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Prodi : Pendidikan Fisika (B)

"Tugas Mekanika"

2.1. a). $F_x = m\ddot{x} = F_0 + Ct$

$$\frac{mdv}{dt} = F_0 + Ct$$

$$mdv = (F_0 + Ct)\, dt$$

$$m\int_{v_0}^{v} dv = \int_0^t (F_0 + Ct)\, dt$$

$$m(v - v_0) = F_0 (t - t_0) + \frac{C}{2} (t^2 - t_0^2)$$

Karena $v_0 = 0$ dan $t_0 = 0$, maka:

$$mv = F_0 t + \frac{Ct^2}{2}$$

$$v(t) = \frac{1}{m}\left(F_0 t \quad \frac{Ct^2}{2}\right) = \frac{dx}{dt}$$

$$\int_{x_0}^{x} dx = \int_{t_0}^{t} \frac{1}{m}\left(F_0 t + \frac{Ct^2}{2}\right) dt$$

$$x - x_0 = \frac{1}{m}\left(\frac{F_0}{2}(t^2 - t_0^2) + \frac{C}{6}(t^3 - t_0^3)\right)$$

$$x = \frac{1}{m}\left[\frac{F_0 t^2}{2} + \frac{Ct^3}{6}\right]$$

b). $F_x = m\frac{dv}{dt} = F_0 \sin Ct$

$$\int_0^v dv = \frac{F_0}{m}\int_0^t \sin Ct\, dt$$

$$v(t) = -\frac{F_0}{mC} \cos Ct$$

$$x(t) = \int_0^x dt$$

$$x(t) = -\frac{F_0}{mC}\int_0^t \cos Ct\, dt$$

$$\therefore x(t) = -\frac{F_0}{mC^2} \sin Ct$$

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c). $F_x = f_0\, e^{ct}$

$$v(t) = \frac{F_0}{m}\int_0^t e^{ct}\, dt$$

$$v(t) = \frac{F_0}{cm}\, e^{ct}$$

$$x(t) = \frac{F_0}{c^2 m}\, e^{ct}$$

2.2. a). $F_x = F_0 + C_x$

$$F(x) = mv\frac{dv}{dx} = F_0 + cx$$

$$\int_{v_0}^{v} mv\, dv = \int_0^x (F_0 + cx)\, dx$$

$$\frac{mv^2}{2} = F_0 x + \frac{c}{2}x^2$$

$$V = \sqrt{\frac{2}{m}\left(F_0 x + \frac{c}{2}x^2\right)}$$

b). $F(x) = mv\dfrac{dv}{dx} = F_0\, e^{-cx}$

$$\frac{1}{2}mv^2 = -\frac{F_0}{c}\, e^{-cx}$$

$$V = \frac{2}{m}\left[-\frac{F_0}{c}\, e^{-cx}\right]^{1/2}$$

c). $F(x) = mv\dfrac{dv}{dx} = F_0 \cos cx$

$$\frac{1}{2}mv^2 = \int_0^x F_0 \cos cx$$

$$= \frac{F_0}{c}\sin cx$$

$$V = \frac{2}{m}\left[\frac{F_0}{2}\sin cx\right]^{1/2}$$

2.3. a). $F_x = -\dfrac{dV}{dx} = F_0 + C_x$

$$u(x) = -\left[F_0 x + \frac{c}{2}x^2\right] + C$$

b). $F_x = -\dfrac{dv}{dx} = F_0\, e^{-cx}$

$$\int_{u(x_0)}^{u(x)} du = -F_0\int_{x_0}^{x} e^{-cx}\, dx$$

c). $F_x = -\dfrac{dV}{dx} = F_0 \cos cx$

$$\int_{u(x_0)}^{u(x)} dv = -F_0\int_{x_0}^{x}\cos(cx)\, dx$$

$$u(x) - u(x_0) = -\frac{F_0}{c}\left[\sin cx - \sin cx_0\right]$$

2.4. $V(x) = -\int F(x)\, dx$

a) $V(x) = -\int(-kx)\, dx$

$$V(x) = \frac{kx^2}{2}$$

Jadi, energi potensial $V(x) = \dfrac{kx^2}{2}$

b). dan c).

