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Prodi : Pendidikan fisika (B)

Lembar Jawaban

4.1) a.) $\vec{F} = -\vec{\nabla} V = -\hat{i}\frac{\partial V}{\partial x} - \hat{j}\frac{\partial V}{\partial y} - \hat{k}\frac{\partial V}{\partial z}$

$\vec{F} = -c(\hat{i}yz + \hat{j}xz + \hat{k}xy)$

b.) $\vec{F} = -\vec{\nabla} V = -\hat{i}\,2\alpha x - \hat{j}\,2\beta y - \hat{k}\,2\gamma z$

c.) $\vec{F} = -\vec{\nabla} V = Ce^{-(\alpha x + \beta y + \gamma z)}(\hat{i}\alpha + \hat{j}\beta + \hat{k}\gamma)$

d.) $\vec{F} = -\vec{\nabla} V = -\hat{e}_r\frac{\partial V}{\partial r} - \hat{e}_\theta\frac{1}{r}\frac{\partial V}{\partial \theta} - \hat{e}_\phi\frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}$

$\vec{F} = -\hat{e}_r C n r^{n-1}$

4.2) a.)

$$\vec{\nabla}\times\vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & y & z \end{vmatrix} = 0 \Rightarrow \text{Konservatif}$$

b.)

$$\vec{\nabla}\times\vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y & -x & z^2 \end{vmatrix} = \hat{k}(-1-1) \neq 0 \Rightarrow \text{tidak Konservatif}$$

c.)

$$\vec{\nabla}\times\vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y & x & z^3 \end{vmatrix} = \hat{k}(1-1) = 0 \Rightarrow \text{Konservatif}$$

d.)

$$\vec{\nabla}\times\vec{F} = \frac{1}{r^2\sin\theta}\begin{vmatrix} \hat{e}_r & \hat{e}_\theta r & \hat{e}_\phi r\sin\theta \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ -kr^{-n} & 0 & 0 \end{vmatrix} = 0 \Rightarrow \text{Konservatif.}$$

4.3) a.)

$$\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & cx^2 & z^3 \end{vmatrix} = k\,(2cx - x) = 0$$

$$2cx - x = 0$$

$$c = \frac{1}{2}$$

b.)

$$\vec{\nabla} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ \frac{z}{y} & \frac{cxz}{y^2} & \frac{x}{y} \end{vmatrix} = \hat{i}\left(-\frac{x}{y^2} - \frac{cx}{y^2}\right) + \hat{j}\left(\frac{1}{y} - \frac{1}{y}\right) + \hat{k}\left(\frac{cz}{y^2} + \frac{z}{y^2}\right)$$

$$-\frac{x}{y^2} - \frac{cx}{y^2} = 0 \qquad c = -1$$

$$\frac{cz}{y^2} + \frac{z}{y^2} = 0 \qquad c = -1$$

4.4) a.) $E = \text{konstan} = V(x,y,z) + \frac{1}{2}mv^2$

$E = 0 + \frac{1}{2}mv^2$

$E = \alpha + \beta + \gamma + \frac{1}{2}mv^2 = \frac{1}{2}mv^2$

$v^2 = v_0^2 - \frac{2}{m}(\alpha + \beta + \gamma)$

$v = \left[v_0^2 - \frac{2}{m}(\alpha + \beta + \gamma)\right]^{\frac{1}{2}}$

b.) $v_0^2 - \frac{2}{m}(\alpha + \beta + \gamma) = 0$

$v_0 = \left[\frac{2}{m}(\alpha + \beta + \gamma)\right]^{\frac{1}{2}}$

c) $m\ddot{x} = f_x = -\frac{\partial v}{\partial x}$

$m\ddot{x} = -a$

$m\ddot{y} = -\frac{\partial v}{\partial y} = -2\beta y$

$m\ddot{z} = -\frac{\partial v}{\partial z} = -3\gamma z^2$

4.5) a.) $\vec{F} = \hat{i}x + \hat{j}y$

$x = y$

$d\vec{r} = \hat{i}dx + \hat{j}dy$

$$\int_{(0,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 F_x\,dx + \int_0^1 F_y\,dy = \int_0^1 x\,dx + \int_0^1 y\,dy = 1$$

