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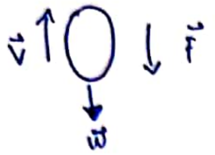
Prodi : Pendidikan fisika (B)

Kuadrat $f = -bv^2$ dengan pengaruh gaya gesekan benda bergerak vertikal keatas



$$\Sigma F = m.a$$
$$-\vec{w} . \vec{f} = m.a$$
$$-mg - bv^2 = m.a$$
$$\int_{v_0}^{v(t)} \frac{dv}{-g - \frac{bv^2}{m}} = \int_0^t dt$$

Misal :
$$-g - \frac{bv}{m} = u$$
$$-\frac{b}{m} dv = du$$
$$dv = \frac{m}{b} . du$$

Maka :
$$\int \frac{1}{u} \left(-\frac{m}{b} - du\right) = -\frac{m}{b} \int \frac{1}{u} dv = \frac{m}{b} \ln(u)$$
$$\int_{v_0}^{v(t)} \frac{1}{-g - \frac{bv^2}{m}} dv = \int_0^t dt$$
$$-\frac{m}{bv} \ln(u) = t$$
$$-\frac{m}{bv} \ln\left(-g - \frac{bv^2}{m}\right)_{v_0}^{v(t)} = t$$
$$-\frac{m}{bv} \left(\ln\left(\frac{-g \times \frac{bv^2}{m}}{-g \times \frac{bv^2}{m}}\right)\right)^{v} = t$$
$$\frac{-g - \frac{bvt}{m}}{-g - \frac{bv_0}{m}} = e - \frac{bv}{m}$$
$$-g - \frac{b}{m} v_t = \left(-g - \frac{b}{m} v_0\right) e - \frac{bv}{m}$$
$$v_t = -\frac{mg}{bv} - \left(-\frac{mg}{bv} - v_0\right) e - \frac{bv}{m}$$

$\rightarrow$ $F = -w$
$$bv = mg$$
$$v(t) = \frac{mg}{bv}$$

$$v(t) = v_T - (v_T - v_0) e - \frac{bvt}{m}$$
$$a(t) = \frac{dv(t)}{dt}$$
$$= \frac{d}{dt}\left(v_T - (-v_0 + v_T) e^{-\frac{bvt}{m}}\right)$$
$$= 0 - (v_0 + v_T)\left(-\frac{bv}{m}\right) e^{-\frac{bvt}{m}}$$
$$= -\frac{bv}{m}\left(v_0 + \frac{bv}{m} v_T\right) e^{-\frac{bvt}{m}}$$

$$a(t) = \left(-g - \frac{b}{m} v_0\right) e^{-\frac{bvt}{m}}$$
$$v(t) = \frac{dy(t)}{dt}$$
$$\int_{y_0}^{y_x} dy(t) = \int_0^t v(t)\, dt$$
$$y(t) = \int_0^t v_T - (-v_0 + v_T) e^{-\frac{bvt}{m}}$$
$$y(t) = \left[v_T t - (v_0 + v_T)\left(-\frac{m}{bv}\right) e^{-\frac{bvt}{m}}\right]$$
$$y(t) = \left[v_T t - (v_0 + v_T) - \left(-\frac{m}{bv}\right) e^{-\frac{bvt}{m}}\right] - \left[(-v_0 - v_T)\left(-\frac{m}{bv}\right)\right]$$
$$y(t) = v_T t - \left(-\frac{m}{bv}\right)(-v_0 + v_T)\left(e^{-\frac{bvt}{m}}\right)$$
$$y(t) = v_T t - \frac{m}{bv}(-v_0 + v_T)\left(1 - e^{-\frac{bvt}{m}}\right)$$
$$y(t) = v_T t - \frac{m}{bm}(-v_0 - v_T)\left(1 - e^{-\frac{bvt}{m}}\right)$$
$$v(t) = v_T - (-v_0 + v_t) e^{-\frac{bvt}{m}}$$
$$a(t) = \left(-g - \frac{bv}{m} v_0\right) e^{-\frac{bvt}{m}}$$

Diaproksimasi
$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} \ldots$$
$$e^{-\frac{bvt}{m}} = 1 - \frac{bvt}{m} + \frac{1}{2}\left(\frac{bvt}{m}\right)^2 + \ldots$$
$$y(t) = v_T t - \frac{m}{bv}(-v_0 - v_T)\left(1 - e^{-\frac{bvt}{m}}\right)$$
$$y(t) = v_T t - (-v_0 + v_T)\left(t - \frac{1}{2}\frac{bv}{m} t^2\right)$$
$$y(t) = v_0 t + \frac{1}{2} \times \frac{bv}{m}$$
$$= v_0 t^2 + \frac{1}{2} \times \frac{bv}{m}\left(-\frac{mg}{bv}\right) t^2$$

* Untuk $b = 0$
$$y(t) = v_0 t - \frac{1}{2} g t^2$$
$$v(t) = v_T - (-v_0 + v_T) e^{-\frac{bvt}{m}}$$
$$v(t) = v_T - (-v_0 + v_T)\left(1 - \left(-\frac{bvt}{m}\right)\right)$$
$$v(t) = v_0 + \frac{bv}{m} . v_0 t - gt$$

* Untuk $b=0$

$$y(t) = V_0 t - \frac{1}{2} g t^2$$

$$V(t) = V_T - (-V_0 + V_T) e^{-\frac{bvt}{m}}$$

$$V(t) = VT - (-V_0 + VT)\left(1 - \left(-\frac{bvt}{m}\right)\right)$$

$$V(t) = V_0 + \frac{bv}{m} \cdot V_0 t - gt$$

* Untuk $b=0$

$$a(t) = -g - \frac{bv}{m} v_0) e^{-\frac{bvt}{m}}$$

$$a(t) = \left(-g - \frac{bv}{m} V_0\right)\left(1 - \frac{bvt}{m}\right)$$

$$a(t) = -g + g \cdot \frac{bvt}{m} - \frac{bv}{m} V_0 + \frac{b^2 v^2}{nt^2}$$

* Untuk $b=0$

$$V_t = -g$$