 12.12$$

$$\theta = \tan^{-1}(12.12) = 85.3^\circ \qquad \#$$

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d) $$F = qE$$

$$= 2\times10^{-6} \times 218979.4$$

$$= 0.438 \quad N.$$

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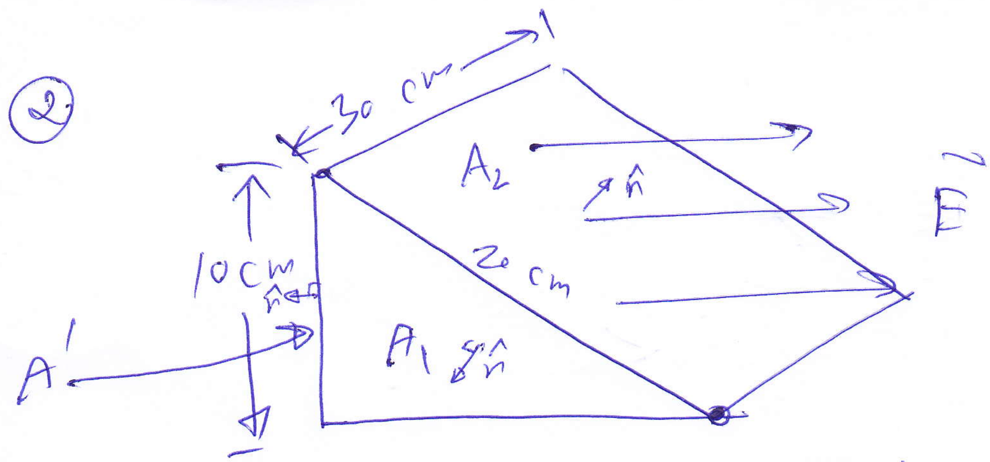
(2)



(a) จาก $\Phi_a = \vec{E}\cdot\vec{A} = +\vec{E}\cdot\hat{n}A'$

$$= +EA'\cos 180^\circ$$

A' มีทิศ ตรงกันข้าม $\vec{E}$

$$\Rightarrow \Phi_a = -EA' = -(7.8\times10^4)(10\times10^{-2}\times30\times10^{-2})$$

$$= -2340 \ \mathrm{Nm^2/C}$$

(b) จาก $\Phi_b = \vec{E}\cdot\vec{A_1} + \vec{E}\cdot\vec{A_1} + \vec{E}\cdot\vec{A_2}$

$$= 0 + 0 + EA_2 \, 60^\circ$$

$\vec{E} \perp \vec{A_1}$, $\vec{E}$ ทำมุม 60° กับ $\vec{A_2}$ $\quad \downarrow A'$

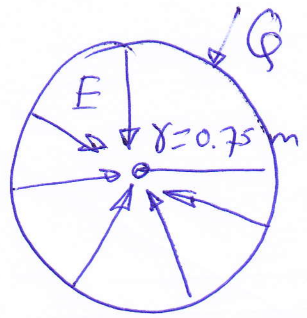
$$\Rightarrow \Phi_b = (7.8\times10^4)(30\times10^{-2}\times20\times10^{-2})\frac{1}{2}$$

$$= 2340 \ \mathrm{Nm^2/C}$$

(c) $\Phi_{total} = \Phi_a + \Phi_b = -2340 + 2340$

$$= 0 \ \mathrm{Nm^2/C} \ \#$$

3



$$E = \frac{kQ}{r^2}$$

แทนค่า $E = 890 = \dfrac{9\times10^{9}\,Q}{(0.75)^2}$

$$Q = \frac{890\times(0.75)^2}{9\times10^{9}} = 5.56\times10^{-8}\ C$$

ประจุบนผิวทรงกลม เกิดจากประจุ $-Q$ ที่จุดศูนย์กลางของทรงกลม #

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4 ประจุทั้งหมดใน ~~...~~ ลูกบาศก์นี้ มีค่าเท่ากับ $Q - 6q_1$

$$Q_{total} = 5\times10^{-6} - 6(1\times10^{-6})\ C$$
$$= -1\times10^{-6}\ C = -1\,\mu C$$