$$E = T_0 = \frac{1}{2}kA^2$$

$$E = T(x) + V(x)$$

$$T(x) = E - V(x)$$

$$T(x) = \frac{1}{2}kA^2 - \frac{1}{2}kx^2$$

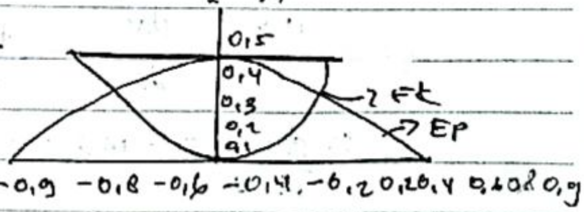
$$T(x) = \frac{k}{2}(A^2 - x^2)$$

d). $E = V_{cx}$

$$\frac{1}{2}kA^2 = \frac{1}{2}kx^2$$

$$x = \pm A$$

e).



Hasilnya = a). $V(x) = \dfrac{kx^2}{2}$

b). $T(x) = \dfrac{k}{2}(A - x^2)$

c). $E = T_0 = \frac{1}{2}kA^2$

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2.8. $v = \frac{b}{x^3}$

$F = m\frac{dv}{dt} = m\frac{dv}{dx}\frac{dx}{dt}$

$= mv\frac{dv}{dx}$

$\frac{dv}{dx} = -\frac{3b}{x^4}$

$F = m\left(\frac{b}{x^3}\right)\left(\frac{-3b}{x^4}\right) = -\frac{3mb^2}{x^7}$

2.11. $F(v) = -cv^{3/2}$

$= m\frac{dv}{dt} = m\frac{dv}{dx}\frac{dx}{dt}$

$= m\frac{dv}{dt}$

$-cv^{3/2} = m\frac{dv}{dx}$

$\int_0^x dx = \int_{v_0}^{v} \frac{-mv}{cv^{3/2}}\,dv$

$x = -\frac{m}{c}\int_{v_0}^{v}\frac{dv}{\sqrt{v}} = -\frac{m}{c}\int_{v_0}^{v} v^{-1/2}dv$

$= -\frac{m}{c}\left.\frac{v^{1/2}}{1/2}\right|_{v_0}^{v}$

$= \frac{2m}{c}\left(\sqrt{v_0} - \sqrt{v}\right)$

Partikel berhenti, maka $v=0$, Jadi

$x_{max} = \frac{2m\sqrt{v_0}}{c}$

2.12. $m.a_x = \Sigma F_x$

$m.a_x = -mg - C_2v^2$

$a_x = \frac{dv}{dt} = \frac{dv\,dx}{dx\,dt} = \frac{dv}{dx}\cdot v$

$m\frac{dv}{dx} = -mg - C_2v^2$

$v\frac{dv}{dx} = -g - \frac{C_2}{m}v^2$

$k = \frac{c^2}{m}$

$\int_{v_0}^{v}\frac{v\,dv}{-g-kv^2} = \int_0^x dv$

$y = -y - kv^2$

$dy = -2kv\,dv$

$v\,dv = -\frac{1}{2k}dy$

$\int_{v_0}^{v}\frac{-1\,dy}{2ky} = \int_0^x dx$

$\frac{-1}{2k}\ln(y)\Big|_{v_0}^{v} = x\Big|_0^x$

$\frac{-1}{2k}\ln(-g-kv^2)\Big|_{v_0}^{v} = x$

$\frac{-1}{2k}\ln\left(\frac{-g-kv^2}{-g-kv_0^2}\right) = x$

$\frac{-g-kv^2}{-g-kv_0^2} = e^{-2kx}$

$-g-kv^2 = \left(-g-kv_0^2\right)e^{-2kx}$

$kv^2 = \left(g+kv_0^2\right)e^{-2kx} - g$

k

$A = \frac{g}{k} + v_0^2$

$\boxed{v^2 = Ae^{-2kx} - \frac{g}{k}}$

$Ma_x = \Sigma F_x$

$m.a_x = -mg + C_2V^2$

$a_x = \frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt} = \frac{dv}{dx}\cdot v$

