45

2018 - 2017 إعدادي بترم اول Final

خواص مادة

Question (1) 15

(a) Suppose that the acceleration (a) of a particle moving with uniform speed (v) in a circle of radius (r), is proportional to (r^n) and (v^m). Determine the values of n and m and write the simplest form of an equation for the acceleration.

$$a \propto r^n v^m$$

$$\frac{L}{T^2} \propto (L)^n \left(\frac{L}{T}\right)^m$$

$$L T^{-2} \propto L^{n+m} T^{-m}$$

$$-m = -2 \qquad \boxed{m = 2}$$

$$n + m = 1$$

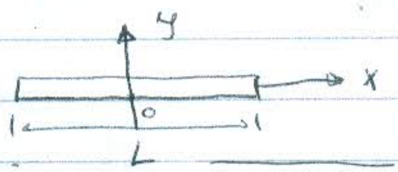
$$n + 2 = 1 \qquad \boxed{n = -1}$$

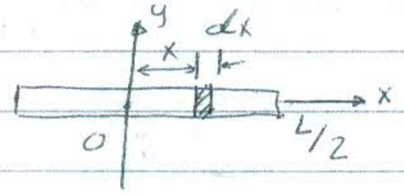
5

$$a \propto r^{-1} v^2$$

$$a = k \frac{v^2}{r} \qquad k: \text{dimensionless constant}$$

(b) Calculate the moment of inertia of a uniform rigid rod of length (L) and mass (M) about an axis ~~pre~~ perpendicular to the rod and passing through its center of mass





$$\rho = \frac{M}{L}$$

$$dm = \rho \, dl$$

$$dm = \frac{M}{L} dl$$

$$\boxed{dm = \frac{M}{L} dx \qquad r^2 = x^2}$$

$$I = \int r^2 dm$$

$$I = \int_{-L/2}^{L/2} \frac{M}{L} x^2 dx$$

5

$$= \frac{M}{L} \left[\frac{x^3}{3}\right]_{-L/2}^{L/2}$$

$$= \frac{M}{3L} \left[\left(\frac{L}{2}\right)^3 - \left(\frac{-L}{2}\right)^3\right]$$

$$= \frac{M}{3\cancel{L}} \, 2 \left[\frac{L^{\cancel{3}\,2}}{8_{\,4}}\right]$$

$$\boxed{I = \frac{1}{12} M L^2}$$

) The position versus time for an object is simple harmonic motion is given by $[x(t) = 0.05 \cos(5t + 0.127\pi)$ m$]$. What is the velocity and acceleration of this object?

$$x(t) = 0.05 \cos(5t + 0.127\pi) \quad m$$

5

$$v(t) = \frac{dx}{dt} = -0.25 \sin(5t + 0.127\pi) \quad m/s$$

$$a(t) = \frac{d^2x}{dt^2} = -1.25 \cos(5t + 0.127\pi) \quad m/s^2$$

Question (2) $\boxed{15}$

(a) A solid steel sphere is initially surrounded by air ($P_0 = 10^5 N/m^2$). The sphere is lowered into the ocean to a depth where the pressure is ($2 * 10^7 N/m^2$). The volume of the sphere in air is ($0.5 m^3$). By how much does this volume change once the sphere is submerged? ($\beta = 20 * 10^{10} N/m^2$)

$$\beta = -\frac{\Delta P}{\Delta V/V} \Rightarrow 20 * 10^{10} = -\frac{2 * 10^7 - 10^5}{\Delta V/0.5}$$

5

$$\Delta V = -0.5 * \frac{(200 * 10^5 - 10^5)}{20 * 10^{10}} = -\frac{0.5 * 199 * 10^5}{20 * 10^{10}} = -5 * 10^{-5} m^3$$

(b) The pressure experienced at a point on the bottom of swimming pool (9m) in depth is (189.5 kpa). What is the density of water? ($P_0 = 10^5$ Pa), ($g = 9.8 m/s^2$)

5

$$P = P_0 + \rho h g$$

$$189.5 * 10^3 = 10^5 + \rho * 9 * 9.8$$

$$\rho = \frac{189.5 * 10^3 - 100 * 10^3}{9 * 9.8} = \frac{89.5 * 10^3}{88.2} = 1014 * 10^3 \ kg/m^3$$