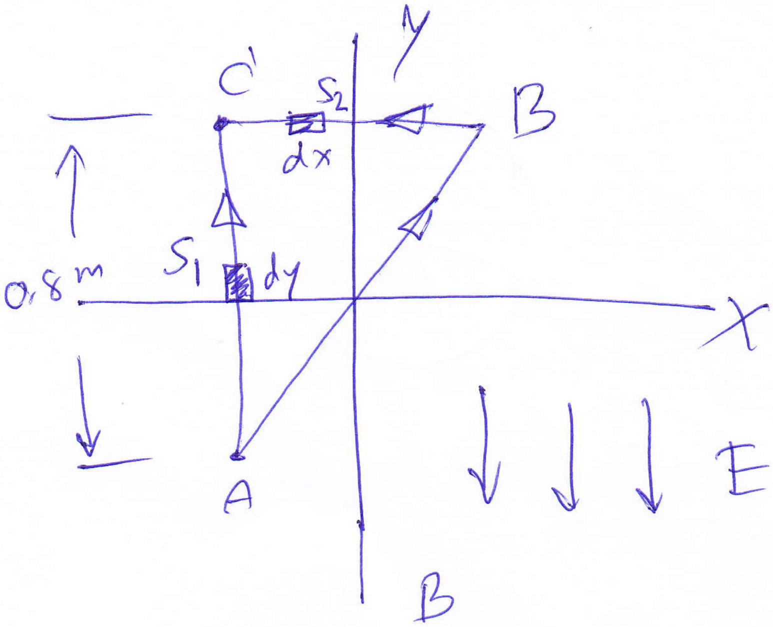
จาก Φ ที่ออกจากผิวทั้งหมด (6 ผิว)

$$\Phi = \frac{Q_{total}}{\varepsilon_0} = \oint E\,dA$$

ฟลักซ์ผ่าน 1 ผิว $= \dfrac{Q_{total}}{6\varepsilon_0} = \dfrac{-1\times10^{-6}}{6\times8.85\times10^{-12}}$

$= 18,832.4\ N\cdot m^2$ #

5



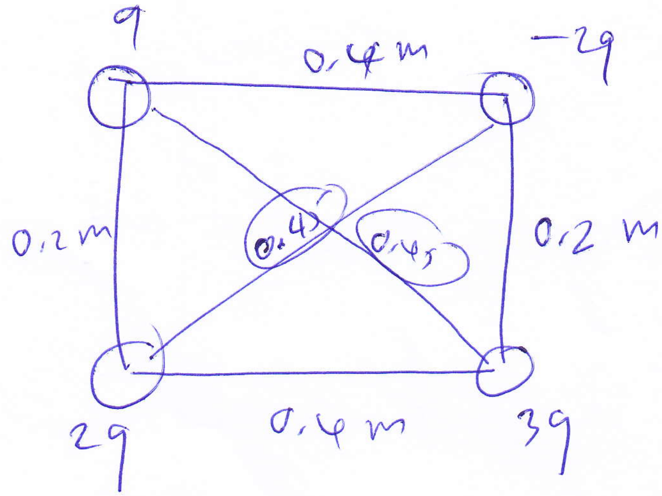
$$V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{s} = -\int_A^C \vec{E}\cdot d\vec{s} - \int_C^B \vec{E}\cdot d\vec{s}$$

$$V_B - V_A = -\int_A^C E\cdot dy\cos 180^\circ - \int_C^B E\,dx\,\cancel{\cos 90^\circ}^{\,0}$$