Pada ~~sumbu~~ x: $d\vec{r} = \hat{i}\,dx$

Pada $x = 1$: $d\vec{r} = \hat{j}dy$

$\int_{(0,0)}^{(1,1)} \vec{F} \cdot d\vec{r} = \int_0^1 F_x\,dx + \int_0^1 F_y dy = 1$ Maka $\vec{F}$ adalah konservatif.

b.) $\bar{F} = \hat{i}y - \hat{j}x$

$x = y$

$$\int_{(0,0)}^{(1,1)} \bar{F}\cdot d\bar{r} = \int_0^1 F_x dx + \int_0^1 F_y dy = \int_0^1 y\,dx - \int_0^1 x\,dy$$

→ $x = y$ $\quad \int_{(0,0)}^{(1,1)} \bar{F}\cdot d\bar{r} = \int_0^1 x\,dx - \int_0^1 y\,dy = 0$

→ Sumbu x $\quad \int_{(0,0)}^{(1,0)} \bar{F}\cdot d\bar{r} = \int_0^1 F_x dx = \int_0^1 y\,dx$

→ $y = 0$ pada sumbu x $\quad \int_{(0,0)}^{(1,0)} \bar{F}\cdot d\bar{r} = 0$

→ $x = 1$ $\quad \int_{(1,0)}^{(1,1)} \bar{F}\cdot d\bar{r} = \int_0^1 F_y dy = \int_0^1 x\,dy$

→ $x = 1$ $\quad \int_{(1,0)}^{(1,1)} \bar{F}\cdot d\bar{r} = \int_0^1 dy = 1$

Pada $\int_{(0,0)}^{(1,1)} \bar{F}\cdot d\bar{r} = 0 + 1 = 1$ Maka $\bar{F}$ tidak konservatif

4.6) Dari Contoh 2.3.2. $V(z) = -mg \dfrac{r_e^2}{(r_e + z)}$

$$V(z) = -mg r_e \left(1 + \frac{z}{r_e}\right)^{-1}$$

$(1+x)^{-1} = 1 - x + x^2 + \ldots$

Maka $V(z) = -mg r_e \left(1 - \dfrac{z}{r_e} + \dfrac{z^2}{r_e^2} + \ldots\right)$

$$V(z) \approx mgz\left(1 - \frac{z}{r_e}\right)$$

$$\bar{F} = -\bar{\nabla} V = -\hat{k}\frac{\partial}{\partial z} V(z)$$

$$= -\hat{k}mg\left[1 - \frac{z}{r_e} + z\left(-\frac{1}{r_e}\right)\right]$$

$$\bar{F} = -\hat{k}mg\left(1 - \frac{2z}{r_e}\right)$$

$m\ddot{x} = F_x = 0 \qquad m\ddot{y} = F_y = 0 \qquad m\ddot{z} = -mg\left(1 - \dfrac{2z}{r_e}\right)$

$$m\dot{z}\frac{d\dot{z}}{dz} = -mg\left(1 - \frac{2z}{r_e}\right)$$

$$\int_{v_z}^{0} \dot{z}\,dz = -g\int_0^h \left(1 - \frac{2z}{r_e}\right) dz$$

$$-\frac{1}{2}V_{0z}^2 = -g\left(h - \frac{h^2}{r_e}\right)$$

$$h^2 - r_e h + \frac{r_e V_{0z}^2}{2g} = 0$$

$$h = \frac{r_e}{2} - \frac{1}{2}\sqrt{r_e^2 - \frac{2 r_e V_{0z}^2}{g}} \quad (h, z << r_e)$$

$$h = \frac{r_e}{2} - \frac{r_e}{2}\sqrt{1 - \frac{2V_{0z}^2}{g r_e}}$$

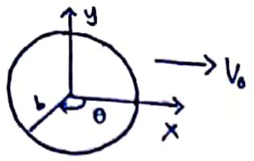
Dari $(1+x)^{\frac{1}{2}} = 1 + \dfrac{x}{2} - \dfrac{x^2}{8} + \ldots$