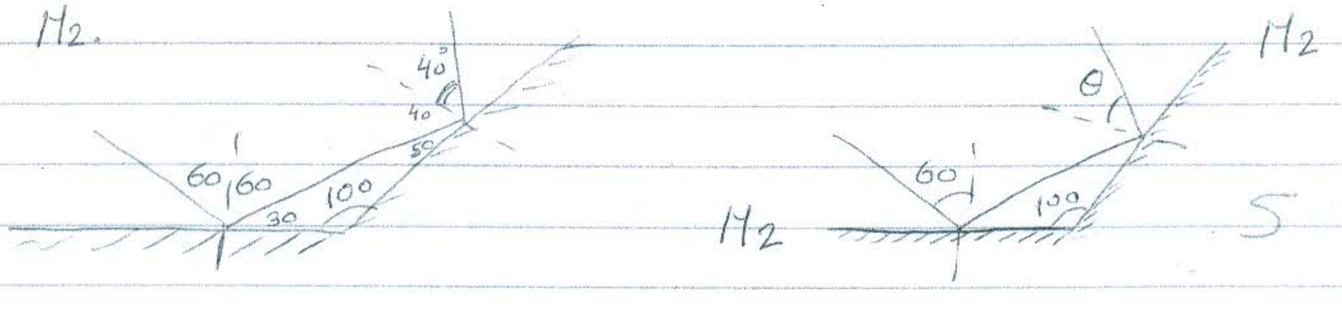
) What is the main assumption of the Ideal fluid flow?

1- non-viscous غير لزج
2- steady flow تدفق مستمر
3- in compressible غير قابل للإنضغاط
4- irrotational ليس به حركات دورانيه

5

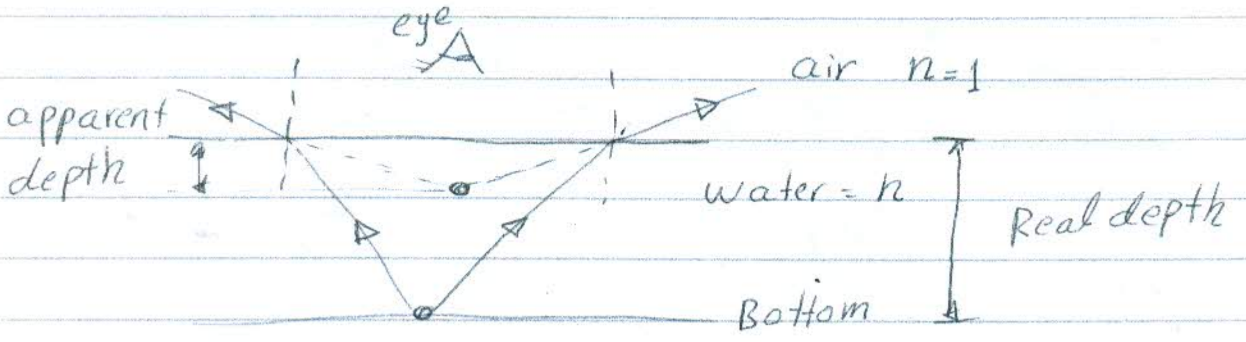
Question (3) $\boxed{15}$

(a) Two mirrors make an angle of (100°) with each other, A ray is incident on mirror M_1 at an angle of (60°). Find the direction of the ray after it is reflected from mirror M_2.



5

(b) Draw a sketch showing the path of light rays from a point on the bottom of a swimming pool to the eye of an observer.



5

(c) An object is placed (15 cm) away from a lens. A virtual image is formed (5 cm) from the lens. Determine the focal length of lens, and the type of lens.