$$= +ES_1 = 325\times 0.8$$

$$= 260\ \mathrm{V} \qquad \#$$

⑥



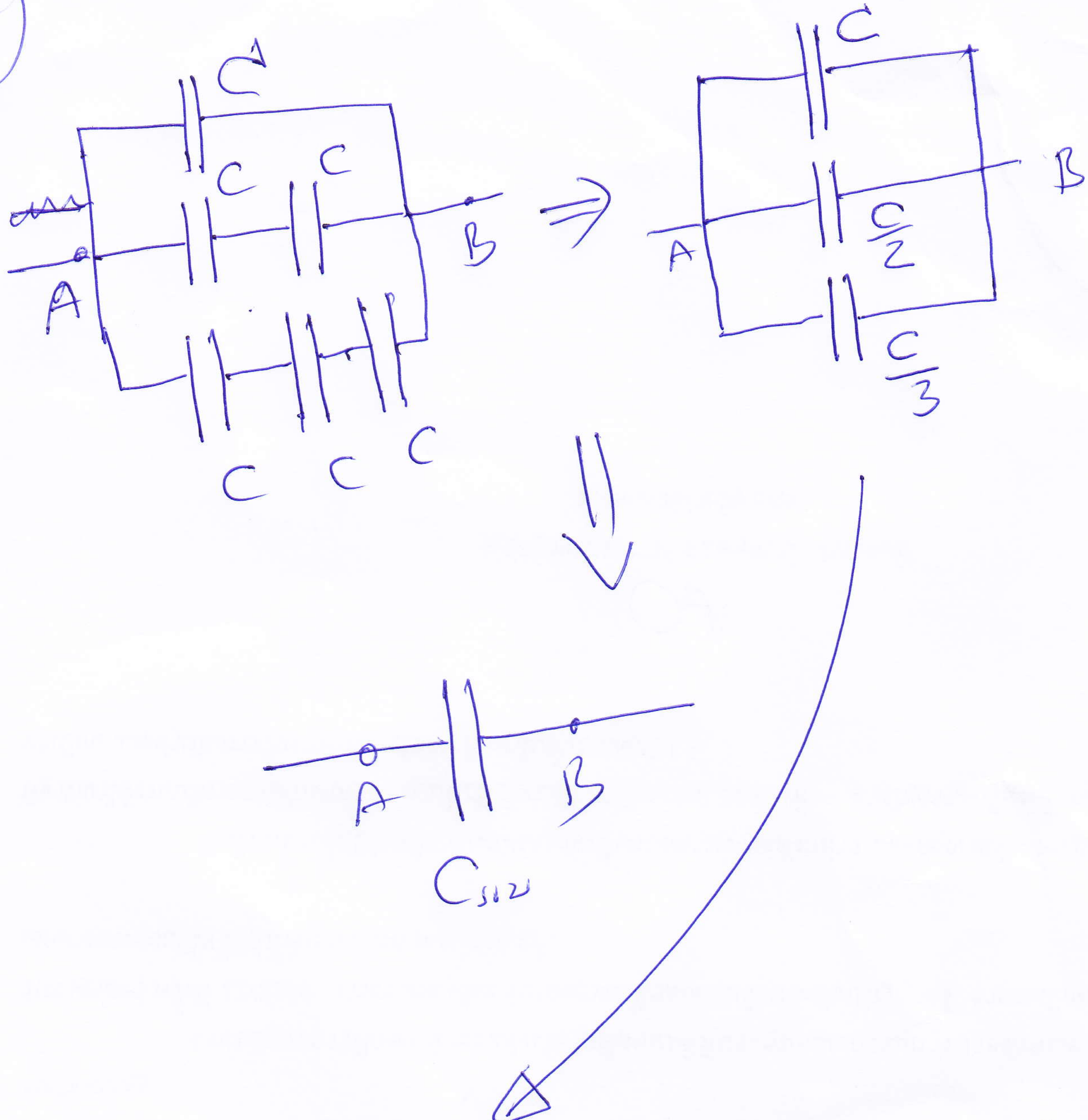
$$W = \frac{kq(2q)}{(0.2)} + \frac{kq(-2q)}{(0.4)} + \frac{k(2q)(3q)}{(0.4)} + \frac{k(-2q)(3q)}{(0.2)} + \frac{kq(-2q)}{(0.45)} + \frac{k(3q)(q)}{(0.45)}$$

$$W = kq^2 \left[10 - 5 + 15 - 30 - 8.9 + 6.7 \right]$$

$$= 9\times10^9 \times (6\times10^{-6})^2 \times (-12.2)$$

$$= -3.95\ J \quad \#$$

7



$$C_{\text{รวม}} = C + \frac{C}{2} + \frac{C}{3} = \left[\frac{6+3+2}{6}\right] C$$

$$= \frac{11}{6} C \quad \#$$

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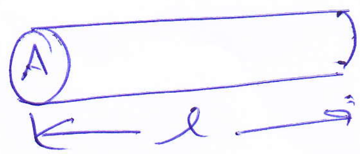
ข้อ 8 — 13

(8)

จาก $I = nevA$

$n \equiv$ จำนวนประจุต่อปริมาตร

$= \frac{N}{V} = \frac{1}{V} =$ (N = 1 ตัว)



$V = Al$

ปริมาตร = $\frac{\text{มวล}}{\text{ความหนาแน่น}} = \frac{m}{\rho}$

แทนค่า $v = \frac{I}{neA} = \frac{I}{\frac{1}{V}eA} = \frac{IV}{eA}$

$= \frac{Im}{eA\rho}$

Aluminum 1 อะตอม มวล $\frac{27\ g}{N_A} = \frac{27\ g}{6.02 \times 10^{23}\ \text{อะตอม}}$