$$h = \frac{r_e}{2} - \frac{r_e}{2} + \frac{V_{0z}^2}{2g} + \frac{V_{0z}^4}{4 g r_e} + \ldots$$

$$h \approx \frac{V_{0z}^2}{2g}\left(1 + \frac{V_{0z}^2}{2 g r_e}\right)$$

Dengan $(1-x)^{-1} \approx 1 + x$, $h \approx \dfrac{V_0^2}{2g}\left(1 + \dfrac{V_0^2}{2 g r_e}\right)$

4.7)



Untuk titik yang diukur pada pusat roda :

$$\vec{r} = \hat{i}\, b\cos\theta - \hat{j}\, b\sin\theta$$

$$\theta = \omega t = \frac{V_0 t}{b}$$

Maka

$$\dot{\vec{r}} = -\hat{i} V_0 \sin\theta - \hat{j}\sin\theta - \hat{j} V_0 \cos\theta$$

$$\vec{v} = \hat{i} V_0 (1-\sin\theta) - \hat{j} V_0 \cos\theta$$

$y_0 = -b\sin\theta$ dan $V_{0y} = -V_0 \cos\theta$

$$V_y = V_{0y} - gt = -V_0\cos\theta - gt$$

$$y = -b\sin\theta - V_0 t\cos\theta - \frac{1}{2} g t^2$$

Pada h_{max}, $V_y = 0$

$$t = -\frac{V_0\cos\theta}{g}$$

$$h = -b\sin\theta - V_0\left(-\frac{V_0\cos\theta}{g}\right)\cos\theta - \frac{1}{2} g\left(-\frac{V_0\cos\theta}{g}\right)^2$$

$$h = -b\sin\theta - \frac{V_0^2\cos^2\theta}{2g}$$

h_{max} untuk $\frac{dh}{d\theta} = 0 = -b\cos\theta - \frac{2V_0^2\cos\theta\sin\theta}{2g}$

$$\sin\theta = -\frac{gb}{V_0^2}$$

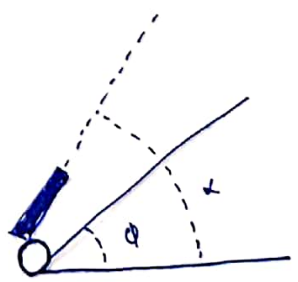
$$\cos^2\theta = 1 - \sin^2\theta = \frac{V_0^4 - g^2 b^2}{V_0^4}$$

$$h_{max} = \frac{gb^2}{V_0^2} + \frac{V_0^4 - g^2 b^2}{2gV_0^2} = \frac{gb^2}{2V^2} + \frac{V_0^2}{2g}$$

$$h'_{max} = b + \frac{gb^2}{2V_0^2} + \frac{V_0^2}{2g}$$

Lumpur Meninggalkan roda pada $\theta = \sin^{-1}\left(-\frac{gb}{V_0^2}\right.$

4.8)



$x = R\cos\phi$ dan $x = V_{0x} t = (V_0\cos\alpha)t$

Maka $t = \frac{R\cos\phi}{V\cos\alpha}$

$y = R\sin\phi$ dan $y = V_y t - \frac{1}{2} g t^2 = (V_0\sin\alpha)t - \frac{1}{2} g t^2$

$$R\sin\phi = (V_0\sin\alpha)\frac{R\cos\phi}{V_0\cos\alpha} - \frac{1}{2} g\left(\frac{R\cos\phi}{V_0\cos\alpha}\right)^2$$

$$\sin\phi = \tan\alpha\cos\phi - \frac{gR\cos^2\phi}{2V_0^2\cos^2\alpha}$$

$$R = \frac{2V_0^2\cos^2\alpha}{g\cos^2\phi}(\tan\alpha\cos\phi - \sin\phi) = \frac{2V_0^2\cos\alpha}{g\cos^2\phi}(\sin\alpha\cos\phi - \cos\alpha\sin\phi)$$

$$\boxed{\sin(\theta+\phi) = \sin\theta\cos\phi + \cos\theta\sin\phi}$$

$$R = \frac{2V_0^2\cos\alpha}{g\cos^2\phi}\sin(\alpha-\phi)$$

R_{max} Untuk $\frac{dR}{d\alpha} = 0 = \frac{2V_0^2}{g\cos^2\phi}\left[-\sin\alpha\sin(\alpha-\phi) + \cos\alpha\cos(\alpha-\phi)\right]$