$mv\frac{dv}{dx} = -mg + C_2v^2$

$v\frac{dv}{dx} = -g + \frac{C_2}{m}v^2$

$k = \frac{C_2}{m}$

$v\frac{dv}{dx} = -g + kv^2$

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$$\int_0^v \frac{v\,dv}{-g+kv^2} = \int_0^x dx$$

$$y = -g+kv^2$$

$$dy = 2kv\,dv$$

$$v\,dv = \frac{1}{2k}\,dy$$

$$\int_0^v \frac{1}{2k}\frac{dy}{y} = \int_{x_0}^x dx$$

$$\frac{1}{2k}\ln(y)\Big|_0^v = x\Big|_{x_0}^x$$

$$\frac{1}{2k}\ln\left(-g+kv^2\right)\Big|_0^v = x - x_2$$

$$\frac{1}{2k}\ln\left(\frac{-g+kv^2}{-g}\right) = x - x_2$$

$$\frac{-g+kv^2}{g} = e^{2k(x-x_0)}$$

$$-g+kv^2 = -ge^{2k(x-x_0)}$$

$$kv^2 = -ge^{2k(x-x_0)}+g$$

$$v^2 = \frac{-g}{k}e^{2kx_0}e^{2kx}+\frac{g}{k}$$

$$B = \frac{g}{k}e^{2kx_0}$$

$$\boxed{V^2 = \frac{g}{k} - Be^{2kx}}$$

2.13. $V^2 = \left(\frac{g}{k}+V_0^2\right)e^{-2kx} - \frac{g}{k}$ keatas

$$V^2 = \frac{-g}{k}e^{-2kx_0}e^{2kx}+\frac{g}{k}$$ kebawah

$V=0$ Pada gerak keatas

$$0 = \left(\frac{g}{k}+V_0^2\right)e^{-2kx}-\frac{g}{k}$$

$$e^{-2kh} = \frac{g/k}{g/k+V_0^2}$$

h adalah posisi awal untuk gerakan kebawah dan (+) $a=0$,

$$V^2 = -\frac{g}{k}e^{-2kh}e^{2kx_0}+\frac{g}{k} \quad \text{Nb}\ x=0$$

$$V^2 = -\frac{g}{k}\cdot\frac{g/k}{g/k+V_0^2}\cdot 1+\frac{g}{k}$$

$$V_t^2 = \frac{g}{k}$$

$$V^2 = -V_t^2\cdot\frac{V_t^2}{V_t^2+V_0^2}+V_t^2$$

$$V^2 = V_t^2\left(\frac{1-V_t^2}{V_t^2+V_0^2}\right)$$

$$V^2 = V_t^2\left(\frac{V_t^2+V_0^2-V_t^2}{V_t^2+V_0^2}\right)$$

$$V^2 = \frac{V_t^2+V_0^2}{V_t+V_0^2}$$

$$V = \frac{V_t\,V_0}{\sqrt{V_t^2+V_0}}$$

2.14. $ma_x = \Sigma F_x$

$$ma_x = -kx^{-2}$$

$$a_x = \frac{dv}{dt} = -kx^{-2}$$

$$v\frac{dv}{dx} = -\frac{k}{m}x^{-2}$$

$$\int_0^v v\,dv = -\frac{k}{m}\int_b^x x^{-2}\,dx$$

$$\frac{v}{2}\Big|_0^v = -\frac{k}{m}(-1)x^{-1}\Big|_0^x$$

$$\frac{v^2}{2} = \frac{k}{m}\left(x^{-1}-b^{-1}\right)$$

$$v^2 = \frac{2k}{m}\left(\frac{b-x}{bx}\right)$$

$$v = \frac{dx}{dt}$$

$$\sqrt{\frac{2k}{m}\left(\frac{b-x}{m}\right)} = \frac{dx}{dt}$$

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$$\int_b^0 \frac{dx}{\sqrt{\frac{2k}{m}\left(\frac{b-x}{bx}\right)}} = \int_0^t dt$$