$= 4.49 \times 10^{-23}\ g/\text{อะตอม}$

แทนค่า

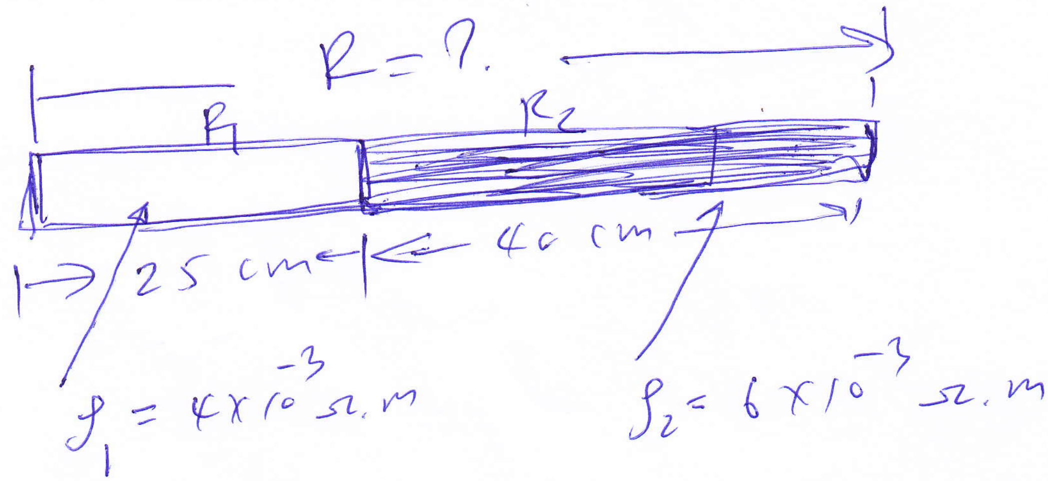
$v = \frac{5 \times 4.49 \times 10^{-23}\ g/\text{อะตอม}}{1.6 \times 10^{-19} \times 4 \times 10^{-6} \times 2.7\ g/cm^3}$ ($cm^3 = 10^{-6}\ m^3$)

$= \frac{5 \times 4.49 \times 10^{-23} \times 10^{-6}}{1.6 \times 10^{-19} \times 4 \times 10^{-6} \times 2.7}\ m/s$

$= 1.3 \times 10^{-4}\ m/s = 0.13\ mm/s$

#

9



$R_1 = \rho_1 \frac{l_1}{A}$, $R_2 = \frac{\rho_2 l_2}{A}$

ดังนั้น $R = R_1 + R_2$

$= \frac{1}{A}\left[\rho_1 l_1 + \rho_2 l_2\right]$

$A = (3\times10^{-3})^2 \, m^2$

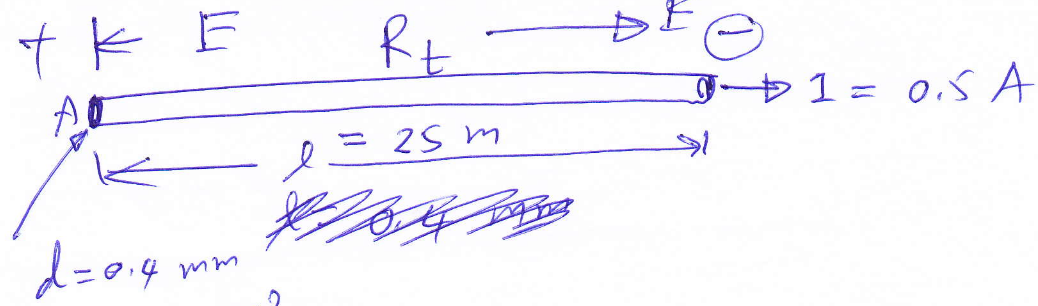
$\Rightarrow R = \frac{1}{9\times10^{-6}}\left[4\times10^{-3}\times25\times10^{-2} + 6\times10^{-3}\times40\times10^{-2}\right]$