$\cos\alpha\cos(\alpha-\phi) - \sin\alpha\sin(\alpha-\phi) = 0$

$\cos(\theta+\phi) = \cos\theta\cos\phi - \sin\theta\sin\phi$

$\cos(2\alpha-\phi) = 0$

$2\alpha - \phi = \frac{\pi}{2}$

$\alpha = \frac{\pi}{4} + \frac{\phi}{2}$

$R_{max} = \frac{2V_0^2}{g\cos^2\phi}\cos\left(\frac{\pi}{4}+\frac{\phi}{2}\right)\sin\left(\frac{\pi}{2}-\frac{\phi}{2}\right)$

$\sin\left(\frac{\pi}{4}-\frac{\phi}{2}\right) = \cos\left[\frac{\pi}{2}-\left(\frac{\pi}{4}-\frac{\phi}{2}\right)\right] = \cos\left(\frac{\pi}{4}+\frac{\phi}{2}\right)$

$R_{max} = \frac{2V_0^2}{g\cos^2\phi}\cos^2\left(\frac{\pi}{2}+\frac{\phi}{2}\right)$

$\boxed{\cos 2\theta = \cos^2\theta - \sin^2\theta = 2\cos^2\theta - 1}$

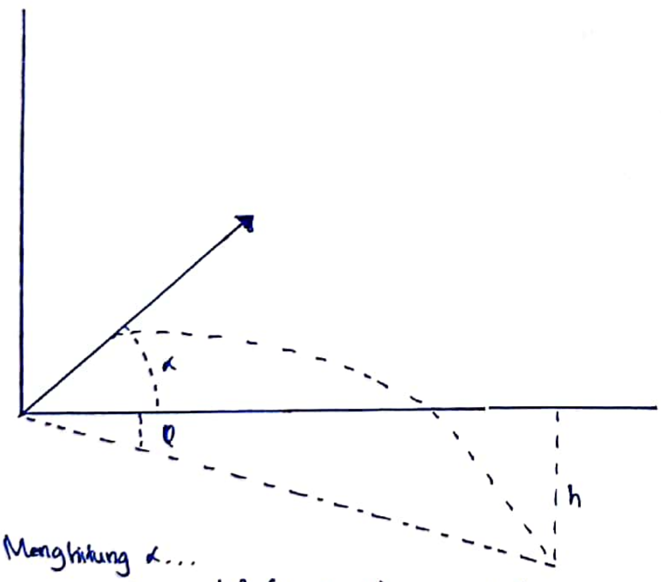
$R_{max} = \frac{2V_0^2}{g\cos^2\phi}\left[\frac{1}{2}\cos\left(\frac{\pi}{2}+\phi\right) + \frac{1}{2}\right] = \frac{V_0^2}{g\cos^2\phi}\left[\cos\left(\frac{\pi}{2}+\phi\right)+1\right]$

$\boxed{\cos\left(\frac{\pi}{2}+\theta\right) = -\sin\theta}$

$R_{max} = \frac{V_0^2}{g(1-\sin^2\phi)}(1-\sin\phi)$

$R_{max} = \frac{V_0^2}{g(1+\sin\phi)}$

4.9)



a.) Disini kita perhatikan bahwa proyektil diluncurkan (menurun) menuju sasaran, yang terletak pada jarak h dibawah meriam sepanjang garis pada sudut ϕ dibawah cakrawala. α adalah sudut proyeksi yang menghasilkan jangkauan maksimum R. Kita dapat menggunakan hasil dari soal 4.8 untuk soal ini

$R = \frac{2V_0^2}{g}\frac{\cos\alpha\sin(\alpha+\phi)}{\cos^2\phi}$

→ ganti ϕ dengan $-\phi$...