$$\int_b^0 \frac{dx}{\sqrt{\frac{2k}{m}}\left(\frac{b-x}{bx}\right)} = \sqrt{\frac{mb}{2k}} \int_b^0 \sqrt{\frac{x}{b-x}}\, dx$$

$$u = \frac{\sqrt{b-x}}{\sqrt{x}}$$

$$du = \frac{\frac{1}{2\sqrt{b-x}}(-1)\cdot\sqrt{x}\, dx \;\frac{1}{2\sqrt{x}}}{x}$$

$$dx = \frac{du}{\frac{1}{-2\sqrt{x}\cdot v\sqrt{x}} - \frac{v\sqrt{x}}{2x^{3/2}}}$$

$$= \frac{du}{\frac{1}{2vx} - \frac{v}{2x}}$$

$$= \frac{-du}{\frac{1+v^2}{2xv}}$$

$$= -\frac{2xv\,dv}{v^2+1}$$

$$dx = -\frac{2bv\,dv}{(v^2+1)^2}$$

$$\sqrt{\frac{mb}{2k}} \int_b^0 \sqrt{\frac{x}{b-x}}\, dx = \sqrt{\frac{mb}{2k}} \int_b^0 \frac{1}{v}(-1)^2 \frac{bv\,dv}{(v^2+1)^2}$$

$$= \sqrt{\frac{mb}{2k}} \int_b^0 \frac{2bv\,dv}{(v^2+1)^2}$$

$$\int \frac{du}{(av+b)^n} = \frac{v}{2(v^2+1)}\Big|_b^0 + \frac{1}{2}\int_b^0 \frac{dv}{v^2+1}$$

$$\int_b^0 \frac{du}{(v^2+1)^2} = \frac{u}{2(v^2+1)}\Big|_b^0 + \frac{1}{2}\arctan v\Big|_b^0$$

$$-\sqrt{\frac{mb}{2k}} \int_b^0 \frac{2b\,du}{(v^2+1)^2} = -2b\sqrt{\frac{mb}{2k}}\left(\frac{v}{2(u^2+1)}\Big|_b^0 + \tfrac{1}{2}\arctan v\Big|_b^0\right)$$

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$$= -2b\sqrt{\frac{mb}{2k}} \cdot \left(\frac{v}{2(v^2+1)} \Big|_0^{-\infty} + \frac{1}{2} \text{ arctan } v \Big|_0^{-\infty} \right)$$

$$= -2b\sqrt{\frac{mb}{2k}} \cdot \left(0-0 + \frac{1}{2} \cdot \left(\frac{-\pi}{0} - 0 \right) \right)$$

$$= \pi\sqrt{\frac{mb^3}{8k}}$$

$$\pi\sqrt{\frac{mb^3}{8k}} = \int_0^t dt$$

$$t = \pi\sqrt{\frac{mb^3}{8k}}$$

2.10.

$$ma = \Sigma F$$

$$ma = mg - C_1V - C_2V^2$$

$$ma = 0$$

$$mg - C_1V - C_2V^2 = 0$$

$$C_2V^2 - C_1V - mg = 0$$

$$V_{1,2} = \frac{-C_1 \pm \sqrt{C_1^2 + 4C_2mg}}{2C_2}$$

Pilih (+)

$$V_1 = \frac{-C_1 + \sqrt{C_1^2 + 4C_2mg}}{2C_2}$$

$$V_1 = V_t = \frac{-C_1}{2C_2} + \sqrt{\left(\frac{C_1}{2C_2}\right)^2 + \frac{mg}{C_2}}$$

$$V_t = \frac{-C_1}{2C_2} + \sqrt{\left(\frac{C_1}{2C_2}\right)^2 + \frac{mg}{C_2}}$$