$= \frac{10^{-5}}{9\times10^{-6}}\left[100 + 240\right] = \frac{3400}{9}$

$= 377.8 \ \Omega$ #

10

(a)



$$A = \frac{\pi d^2}{4}$$

จาก $$E = \frac{V}{l} = \frac{IR}{l} = \frac{I \rho \cancel{l}}{\cancel{l} A}$$

ความต้านทาน $\rho = 1.5 \times 10^{-6}\ \Omega.m$

$$\Rightarrow E = \frac{0.5 \times (1.5 \times 10^{-6})}{\pi \frac{(0.4 \times 10^{-3})^2}{4}}$$

$$= 5.97 \ V/m \quad \#$$

(b)

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$= I^2 \rho \frac{l}{A} = \frac{(0.5)^2 (1.5 \times 10^{-6})\, 25}{\pi \frac{(0.4 \times 10^{-3})^2}{4}}$$

$$= 74.6 \ W$$

หรือ $E = \frac{V}{l} \Rightarrow V = El$

$= 5.97 \times 25$

$= 149.25$ โวลท์

$$P = IV = (0.5)\, 149.25 = 74.6 \ W. \ \#$$

(c)

$$R_t = R_0(1+\alpha\Delta T)$$

$$\Delta T = T - T_0 = 340 - 20$$
$$= 320 \ ^\circ C$$

α වල ~~[illegible]~~ තියනවා

$$= 0.4\times10^{-3} \ (^\circ C)^{-1}$$

$$R_0 = \rho\frac{l}{A} = \frac{1.5\times10^{-6}\times25}{\frac{\pi\,(0.4\times10^{-3})^2}{4}}$$

$$= 298.6 \ \Omega$$

$$R_t = 298.6\left[1 + 0.4\times10^{-3}\times320\right]$$
$$= 336.8 \ \Omega$$, V ගත්

(d)

$$P = \frac{V^2}{R} = \frac{149.25\times149.25}{336.8}$$

$$= 66.3 \ W$$ #

(11)

(a) หลอดไฟ A และ B จะสว่างเท่ากัน
เนื่องจากกระแสไหลเท่ากัน

(b) หลอด C จะดับ เนื่องจากไม่มีกระแสไหล
ผ่าน (กระแสจะผ่าน S แทน เพราะมี
ความต้านทานน้อยกว่า)

(c) ความต่างศักย์ที่คร่อมหลอด A และหลอด B
จะเท่ากัน แต่ความต่างศักย์ที่คร่อม C $\Rightarrow 0$

(d) เนื่องจาก $P = \frac{V^2}{R} = IV$

$= I^2R$

เมื่อ V คงที่ แต่ R ลดลงตลอด $\Rightarrow$ P เพิ่มขึ้น

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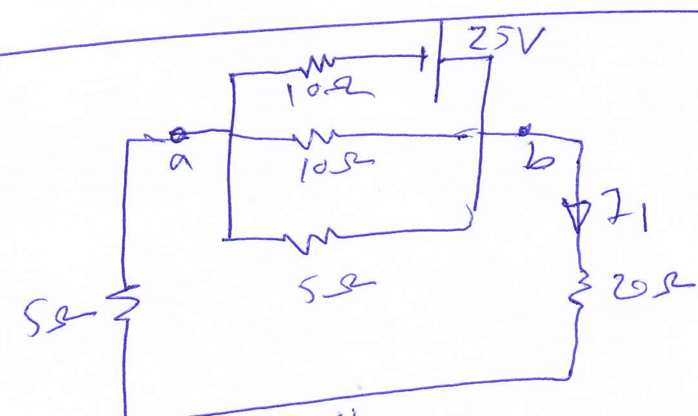
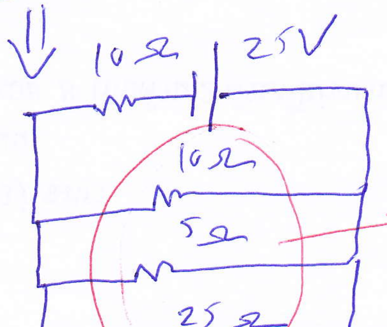
(12)

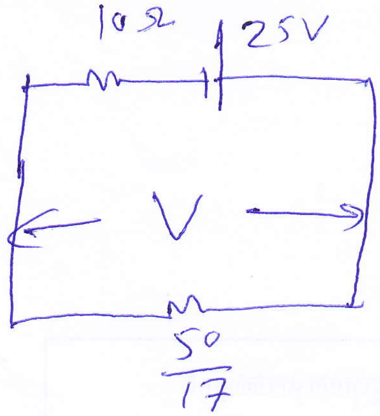




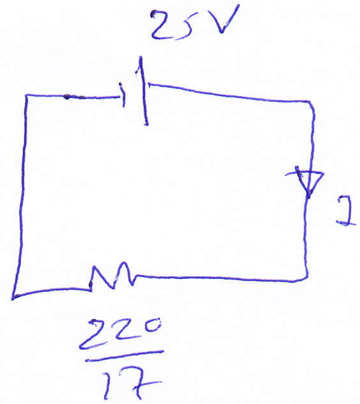
$\frac{1}{10} + \frac{1}{5} + \frac{1}{25} = \frac{5+10+2}{50}$