$R_{max} = \frac{V_0^2(1+\sin\phi)}{g\cos^2\phi}$ dan.. $2\alpha = \frac{\pi}{2} - \phi$

→ Menghitung α...

$R_{max} = \frac{h}{\sin\phi} = \frac{V_0^2}{g}\frac{(1+\sin\phi)}{\cos^2\phi} = \frac{V_0^2}{g(1-\sin\phi)}$

→ Untuk $\sin\phi$...

$\sin\phi = \frac{gh}{V_0^2} \Big/ \left(1+\frac{gh}{V_0^2}\right)$

Dari $\sin\theta = \sin\left(\frac{\pi}{2} - 2\alpha\right) = \cos 2\alpha = 1 - 2\sin^2\alpha$

Maka, $1 - 2\sin^2\alpha = \frac{gh}{V_0^2} / \left(1 + \frac{gh}{V_0^2}\right)$

$$2\sin^2\alpha = \frac{2}{\csc^2\alpha} = 1 - \frac{gh}{V_0^2} / \left[1 + \frac{gh}{V_0^2}\right] = \frac{1}{1 + \frac{gh}{V_0^2}}$$

$$\csc^2\alpha = 2\left(1 + \frac{gh}{V_0^2}\right)$$

b.) $R_{max} = \frac{h}{\sin\theta} = \frac{h}{1 - 2\sin^2\alpha} = \frac{h}{1 - \frac{2}{\csc^2\alpha}}$

Subsitusi $\csc^2\alpha$

$$R_{max} = \frac{V_0^2}{g}\left(1 + \frac{gh}{V_0^2}\right)$$

4.12) $x = V_0 t \cos\frac{1}{2}\theta$

$z = V_0 t \cos\frac{1}{2}\theta_0 \sin\theta_0 - \frac{1}{2}gt^2$

$V_x = V_0 \cos\frac{1}{2}\theta$

$R = \frac{V_0^2}{g}\cos^2\frac{1}{2}\theta_0 \sin 2\theta$

Max $= \frac{dR}{d\theta} = 0$

$$\frac{dR}{d\theta} = \frac{V_0^2}{g}\left(2\cos^2\frac{1}{2}\theta_0 \cos 2\theta_0 - \cos\frac{1}{2}\theta_0 \sin\frac{1}{2}\theta_0 \sin 2\theta\right) = 0$$

Maka, $2\cos^2\frac{1}{2}\theta_0 \cos 2\theta_0 = \cos\frac{1}{2}\theta_0 \sin\frac{1}{2}\theta_0 \sin 2\theta$

Gunakan $2\cos^2\theta_0 = 1 + \cos 2\theta$, dan $\sin 2\theta_0 = 2\sin\theta_0\cos\theta_0$

$(1 + \cos\theta_0)(2\cos^2\theta_0 - 1) = \sin\theta_0 \sin\theta_0 \cos\theta_0 = (1 - \cos^2\theta_0)\cos\theta_0$

atau

$(1 + \cos\theta_0)(3\cos^2\theta_0 - \cos\theta_0 - 1) = 0$

$\cos\theta_0 = -1$

$\cos\theta_0 = \frac{1}{6}(1 \pm \sqrt{13})$

↳ Untuk $0 \leq \theta_0 \leq \frac{\pi}{2}$

$\cos\theta_0 = \frac{1}{6}(1 + \sqrt{13}) = 0,7676 \quad \theta_0 = 39°51'$

Maka (b) Untuk $V_0 = 25$ m/s $\quad R_{max} = 55,4$ m $\quad \theta_0 = 39°51'$

(a) h_{max} pada $\frac{dz}{dt} = 0$

$V_0 \cos\frac{1}{2}\theta_0 \sin\theta_0 = gT$ atau $T = \frac{V_0 \cos\frac{1}{2}\theta_0 \sin\theta_0}{g}$