5

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{15} - \frac{1}{5} = \frac{1}{15} - \frac{3}{15} = \frac{-2}{15}$$

$f = -7.5$ cm concave

1

a)

1- $\rho = \frac{Q}{V} = \frac{6.3\times10^{-8}}{\frac{4}{3}\pi r^3} = 7.6\times10^{-4}\ C/m^3$ (e) 2 ①

2- $C = \frac{Q}{V} = \frac{10^{-3}}{100} = 10^{-5} = 10\ \mu F$ (b) 2 ②

3- (a) $C = \frac{\epsilon A}{d}$ (a) 2 ③

4- $R = \frac{\rho L}{A} \rightarrow [\rho] = \Omega \cdot m$ (b) 2 ④

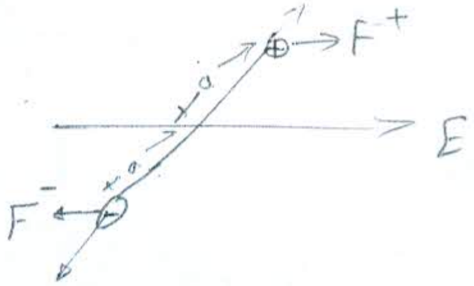
5-  $= 25\Omega$ (b) 2 ⑤

6- $C = \frac{Q}{V} \not\Rightarrow F = \frac{C}{V}$ (c) 2 ⑥

7- $C = \frac{\epsilon A}{d} = \frac{Q}{V}$ ∴ as $A\uparrow$ ∴ $Q\uparrow$ (e) 2 ⑦ 14

b)

2 opposite charge with fixed distance between & equal values.



$P = qd = 2qa$

$\vec{F}^+ = qE\hat{i}$ $\vec{F}^- = -qE\hat{i}$

$\vec{\tau} = r\times F$

$= \vec{r}_+\times\vec{F}^+ + \vec{r}_-\times F^-$

$= \vec{r}_+\times(q\vec{E}\hat{i}) + \vec{r}_-\times(-qE\hat{i}) = (2qa\hat{u})\times\vec{E}$

$= \vec{P}\times\vec{E}$ 4

15

Q5) a) R & $\rho = ar$.

1) $r<R$; $\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$; $q_{in} = \int_0^r \rho\, dV = \int_0^r ar\, 4\pi r^2 dr$

$E\int dA = \frac{ar^4}{4\epsilon_0}$; $= a\int_0^r r^3 dr = a\frac{r^4}{4}\Big|_0^r = \frac{ar^4}{4}$

$E\, 4\pi r^2 = \frac{ar^4}{4\epsilon_0}$ $\boxed{E = \frac{ar^2}{16\pi\epsilon_0}}$ 1

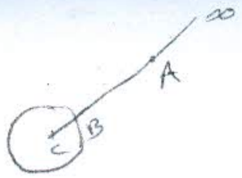
$r>R$

$E\int dA = \frac{aR^4}{4\epsilon_0}$ $= \boxed{E = \frac{aR^4}{16\pi\epsilon_0 r^2}}$ 1

$V_\infty = 0$

$$V = -\int_\infty^r E \cdot dr$$

$$= -\int_\infty^r \frac{aR^4}{16\pi\epsilon_0 r^2} dr = -\frac{aR^4}{16\pi\epsilon_0}\int_\infty^r \frac{dr}{r^2}$$



2

$$= -\frac{aR^4}{16\pi\epsilon_0}\left[\frac{-1}{r}\right]_\infty^r = \boxed{\frac{aR^4}{16\pi\epsilon_0 r}}$$

$r = R$

$$V_R = \frac{aR^3}{16\pi\epsilon_0}$$

$r < R$

$$V - V_R = -\int_R^r \bar{E}\cdot d\bar{r} = -\int_R^r \frac{a r^2}{16\pi\epsilon_0} dr$$

$$V - \frac{aR^3}{16\pi\epsilon_0} = -\frac{a}{16\pi\epsilon_0}\left[\frac{r^3}{3}\right]_R^r$$

$$V - \frac{aR^3}{16\pi\epsilon_0} = \frac{-a}{16\pi\epsilon_0}\left[\frac{r^3}{3} - \frac{R^3}{3}\right]$$

$$\boxed{V = \frac{a}{16\pi\epsilon_0}\left[\frac{4}{3}R^3 - \frac{r^3}{3}\right]}$$

3)