$= \frac{17}{50}$

$\Rightarrow$



$\Rightarrow$



$$10 + \frac{50}{17} = \frac{170+50}{17}$$

$$= \frac{220}{17}$$

$$I = \frac{\Sigma E}{\Sigma R} = \frac{25}{\frac{220}{17}}$$

$$I = \frac{17 \times 25}{220} = 1.93\ A$$

ແລ້ວ $V = IR = 1.93 \times \frac{50}{17} = 5.68\ V$

ຫາ $I_1 = ?$

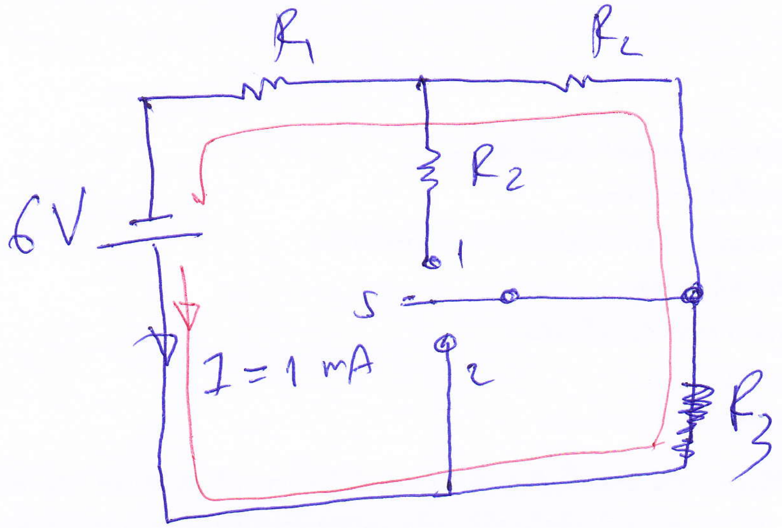
$$I_1 = \frac{V}{R} = \frac{5.68}{25} = 0.227\ A \quad \#$$

$$= 227\ mA$$

(b) [illegible]

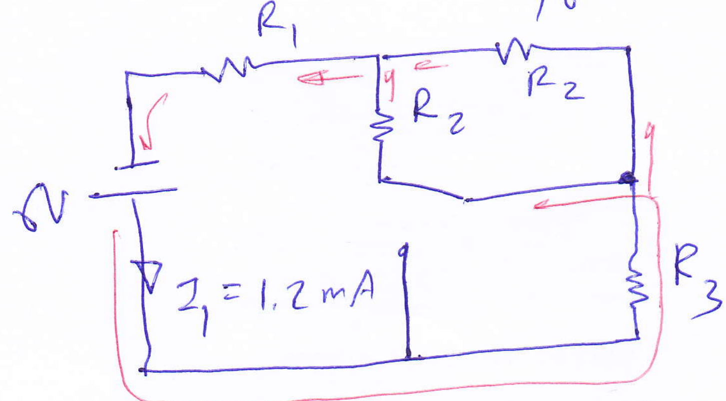
5.68 V

(13)



$$\Rightarrow \quad I = \frac{\Sigma \mathcal{E}}{\Sigma R} = \frac{6}{R_1 + R_2 + R_3} = 1\ mA$$

