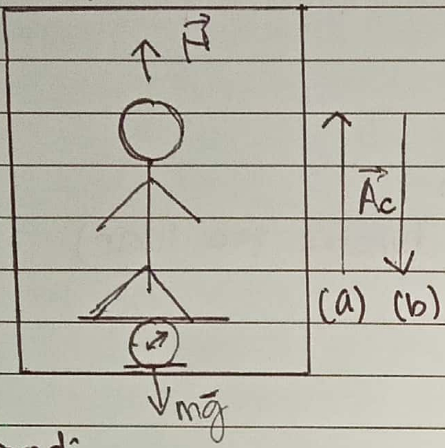
No.

Date . .

5.1 A 120 lb person stands on a bathrom spring scale while riding in an elevator. If the elevator has (a) upward and (b) downward acceleration of $g/4$, what is the weight indicated on the scale in each case?



Jadi

(a) upward

$\vec{N} + m\vec{g} - m\vec{A_0} = 0$

$N - mg - mA_0 = N - mg - m\frac{g}{4}$

$= N - \frac{5}{4}mg = 0$

$w' = N = \frac{5}{4}mg = \frac{5}{4}w'$

$w' = 150 lb$

(b) The acceleration is downward in th same direction as $\vec{g}$

$N - mg + m\left(\frac{g}{4}\right) = 0$

$w' = w - \frac{w}{4}$

$= \frac{3}{4}w'$

$w' = 90 lb$

No.

Date

5.2 An ultracentrifuge has a rotational speed of 500rps. (a) Find the centrifugal force on a 1-μg particel in the sample chamber if the particel is 5 cm from the rotational axis. (b) express th result as the ratio of the centrifugal force to the weight of the particle.

Jadi

(a). $\vec{F}_{cent} = -m\vec{\omega} \times (\vec{\omega} \times \vec{r})$

untuk $\vec{\omega} \perp \vec{r}$. $\vec{F}_{cent} = m\omega^2 r' \hat{e}_r$

$\omega = 500 s^{-1} = 1000\pi s^{-1}$,

$\vec{F}_{cent} = 10^{-6} (1000\pi)^2 \times 5 \hat{e}_r = 5\pi^2$ (dyness ke luar)

(b) $\dfrac{F_{cent}}{F_g} = \dfrac{\omega^2 m r'}{mg}$

$= \dfrac{(1000\pi)^2 5}{980}$

$= 5,04 \times 10^4$

5.3 A plumb line is held steady while being carried along in a moving train. If the mass of the plumb bob is m, find the tension in the cord and the deflection from the local vertical if the train is accelerating forward with constand acceleration g/10. (Ignore any effects of earth's rotation)

Jadi

$m\vec{g} + \vec{T} - m\vec{A}_0 = 0$

$-mg\,\hat{j} + T\cos\theta\,\hat{j} + T\sin\theta\,\hat{i} - m\left(\dfrac{g}{10}\right)\hat{i} = 0$

$T\cos\theta = mg$, dan $T\sin\theta = \dfrac{mg}{10}$

$\tan\theta = \dfrac{1}{10}$.

$\theta = 5,71$

$T = \dfrac{mg}{\cos\theta} = 1.005\ mg$.

5.4 If, in problem 5.3 the plumb line is not held steady but oscillates as a simple pendulum, find the period of oscillation for small amplitude.

Answer:

Pengamat no inersia berpikir bahwa $\vec{g}$ menunjuk ke bawah ke arah balok tegak yang tergantung.

Dengan demikian:

$$\vec{g}' = \bar{g} - \bar{A}_0$$
$$= g\hat{j} - \frac{g}{10}\hat{i}$$

Untuk osilasi kecil bandul sederhana:

$$T = 2\pi\sqrt{\frac{l}{g'}}$$

$$g' = \sqrt{g^2 + \left(\frac{g}{10}\right)^2} = 1500\, g$$

$$T = 2\pi\sqrt{\frac{l}{1005\, g}} = 1995\,\pi\sqrt{\frac{l}{g}}$$

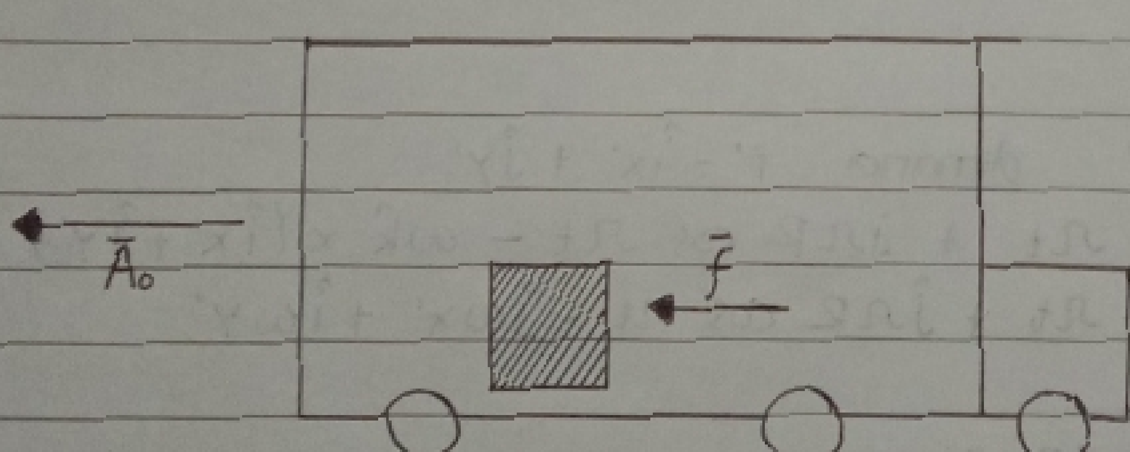
5.5 A hauling truck is travelling on a level road. The driver suddenly applies the brakes, causing the truck to decelerate by an amount $g/2$. This causes a box in the rear of the truck to slide forward. If the coefficient of sliding friction between the box and the truck bed is $1/3$, find the acceleration of the box relative to

a.) the truck and

b.) the road

Answer:

a.) $f = -\mu m g$ → Gaya gesekan yang bekerja pada kotak



Jadi, $\bar{f} - m\bar{A}_0 = m\bar{a}'$ ($\bar{a}'$ adalah percepatan kotak relatif terhadap truk)

b.) $\bar{f}$ satu-satunya gaya nyata yang bekerja secara horizontal, sehingga percepatan relatif terhadap jalan yaitu:

$$a = \frac{f}{m} = -\frac{\mu m g}{m} = -\mu g = -\frac{g}{3}$$

(Untuk (+) dalam arah truk yang bergerak, untuk (−) arah gesekan melawan geser kotak ke depan).

$$A_0 = -\frac{g}{2} \quad \text{(Truk melambat)}$$

Dari atas, $ma - mA_0 = ma'$

Jadi, $a' = a - A_0$

$$= -\frac{g}{3} + \frac{g}{2}$$

$$= \frac{g}{6}$$

5.6. The position of a particle in a fixed inertial frame of reference is given by the vector $r = i\,(x_0 + R\cos \Omega t) + jR \sin \Omega t$

Where x_0, R, and Ω are constants

a.) Show that the particle moves in a circle with constant speed.

b.) Find two coupled, first-order differential equations of motion that relate the components of position, x' and y', and the components of velocity, $\dot{x}'$ and $\dot{y}'$, of the particle relative to a frame of reference rotating frames of reference rotating with an angular velocity $\omega = k\omega$

c.) Letting the fixed and rotating frames of reference coincide at times $t=0$ and letting $u' = x' + iy'$, find $u'(t)$, assuming that $\Omega \neq -\omega$ (Note: $i = \sqrt{-1}$).

Answer:

a.) $\bar{r} = \hat{i}\,(x_0 + R\cos \Omega t) + \hat{j}R \sin \Omega t$

$\dot{\bar{r}} = -\hat{i}\,\Omega R \sin \Omega t + \hat{j}\,\Omega R \cos \Omega t$

$\dot{\bar{r}} \cdot \dot{\bar{r}} = v^2$ $\Rightarrow \underline{v = \Omega R}$ (Gerak melingkar berjari-jari R)

$= \Omega^2 R^2$

b.) $\dot{\bar{r}}' = \dot{\bar{r}} - \bar{\omega} \times \bar{r}'$ dimana $\bar{r}' = \hat{i}x' + \hat{j}y'$

$= -\hat{i}\,\Omega R \sin \Omega t + j\Omega R \cos \Omega t - \omega\hat{k} \times (\hat{i}x' + \hat{j}y')$

$= -\hat{i}\,\Omega R \sin \Omega t + \hat{j}\,\Omega R \cos \Omega t - \hat{j}\omega x' + \hat{i}\omega y'$

$\dot{x}' = \omega y' - \Omega R \sin \Omega t$

$\dot{y}' = -\omega x' + \Omega R \cos \Omega t$

c.) $u' = x' + iy'$ dimana $i = \sqrt{-1}$!

