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Kelas : B

Prodi : Pendidikan Fisika

Mekanika

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

$$m \frac{dv}{dt} = F_0 + Ct$$

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

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

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

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

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

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

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

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

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

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

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

$$v(t) = -\frac{F_0}{mc}\cos ct$$

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

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

$$x(t) = -\frac{F_0}{mc^2}\sin ct$$

(c.) $F_x = F_0 e^{ct}$

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

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

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

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2.2 (a.) $F_x = F_0 + Cx$

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

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

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

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

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

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

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

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

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

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

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

2.3 (a.) $F_x = -\frac{du}{dx} = F_0 + Cx$

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

(b.) $F_x = -\frac{du}{dx} = F_0 e^{-cx}$

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

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

(c.) $F_x = -\frac{du}{dx} = F_0 \cos cx$

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

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

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

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

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

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

(b.) dan (c.)

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

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

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

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

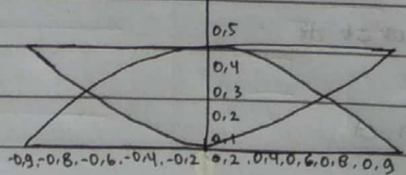
$$T(x) = \frac{k}{2}(A^2 - x^2)$$

(d.) $E = Vc\,x$

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

$$x = \pm A$$

(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) $V = \frac{b}{x^3}$

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

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

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

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

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

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

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

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

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

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

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

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

Partikel berhenti, maka $v = 0$, jadi :

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

(2.12) $m \cdot a_x = \Sigma F_x$

$$m \cdot a_x = -mg - C_2 v^2$$

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

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

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

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

$$dy = 2kv\,dv$$

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

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

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

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

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

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

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

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

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

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

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

(2.13) $v^2 = \left(\frac{g}{k} + v_0^2\right)e^{-2kx} - \frac{g}{k}$ ⇒ ke atas.

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

$v = 0$ pada gerak ke atas :

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

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

h adalah posisi awal untuk gerakan ke bawah dan (t) a = 0,

$$v^2 = \frac{-g}{k}e^{-2kh}e^{2k0} + \frac{g}{k}$$ ⇒ subs $x = 0$

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

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

$$v^2 = -v_t^2\cdot\frac{v_t^2}{v_t^2 + v_0^2} + v_t^2$$

$$v^2 = v_t^2\left(1 - \frac{v_t^2}{v_t^2 + v_0^2}\right)$$

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

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

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

(2.14) $max = \Sigma F_x$

$max = -kx^{-2}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= \frac{du}{-\frac{1}{2ux} - \frac{u}{2x}}$$

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

$$= -\frac{2xu\,du}{u^2+1}$$

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

$$b - x = u^2 x$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= t - 0$$

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

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2.15 $ma = \Sigma F$

$ma = mg - C_2V - C_2V^2$

$ma = 0$

$mg - C_1V - C_2V^2 = 0$

$C_2V^2 - C_1V - mg = 0$

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

Pilih (+)

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

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

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

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