No.

Date

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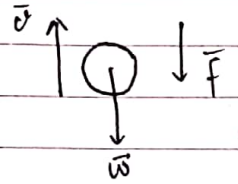
Prodi : Pendidikan Fisika.

Diskusi gerak vertikal ke atas dipengaruhi (hambatan udara $f = -bv^2$).



$f = -bv^2$

$\Sigma F = m \cdot a$

$-w - f = m \cdot a$

$-mg - bv^2 = m \cdot a \quad | \times \frac{1}{m}$

$-g - \frac{bv^2}{m} = a$

$-g - \frac{bv^2}{m} = \frac{dv}{dt}$

$\int_{v_0}^{v_t} \frac{dv}{-g - \frac{b}{m} v^2} = \int_0^t dt$

$\int_{v_0}^{v_t} \frac{f}{v} \frac{dv}{-g - \frac{bv^2}{m}} = \int_0^t dt$

$\int_{v_0}^{v_t} \frac{1}{-g - \frac{bv^2}{m}} \, dv = \int_0^t dt$

$\frac{-m}{bv} \ln u \Big]_{v_0}^{v_t} = t$

$\frac{-m}{bv} \ln \left[-g - \frac{bv^2}{m} \right] \Big]_{v_0}^{v_t} = t$

misalkan:

$-g - \frac{bv^2}{m} = u$

$-\frac{b}{m} \cdot dv = du$

$dv = -\frac{m}{b} \cdot du$

$\int \frac{1}{u} dv = \int \frac{1}{u} \left(-\frac{m}{b} \right) du$

$= -\frac{m}{b} \int \frac{1}{u} du$

$= -\frac{m}{b} \ln u$

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$$\frac{-m}{bv}\left(\ln\left|\frac{-g-\frac{bv_t}{m}}{-g-\frac{bv_0^2}{m}}\right|\right)=t$$

$$\frac{-g-\frac{bv_t}{m}}{-g-\frac{bv_0}{m}}=e^{-\frac{bv^2t}{m}}$$

$$-g-\frac{bv_t}{m}=\left(-g-\frac{bv_0}{m}\right)e^{-\frac{btv^2}{m}}$$

$$v_t=\left(\frac{mg}{bv}\right)-\left(-\frac{mg}{bv}-v_0\right)e^{-\frac{btv}{m}}$$

karena $v_T=\frac{mg}{bv}$

maka

$$v(t)=v_T-(v_T-v_0)\,e^{-\frac{btv}{m}}$$

a). $a(t)=\frac{dv(t)}{dt}$

$$=\frac{d}{dt}\left(v_T-(v_T-v_0)\,e^{-\frac{btv}{m}}\right)$$

$$=0-(-v_0+v_T)\left(-\frac{bv}{m}\right)e^{-\frac{btv}{m}}$$

$$=-\frac{bv}{m}\left(-v_0+v_T\right)e^{-\frac{btv}{m}}$$

$$=-\frac{bv}{m}\left(v_0+\frac{bv}{m}v_T\right)e^{-\frac{btv}{m}}$$

•> $v(t)=\frac{dy(t)}{dt}$

$$\int_0^{y(t)}dy(t)=\int_0^t v(t)\,dt$$

$$y(t)=\int_0^t\left(v_T-(-v_0+v_T)\,e^{-\frac{btv}{m}}\right)dt$$

$$=v_Tt-\left(-v_0+v_T\right)\left(-\frac{m}{bv}\right)e^{-\frac{btv}{m}}\Big]_0^t$$

$$= \left[V_T t - \left(-V_0 + V_T\right)\left(\frac{-m}{bv}\right) e^{-\frac{btv}{m}} \right] - \left[\left(-V_0 + V_T\right)\left(\frac{-m}{bv}\right) \right].$$

$$= V_T t - \left(\frac{m}{bv}\right)\left(-V_0 + V_T\right)\left(e^{-\frac{btv}{m}}\right).$$

$$= V_T t - \frac{m}{bv}\left(-V_0 + V_T\right)\left(1 - e^{-\frac{btv}{m}}\right).$$

$$y(t) = V_T t - \frac{m}{b}\left(V_0 - V_T\right)\left(1 - e^{-\frac{btv}{m}}\right).$$

$$v(t) = V_T - \left(-V_0 + V_T\right)\left(e^{-\frac{btv}{m}}\right).$$

$$a(t) = \left(-g - \frac{bv}{m} V_0\right) e^{-\frac{btv}{m}}$$

Aproksimasi. $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!}$

$$e^{-\frac{btv}{m}} = 1 - \frac{btv}{m} + \frac{1}{2}\left(\frac{btv}{m}\right)^2$$

$$\Rightarrow y(t) = V_T t - \frac{m}{bv}\left(-V_0 - V_T\right)\left(1 - e^{-\frac{btv}{m}}\right).$$

$$y(t) = V_T t - \left(-V_0 + V_T\right)\left(t - \frac{1}{2}\frac{bv}{m} t^2\right).$$

$$y(t) = V_0 t + \frac{1}{2}\frac{bv}{m} V_0 t^2 + \frac{1}{2}\frac{bv}{m}\left(\frac{-mg}{bv}\right) t^2.$$

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

Untuk $b = 0$ maka $y(t) = V_0 t - \frac{1}{2} g t^2$.

$$\Rightarrow v(t) = V_T - \left(-V_0 + V_T\right) e^{-\frac{btv}{m}}$$

$$= V_T - \left(-V_0 + V_T\right)\left(1 - \frac{btv}{m}\right)$$

$$= V_T + V_0 - V_T - \frac{btv V_0}{m} - \frac{btv V_T}{m}$$

$$= V_0 - \frac{btv\, mg}{bv\, m} - \frac{btv V_0}{m}$$

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$= V_0 - gt - \frac{bt v V_0}{m}$

Jika $b = 0$ maka $v(t) = V_0 - gt$.

$a(t) = \left(-g - \frac{bv}{m} V_0\right) e^{-\frac{bt \cdot v}{m}}$

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

$= -g + g\frac{btv}{m} - \frac{bv}{m} V_0 + \frac{b^2 v^2}{m^2} V_0 t$

Untuk $b = 0$ maka $a = -g$.