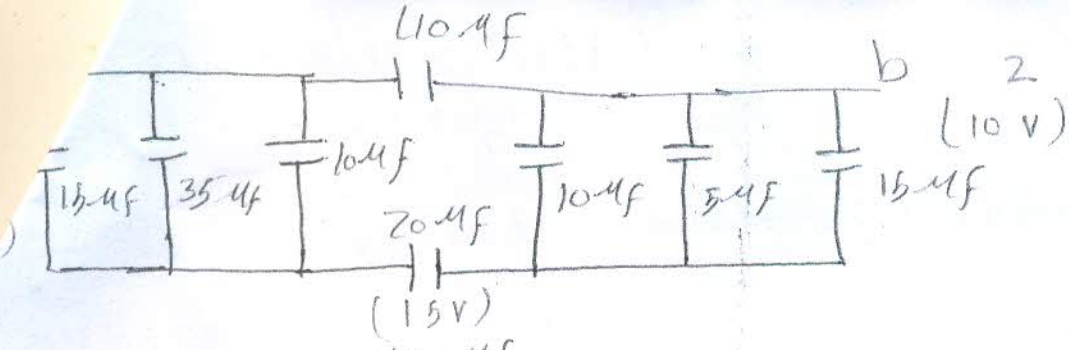
$$U = \int_0^R V\,dq = \int_0^R \frac{a}{16\pi\epsilon_0}\left[\frac{4}{3}R^3 - \frac{r^3}{3}\right] ar\,4\pi r^2\,dr$$

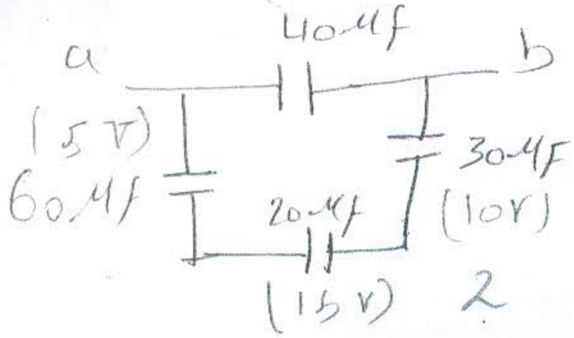
$$= \int_0^R \frac{a^2}{4\epsilon_0}\left[\frac{4}{3}R^3 - \frac{r^3}{3}\right] r^3 dr = \int_0^R \frac{a^2}{4\epsilon_0}\left[\frac{4}{3}R^3 r^3 - \frac{r^6}{3}\right]$$

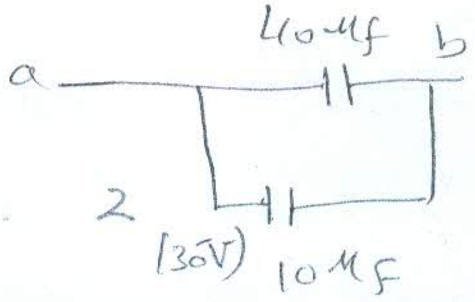
$$= \frac{a^2}{4\epsilon_0}\left[\frac{\cancel{4}}{3*\cancel{4}}R^3 r^4 - \frac{r^7}{21}\right]_0^R = \frac{a^2}{4\epsilon_0}\left[\frac{R^7}{3} - \frac{R^7}{21}\right]$$

$$\frac{\cancel{3}\,\cancel{6}\,a^2R^7}{2\,\cancel{4}*21\cancel{7}} = \boxed{\frac{a^2R^7}{14}} \quad J$$