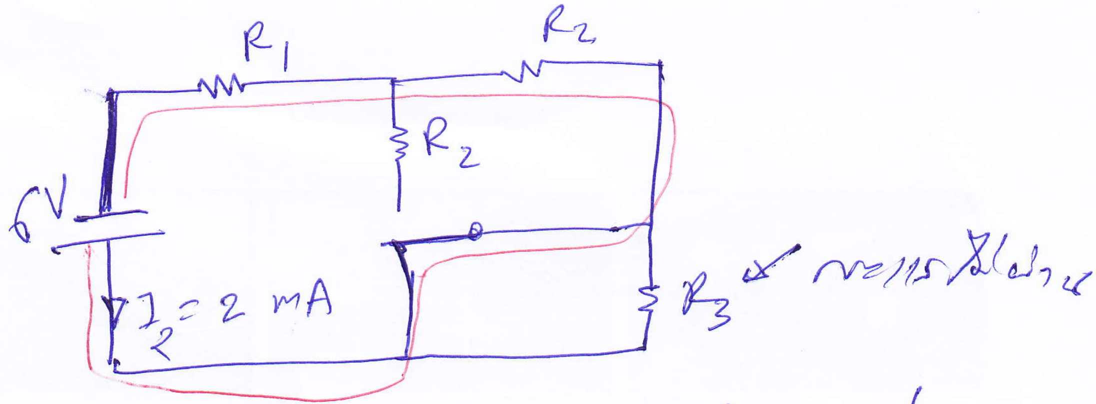
$$\Rightarrow \quad R_1 + R_2 + R_3 = \frac{6}{10^{-3}} = 6000 \quad \text{—— (1)}$$



$$I_1 = 1.2\ mA = \frac{\Sigma \mathcal{E}}{\Sigma R} = \frac{6}{R_1 + R_3 + \frac{R_2}{2}}$$

$$\Rightarrow \quad R_1 + \frac{R_2}{2} + R_3 = \frac{6}{1.2 \times 10^{-3}} = \frac{6000}{1.2} = \frac{60000}{12}$$

$$= \cancel{600}\ 5000 \quad \text{—— (2)}$$



$$I_2 = 2\,mA = \frac{6}{R_1+R_2} \Rightarrow R_1+R_2 = \frac{6}{2\times10^{-3}}$$

$$\Rightarrow R_1+R_2 = 3000 \quad \text{———} \quad (3)$$

[illegible] (1) [illegible] (3) $\quad 3000 + R_3 = 6000$

$$R_3 = 3000\ \Omega \quad \text{———} \quad (4)$$

[illegible] (2) $\Rightarrow$

$$R_1 + \frac{R_2}{2} + 3000 = 5{,}000$$

$$R_1 + \frac{R_2}{2} = 2{,}000 \quad \text{———} \quad (5)$$

(3) − (5) $\Rightarrow \quad \frac{R_2}{2} = 3000 - 2000 = 1000$

$$R_2 = 2{,}000\ \Omega \quad \text{———} \quad (6)$$

[illegible] (3) $\quad R_1 = 3000 - 2000$

$$= 1{,}000\ \Omega \quad \text{———} \quad (7)$$

#

[illegible]

נס׳ 14 – 18

(14) (a) $X_L = \omega L = 2\pi f L$

$= 2\pi \times 50 \times 250 \times 10^{-3}\ \Omega$

$= 78.5\ \Omega$

(b) $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi\, 50 \times 2\times 10^{-6}} = \cancel{79617.8\ \Omega}\ 1592.4\ \Omega$

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

$= \sqrt{(78.5 - \cancel{79617.8})^2 + (150)^2}$

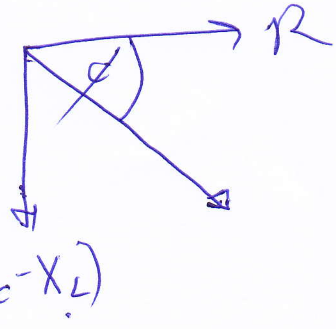
$= 79{,}539.4\ \Omega$

(d) $I = \frac{V}{Z} = \frac{210}{79539.4} = 2.6\ mA$

(e) on s.l phase diagram

$\tan\phi = \left|\frac{X_C - X_L}{R}\right| = \frac{79539.3}{150}$

$= 530.3$



(14) (a) $X_L = \omega L = 2\pi f L$

$= 2\pi \times 50 \times 250 \times 10^{-3}\ \Omega$

$= 78.5\ \Omega$

(b) $X_C = \dfrac{1}{\omega C} = \dfrac{1}{2\pi f C}$

$= \dfrac{1}{2\pi \times 50 \times 2 \times 10^{-6}} = 1592.4\ \Omega$

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

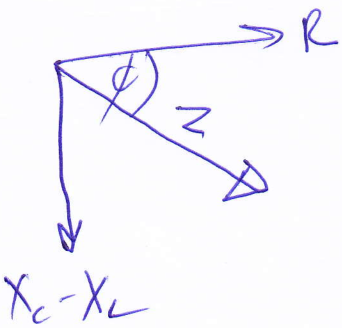
$= \sqrt{150^2 + (78.5 - 1592.4)^2}$

$= 1521.3\ \Omega$

(d) $I = \dfrac{V}{Z} = \dfrac{\cancel{2}210}{1521.3} = 0.138\ A$

$= 138\ mA$

(e)



