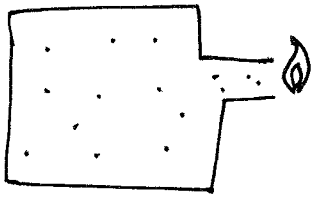
Lecture 18

10/22/09

Milk jug rocket



Δm = mass of gas

M = mass of milk jug.

$$(M+\Delta m).0 = MV + \Delta m . v$$

$$\Rightarrow \quad V = -\frac{\Delta m}{M} . v$$

for large V, v has to be extremely large since $\Delta m << M$. That's why there was an explosion when I ignited the gas.

Glancing collisions

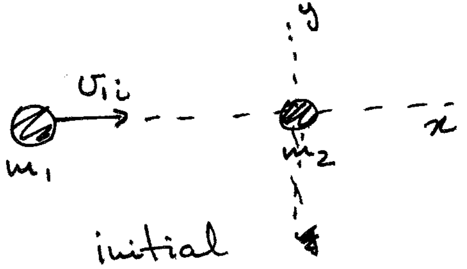
$\vec{p}_i = \vec{p}_f$ (conservation of momentum)

Since momentum is a vector if $\vec{p}_i = \vec{p}_f$

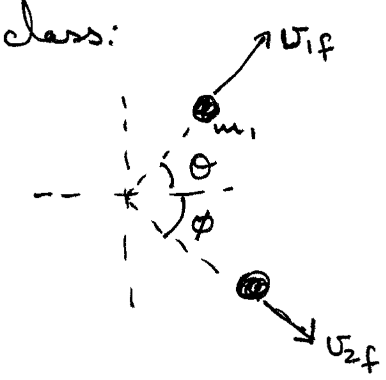
then $p_{ix} = p_{fx}$ & $p_{iy} = p_{fy}$

See formula in lecture17slides.

For the problem shown in class:



initial



final.

$p_{ix} = m_1 v_{1ix} + m_2 v_{2ix} = m_1 v_{1i} + 0 = m_1 v_{1i}$

$p_{iy} = m_1 v_{1iy} + m_2 v_{2iy} = 0 + 0 = 0$

$p_{fx} = m_1 v_{1fx} + m_2 v_{2fx} = m_1 v_{1f} \cos\theta + m_2 v_{2f} \cos\phi$

$p_{fy} = m_1 v_{1fy} + m_2 v_{2fy} = m_1 v_{1f} \sin\theta - m_2 v_{2f} \sin\phi$

$p_{ix} = p_{fx} \Rightarrow m_1 v_{1f} \cos\theta + m_2 v_{2f} \cos\phi = m_1 v_{1i}$

$p_{iy} = p_{fy} \Rightarrow m_1 v_{1f} \sin\theta - m_2 v_{2f} \sin\phi = 0$

KE is conserved for all elastic collisions including glancing collisions. See equation in lectureslides.

REMEMBER

$\boxed{\cancel{v_{1i} + v_{1f} = v_{2i} + v_{2f}}}$ ~~→ is not applic~~ → is NOT applicable because this equation true ONLY for 1D elastic collisions.

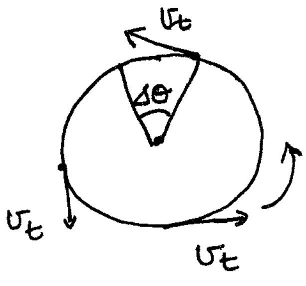
Rotations → see lecture slides

$\Delta\theta = \frac{\Delta s}{r}$, $\Delta\theta$ has units radians but is dimensionless.

Angular velocity

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \lim_{\Delta t \to 0} \frac{1}{r} \frac{\Delta s}{\Delta t} = \frac{v_t}{r}$$ where

v_t is the tangential velocity.



if ω changes: $\Delta\omega = \frac{\Delta v_t}{r}$

Angular acceleration $\alpha = \lim_{\Delta t \to 0} \frac{\Delta \omega}{\Delta t} = \lim_{\Delta t \to 0} \frac{1}{r} \frac{\Delta v_t}{\Delta t}$

$$= \frac{a_t}{r}$$

$\Rightarrow \quad \alpha = \frac{a_t}{r}$, where a_t is the tangential acceleration.

$$\boxed{\begin{aligned} \Delta s &= r\Delta\theta \\ v_t &= r\omega \\ a_t &= r\alpha \end{aligned}} \longrightarrow \textcircled{I}$$

"Kinematic" equations for angular quantities

$$v_t = v_{ti} + a_t t$$

$$\Rightarrow \frac{v_t}{r} = \frac{v_{ti}}{r} + \frac{a_t}{r} t$$

$$\Rightarrow \omega = \omega_i + \alpha t \longrightarrow \textcircled{II}$$

Similarly

$$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2 \longrightarrow \textcircled{III}$$

$$\omega^2 = \omega_i^2 + 2\alpha\Delta\theta \longrightarrow \textcircled{IV}$$