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Kelas B

Mekanika

2.1 a) $F(x) = m\ddot{x} = F_0 + C_t$

$$m.\frac{dv}{dt} = F_0 + C_t$$

$$m.dv = (F_0 + Ct)\,dt$$

$$m\int_{V_0}^{V} dv = \int_0^t (F_0 + Ct)\,dt$$

$$m(V - V_0) = F_0(t - t_0) + \frac{C}{2}(t^2 - t^2_0)$$

Karena $V_0 = 0$ dan $t_0 = 0$, maka :

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

$$V(t) = \frac{1}{m}\left(F_{0t} + \frac{Ct^2}{2}\right) = \frac{dx}{dt}$$

$$\int_{x_0}^{x} dx = \int_{t_0}^{t} \frac{1}{m}\left(F_{0t} + \frac{Ct^2}{2}\right)dt$$

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

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

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

$$\int_0^V dv = \frac{F_0}{m}\int_0^t \sin ct\,dt$$

$$V(t) = \frac{-F_0}{mC} \cos C_t$$

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

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

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

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c). $F_t = F_0 e^{ct}$

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

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

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

2.2 a) $F_x = F_0 + Cx$

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

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

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

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

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

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

$$= \frac{F_0}{C}\sin Cx$$

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

2.3 a). $F_x = \dfrac{-dv}{dx} = F_0 + Cx$

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

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

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

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

c). $F_x = \frac{-dv}{dx} = F_0 \cos Cx$

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

$$u(x) - u(x_0) = -\frac{F_0}{c}\left[\sin Cx - \sin Cx_0\right]$$

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

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

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

Jadi, energi Potensial $V(x) = \frac{kx^2}{2}$

b). dan c)

$E = T_0 = \frac{1}{2} k A^2$

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

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

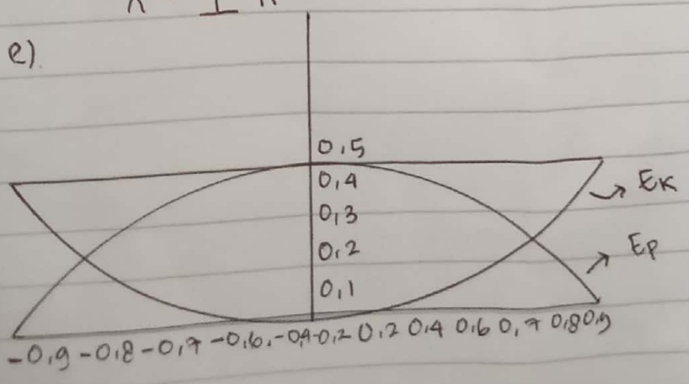
$T(x) = \frac{1}{2} kA^2 - \frac{1}{2} kx^2$

d). $E = V(x)$

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

$x = \pm A$

e)



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

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

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

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2.8 $V = \frac{b}{x^3}$

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

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

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

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

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

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

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

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

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

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

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

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

Partikel berhenti, maka $V = 0$, jadi

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

2.12 $m - a_x = \Sigma F_x$

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

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

$$m . \frac{dv}{dx} = -mg = C_2V^2$$

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

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

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

$$dy = -2kv\,dv$$

$$v\,dv = -1/2k\ dy$$

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

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

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

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

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

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

$$kv^2 = (g+kv_0^2)\,e^{-2kx} - \frac{g}{k}$$

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

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

$$ma_x = \Sigma F_x$$

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

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

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

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

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

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

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

$$dy = 2kv\,dv$$

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

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

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

$$\frac{1}{2k}\ln(-g+kv^2)\Big|_0^v = x - x_0$$

$$\frac{1}{2k}\ln\left(\frac{-g+kv^2}{-g}\right) = x - x_0$$

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

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

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

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

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

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

2.13 $v^2 = \left(\frac{g}{\cancel{k}} + v_0^2\right)e^{-2kx} - \frac{g}{k}$ (keatas)

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

$v = 0$ pada gerak keatas

$$0 = \left(\frac{g}{k} + v_0^2\right)e^{-2kx_0} - \frac{g}{k}$$

$$e^{-2kh} = \frac{g/k}{g/k + v_0^2}$$

h adalah posisi awal untuk gerakan kebawah dan ~~(t)~~ (t) a=0,

$v^2 = \frac{-g}{k}e^{-2kh}e^{2kx_0} + \frac{g}{k}$ Sub $x=0$

$$v^2 = \frac{-g}{k}\cdot\frac{g/k}{g/k+v_0^2}\cdot 1 + g/k$$

$$v_t^2 = g/k$$

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$$V^2 = \frac{Vt^2 \cdot Vt^2}{Vt^2 + Vo^2} + Vt^2$$

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

$$V^2 = Vt^2 \left(\frac{Vt^2 + Vo^2 - Vt^2}{Vt^2 + Vo^2} \right)$$

$$V^2 = \frac{Vt^2 Vo^2}{Vt + Vo^2}$$

$$V = \frac{Vt\, Vo}{\sqrt{Vt^2 + Vo}}$$

2.14 $max = \Sigma F_x$

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

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

$$mv \frac{dv}{dx} = -kx^{-2}$$

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

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

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

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

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

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

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

$$\int_b^{0} \frac{dx}{\sqrt{\frac{2k}{m} \cdot \left(\frac{bx}{bx} \right)}} = \frac{dx}{dt}$$

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

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

$$dv = \frac{\frac{1}{2\sqrt{b-x}}(-1).\sqrt{x}\,dx - \frac{1}{2\sqrt{x}}}{x}$$

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

$$= \frac{du}{1/2V_x - V/2x}$$

$$= -\frac{dr}{\frac{1+V_2}{2xv}}$$

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

$$\sqrt{b-x} = v\sqrt{x}$$

$$b - x = V^2 x$$

$$b = x^2(V^2+1)$$

$$x = \frac{b}{u^2+1}$$

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

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

$$\int \frac{dv}{(av+b)^n} = \frac{2n-3}{2b(n-1)}\int \frac{dv}{(av^2+b)^{n-1}} + \frac{v}{2b(n-1)(av^2+b)^{n-1}}$$

$$= \frac{u}{2(v^2+1)} + \frac{1}{2}\int \frac{dv}{v^2+1}$$

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

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

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

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

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

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

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

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

2.15 $Ma = \Sigma F$

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

$$Ma = 0$$

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

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

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

Pilih (+)

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

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

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

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