$\tan\phi = \left|\dfrac{X_L - X_C}{R}\right|$

$= \left|\dfrac{-1513.9}{150}\right| = 10.1$

$\phi = 84.3°$

#

(15) (a) $V_{max} = I_{max} Z$

$R = 500\,\Omega,\ X_L = \omega L\ \ \ X_C = \frac{1}{\omega C}$

ให้ $V_R = I_{max} R = (250 \times 10^{-3}) \times 500$

$= 125\ V$

ที่ $f = 50\ Hz.$

$X_L = 2\pi f L = 2\pi \times 50 \times 400 \times 10^{-3}$

$= 125.6\ \Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 4.43 \times 10^{-6}}$

$= 718.9\ \Omega$

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

$= \sqrt{(500)^2 + (125.6 - 718.9)^2}$

$= 775.9\ \Omega$

$\Rightarrow V_{max} = 250 \times 10^{-3} \times 775.9 = 194\ V$

(b) $\tan\phi = \left|\frac{V_L - V_C}{R}\right| = \left|\frac{-593.3}{500}\right| = +1.19$

$\phi = 49.96°$

มุมเฟสของแรงดัน [illegible] อยู่ 49.96

(16)

$$X_L = \omega L = 2\pi f L = 2\pi \frac{500}{\pi} \times 0.2$$

$$= 200\ \Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi \frac{500}{\pi} \times 11\times10^{-6}}$$

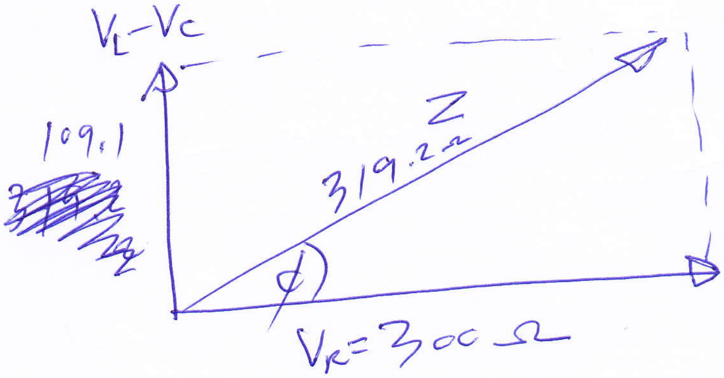
$$= 90.9\ \Omega$$

$$R = 300\ \Omega$$

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

$$= \sqrt{(300)^2 + (200 - 90.9)^2}$$

$$= 319.2\ \Omega$$



$$\tan\phi = \left|\frac{V_L - V_C}{R}\right|$$

$$= \frac{109.1}{300}$$

$$= 0.361$$

$$\phi = \tan^{-1}(0.361)$$

$$= 19.8°$$

#

(17)

$$P_{\text{الفعلية}} = I_{rms} V_{rms} = \frac{V_{rms}^2}{R} = I_{rms}^2 R$$

$$= \cancel{\quad}$$

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{210}{75} = 2.8 \text{ A}$$

$$P_{\text{الفعلية}} = I_{rms}^2 R = (2.8 \times 2.8)\, 45$$

$$= 352.8 \text{ W}$$

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(18)

$$\Delta V_{max} = 100 \text{ V}$$

$$I_{max} = ? = \frac{\Delta V_{max}}{Z}$$

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

$R = 400\,\Omega$, $\omega = 1000$ rad/s, $L = 0.5$ H, $C = 5\,\mu F$

$$X_L = \omega L = 1000 \times 0.5 = 500\,\Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{1000 \times 5 \times 10^{-6}} = 200\,\Omega$$

$$\Rightarrow Z = \sqrt{(400)^2 + (500-200)^2} = 500\,\Omega$$

$$Z_{mx} = \frac{100 \text{ V}}{500\,\Omega} = 0.2 \text{ A}$$

$$P_{\text{الفعلية}} = I_{rms}^2 R = \frac{(0.2 \times 0.2)(400)}{2}$$

$$= I_{max} I_{max} R = \cancel{20 \text{ W}} \div 2$$