$$H = \frac{V_0^2}{2g}\cos^2\frac{1}{2}\theta_0 \sin^2\theta$$

↳ Pada $\frac{dH}{d\alpha} = 0$

$$\frac{dH}{d\alpha} = \frac{V_0^2}{2g}\left(2\cos^2\tfrac{1}{2}\theta_0 \sin\theta_0 \cos\theta_0 - \cos\tfrac{1}{2}\theta_0 \sin\tfrac{1}{2}\theta_0 \sin^2\theta_0\right) = 0$$

$$(1+\cos\theta_0)\sin\theta_0\cos\theta_0 = \tfrac{1}{2}\sin\theta_0 \sin^2\theta_0 = \tfrac{1}{2}\sin\theta_0(1-\cos^2\theta_0)$$

atau $\sin\theta_0(1+\cos\theta_0)(3\cos\theta_0 - 1) = 0$

$\sin\theta_0 = 0$, $\cos\theta_0 = -1$, $\cos\theta_0 = \frac{1}{3}$

Maka $H_{max} = 18{,}9\,m$

$\theta_0 = \cos^{-1}\frac{1}{3} = 70°32'$

4.13) $z = \frac{\dot{z}_0}{\dot{r}_0} r - \frac{g}{2\dot{r}_0^2} r^2$ dimana $\dot{r}_0 = V_0\cos\theta_0$ $\dot{z}_0 = V_0\sin\theta_0$

Maka, $z = r\tan\theta_0 - \frac{gr^2}{2V_0^2}\sec^2\theta_0$

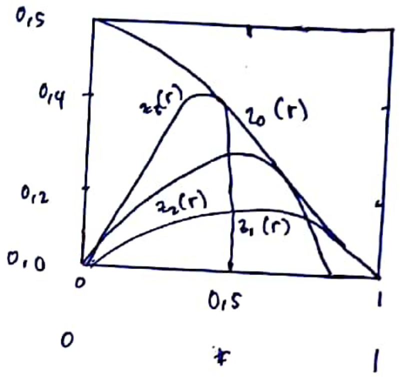
$\sec^2\theta_0 = 1 + \tan^2\theta_0$

Kordinat (r, z)

$$\tan\theta_0 = \frac{1}{gr}\left[V_0^2 \pm (V_0^4 - 2gzV_0^2 - g^2r^2)^{\frac{1}{2}}\right]$$

$V_0^4 - 2gzV_0^2 - g^2r^2 \geq 0$

$V_0^4 - 2gzV_0^2 - g^2r^2 = 0$



4.17) $m\ddot{x} = F_x = -\frac{\partial V}{\partial x} = -kx = -\pi^2 m x$

$x = A\cos\left[\sqrt{\frac{k}{m}}t + \alpha\right] = A\cos(\pi t + \alpha)$

$m\ddot{y} = -\frac{\partial V}{\partial y} = -4\pi^2 m x$

$y = B\cos(2\pi t + \beta)$

$m\ddot{z} = -\frac{\partial V}{\partial z} = -9\pi^2 m z$

$z = C\cos(3\pi t + \gamma)$

↳ $x = y = z = 0$, $t = 0$, $\alpha = \beta = \gamma = -\frac{\pi}{2}$

$x = A\cos(\pi t - \frac{\pi}{2}) = A\sin\pi t$

$\dot{x} = A\pi\cos\pi t$

↳ $V_0^2 = \dot{x}_0^2 + \dot{y}_0^2 + \dot{z}_0^2$ dan $\dot{x}_0 = \dot{y}_0 = \dot{z}_0$