$\dot{u}' = \dot{x}' + i\dot{y}' = \omega y' - \Omega R \sin \Omega t - i\omega x' + i\Omega R \cos \Omega t$

$i\omega u' = \quad -\omega y' \quad + i\omega x'$

$\therefore \dot{u}' + i\omega u' = -\Omega R \sin \Omega t + i\Omega R \cos \Omega t = i\Omega R e^{i\Omega t}$

Solusi dari bentuk

$u' = Ae^{-i\omega t} + Be^{i\Omega t}$

$\dot{u}' = -i\omega Ae^{-i\omega t} + i\Omega Be^{i\Omega t}$

$i\omega u' = i\omega Ae^{-i\omega t} + i\omega Be^{i\Omega t}$

$\therefore \dot{u}' + i\omega u' = i(\omega + \Omega) Be^{i\omega t}$ Jadi, $B = \dfrac{\Omega R}{\omega + \Omega}$

Pada saat $t = 0$ sistem koordinat bertepatan yaitu:

$$u' = A + B$$
$$= x'(0) + iy'(0)$$
$$= x_0 + R$$

$\therefore A = x_0 + R - B$

$= x_0 + R - \dfrac{\Omega R}{\omega + \Omega}$

Jadi, $A = x_0 + \dfrac{\omega R}{\omega + \Omega}$

Dengan demikian:

$$u' = \left[x_0 + \frac{\omega R}{\omega + \Omega} \right] e^{-i\omega t} + \frac{\Omega R}{\omega + \Omega} e^{i\Omega t}$$

examine: $\bar{A} - \bar{A}_c - \bar{\Omega} \times \bar{\Omega} \times \bar{r}$

$= \bar{\omega} \times \bar{\omega} \times \bar{R} - \bar{\Omega} \times \bar{\Omega} \times \bar{R}_c - \bar{\Omega} \times \bar{\Omega} \times (\vec{R} - \vec{R}_c)$

$= (\bar{\omega} \times \vec{\omega} - \vec{\Omega} \times \vec{\Omega}) \times \vec{R} = -(\omega^2 - \Omega^2)\vec{R}$ Note: $\vec{\omega} = \omega\bar{k}$. $\vec{\Omega} = \Omega\bar{k}$

thus

$\vec{a} = (\Omega^2 - \omega^2)\bar{R} - 2\vec{\Omega} \times \bar{v}$

therefore:

$(\bar{i}\ddot{x} + \bar{j}\ddot{y}) = (\Omega^2 - \omega^2)[\bar{i}R\cos(\Omega - \omega)t - \bar{j}R\sin(\Omega - \omega)t] - 2\bar{j}\Omega\dot{x} + 2\bar{i}\Omega\dot{y}$

thus

$\ddot{x} = (\Omega^2 - \omega^2)R\cos(\Omega - \omega)t + 2\Omega\dot{y}$

$\ddot{y} = -(\Omega^2 - \omega^2)R\sin(\Omega - \omega)t - 2\Omega\dot{x}$

for $\ddot{x} = (\Omega - \omega)\dot{y}$ and $\ddot{y} = (\Omega - \omega)\dot{x}$

then, we have

$\dot{y} = (\Omega - \omega)R\cos(\Omega - \omega)t + \frac{2\Omega}{(\Omega - \omega)}\dot{y}$ which reduce to

$\dot{y} = -(\Omega - \omega)R\cos(\Omega - \omega)t$

Integrating... $\boxed{y = -R\sin(\Omega - \omega)t} \to 0$ at $t = 0$

Also.

$-\dot{x}(\Omega - \omega) = -(\Omega^2 - \omega^2)R\sin(\Omega - \omega)t - 2\Omega\dot{x}$

or $\dot{x} = (\Omega + \omega)R\sin(\Omega - \omega)t + 2\Omega\dot{x}$

$\dot{x} = -(\Omega - \omega)R\sin(\Omega - \omega)t$

Integrating.... $x = R\cos(\Omega - \omega)t + \text{Const}$

$\boxed{x = R\cos(\Omega - \omega)t - R_c} \to R - R_c$ at $t = 0$