2







$$\frac{1}{C} = \frac{1+3+2}{60}$$

$$C = 10\mu f$$

$$Q = CV$$
$$= 10 * 30 = 300\mu C$$

$$C_{eq} = 10 + 40 = 50\mu f$$

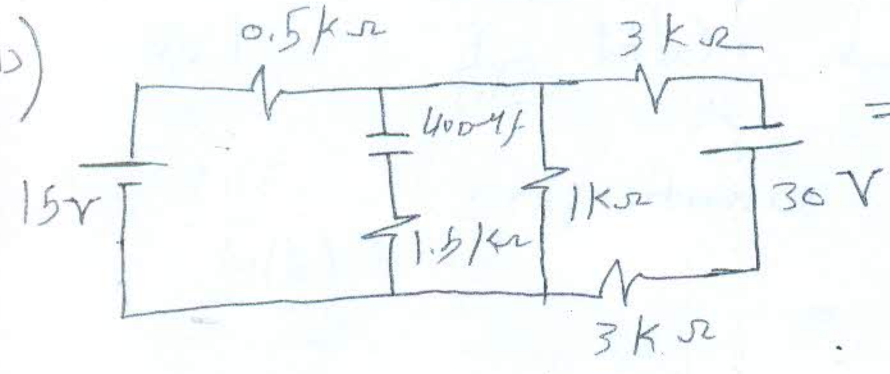
Q6) a) $I = nev_d A \Rightarrow V = IR = I\left(\frac{\rho l}{A}\right)$ 2

$$V = IR$$

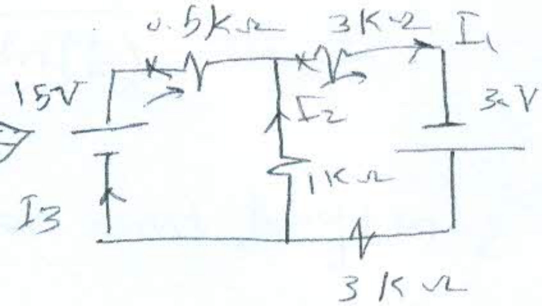
$$12 = 4 * 3 * 10^{20} * 1.6 * 10^{-19} * V_d * \cancel{A}\left(\frac{20 * 200}{\cancel{A}}\right) \quad 2$$

$$V_d = \frac{12}{12 * 1.6 * 4 * 10^4} = 0.156 * 10^{-4}\ cm/s$$

b)



$\Rightarrow$



$I_4 = 0$

$I_1 = I_2 + I_3 \longrightarrow I_1 - I_2 - I_3 = 0$ — ①

$0.5I_3 - I_2 - 15 = 0 \longrightarrow 0 - I_2 + 0.5I_3 = 15$ — ②

$3I_1 - 30 + 3I_1 + I_2 = 0 \longrightarrow 6I_1 + I_2 + 0 = 30$ — ③

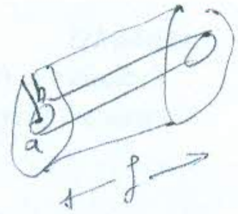
$I_1 = 6.32\,mA\ \frac{3}{475}$ $I_2 = -7.9\,mA\ \frac{3}{380}$ $I_3 = 14.21\,mA\ \frac{27}{1900}$

$|\Delta V_{ab}| = 7.9\,V \qquad Q = CV = 0.00317\,C$

$$U = \frac{1}{2}CV^2 = \frac{1}{2} * 400 * 10^{-6} * (7.9)^2 = 0.125\,J$$

- The electric field inside it is zero (1.5) 4
- ~ Charge ~ ~ ~ ~ (1.5)
- ~ Tangential component of the electiric fied on the surface is zero (1.5)
- Equipotential surface or $E = E_n$ (1.5)

5-b) for $a < r < b$



$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{en}}{\epsilon_0}$$

$$E \int dA = \frac{\lambda \ell}{\epsilon_0}$$

$$E \, 2\pi r \ell = \frac{\lambda \ell}{\epsilon_0} \rightarrow \boxed{E = \frac{\lambda}{2\pi \epsilon_0 r}} \quad (2)$$

$$\Delta V_{ab} = -\int_a^b \vec{E} \cdot dr = -\frac{\lambda}{2\pi\epsilon_0} \int_a^b \frac{dr}{r} = \boxed{\frac{-\lambda}{2\pi\epsilon_0} \ln\left(\frac{b}{a}\right)} \quad (2)$$

$$C = \frac{Q}{|\Delta V|} = \frac{\lambda \ell}{\frac{\lambda}{2\pi\epsilon_0} \ln\left(\frac{b}{a}\right)} = \boxed{\frac{2\pi\epsilon_0 \ell}{\ln\left(\frac{b}{a}\right)}} \quad (2)$$

$$C = \frac{2\pi\epsilon_0}{\ln\left(\frac{b}{a}\right)}$$ = capacitance per unit length