$\dot{x}_0 = \frac{V_0}{\sqrt{3}} = A\pi$

$A = \frac{V_0}{\pi\sqrt{3}}$

$x = \frac{V_0}{\pi\sqrt{3}}\sin\pi t$

$y = B\sin 2\pi t$ $\dot{y} = 2B\pi\cos 2\pi t$

$\dot{y}_0 = \frac{V_0}{\sqrt{3}} = 2\pi B$

$B = \frac{V_0}{2\pi\sqrt{3}}$

$y = \frac{V_0}{2\pi\sqrt{3}}\sin 2\pi t$

$z = C\sin 3\pi t$ $\dot{z} = 3C\pi\cos 3\pi t$

$\dot{z}_0 = \frac{V_0}{\sqrt{3}} = 3C\pi$

$C = \frac{V_0}{3\pi\sqrt{3}}$

$z = \frac{V_0}{3\pi\sqrt{3}}\sin 3\pi t$

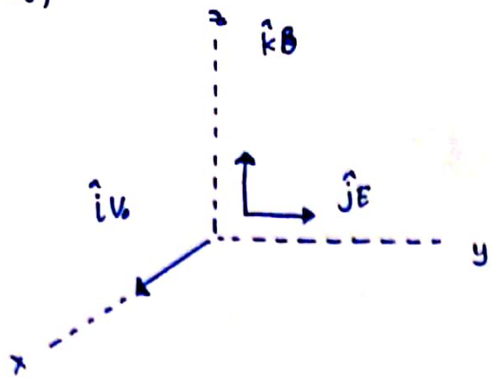
↳ $\omega_x = \pi$, $\omega_y = 2\pi$ dan $\omega_z = 3\pi$

$$t_{min} = \frac{2\pi n_1}{\omega_x} = \frac{2\pi n_2}{\omega_y} = \frac{2\pi n_3}{\omega_z}$$

↳ $n_1 = 1$ $n_2 = 2$ $n_3 = 3$

$t_{min} = \frac{2\pi}{\pi} = 2.$

4.20)



$\bar{F} = q(\bar{E} + \bar{v} \times \bar{B})$

$\bar{V} \times \bar{B} = (\hat{i}\dot{x} + \hat{j}\dot{y} + \hat{k}\dot{z}) \times \hat{k}B = \hat{i}\dot{y}B - \hat{j}\dot{x}B$

$\bar{F} = \hat{i}q\dot{y}B + \hat{j}q(E - \dot{x}B)$

$m\ddot{x} = F_x = q\dot{y}B$

$\dot{x} - \dot{x}_0 = \frac{qB}{m}y$

$m\ddot{y} = F_y = qE - q\dot{x}B = qE - qB\left(\dot{x}_0 + \frac{qB}{m}y\right)$

$\ddot{y} = \frac{qE}{m} - \frac{qB\dot{x}_0}{m} - \left(\frac{qB}{m}\right)^2 y = -\frac{eE}{m} + \frac{eB\dot{x}_0}{m} - \left(\frac{eB}{m}\right)^2 y$

$\ddot{y} + \omega^2 y = -\frac{eE}{m} + \omega\dot{x}_0 \qquad \omega = \frac{eB}{m}$

$y = \frac{1}{\omega^2}\left(-\frac{eE}{m} + \omega x_0\right) + A\cos(\omega t + \theta_0)$

$\dot{y} = -A\omega\sin(\omega t + \theta_0)$

$\dot{y}_0 = 0$ Maka $\theta_0 = 0$

$y_0 = 0$ Maka $A = -\frac{1}{\omega^2}\left(-\frac{eE}{m} + \omega\dot{x}_0\right)$

$y = a(1 - \cos\omega t)$. $\quad a = \frac{1}{\omega^2}\left(-\frac{eE}{m} + \omega\dot{x}_0\right)$

$\dot{x} = \dot{x}_0 + \frac{qB}{m}y = \dot{x}_0 - \omega y = \dot{x}_0 - \omega a(1 - \cos\omega t)$

$\dot{x} = (\dot{x}_0 - \omega a) + \omega a\cos\omega t$

$x = (\dot{x}_0 - \omega a)t + a\sin\omega t$

$x = a\sin\omega t + bt$, $\quad b = \dot{x}_0 - \omega a$

$m\ddot{z} = F_z = 0$

$z = \dot{z}_0 t + z_0 = 0$