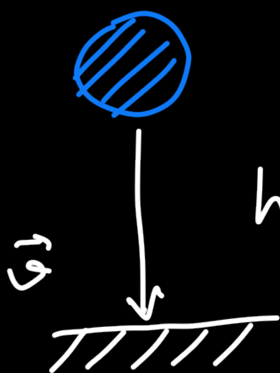
Homework 14

N1.



$m = 10\,g$ $\quad t = 0.01\,s.$

$h = 180\,m$

$\vartheta = \sqrt{2gh} \simeq 60\,\frac{m}{s}$

$m = 10^{-2}\,kg. \rightarrow p = m\vartheta = 0.6\,kg \cdot m/s$

$p' = -m\vartheta \Rightarrow \Delta p = p - p' = 2m\vartheta$

$$\boxed{\Delta p = 1.2\,kg \cdot m/s}$$

$$\Delta p = F \cdot t \Rightarrow \boxed{F = \frac{\Delta p}{t} = 120\,N}$$

$$\boxed{h = g\,T^2/2} \Rightarrow \boxed{T = \sqrt{2h/g}}$$

$$\boxed{\vartheta = g \cdot T = g \cdot \sqrt{2h/g} = \sqrt{2gh}}$$

N2.

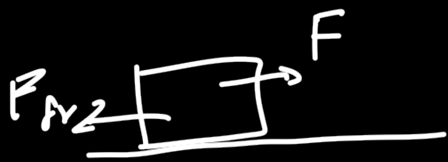
$\Delta p_1 = 20\,kg \cdot m/s$ $\quad | \quad F_2 = 250\,N$

$\Delta p_2 = 10\,kg \cdot m/s$

$$F_1 = \frac{\Delta p_1}{0.025\,s} = 800\,N \,; \quad F_2 = \frac{\Delta p_2}{0.04\,s} = 250\,N$$

N 3*

$$mv = |\Delta\vec{p}| = F_{fr}\cdot 3\Delta t$$



$$|\Delta\vec{p}| = (F - F_{fr})\Delta t$$

$$\parallel mv$$

$$F_{fr}\cdot 3\cancel{\Delta t} = (F - F_{fr})\cdot\cancel{\Delta t}$$

$$4F_{fr} = F$$

$$\Downarrow$$

$$\boxed{F_{fr} = \frac{F}{4}}$$

Energy → Kinetic energy.

Why is it useful?

→ energy conservation laws.

→ has different forms.

→ only the total energy is conserved!

Types:

- kinetic energy
- potential energy
- elastic energy.
- thermal energy.
- sound

Kinetic energy:

$$\boxed{E_{kin.} = \frac{m \cdot v^2}{2}}$$

$$[E] = kg \cdot \frac{m^2}{s^2} = 1\,J$$

Another way using momentum:

$$\boxed{E_{kin} = \frac{p^2}{2\cdot m}} \qquad p = m\cdot v$$

$$\frac{m^{\cancel{2}}\cdot v^2}{2\,\cancel{m}} = \frac{m v^2}{2}$$

<u>Example</u>: $m = 80\,kg$, $v = 5\,m/s$

$$E_{kin} = \frac{80\,kg \cdot 25\,m^2/s^2}{2} = 1000\,J$$

$$= \underline{1\,kJ}$$

<u>Martial arts</u>: velocity beats the mass!

$$\boxed{\begin{array}{l} v \rightarrow 4\,v \\ E_{kin} \rightarrow 16\,v \end{array}}$$

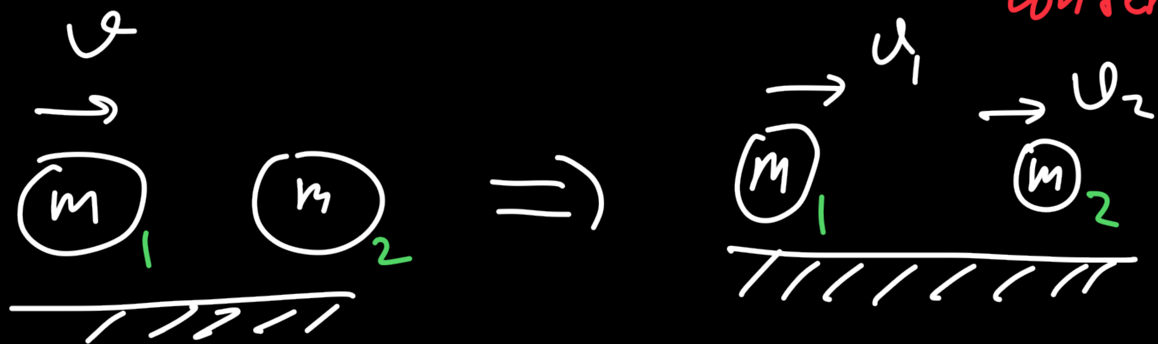
Collissions

inelastic

(E kin is not conserved)

completely elastic

(kinetic energy is conserved!)



Completely elastic:

$$E_{kin} = \frac{mv^2}{2} + 0 = \frac{mv^2}{2}$$

after: $E_{kin} = \frac{mv_1^2}{2} + \frac{mv_2^2}{2}$

$$\frac{\cancel{m}v^2}{\cancel{2}} = \frac{\cancel{m}v_1^2}{\cancel{2}} + \frac{\cancel{m}v_2^2}{\cancel{2}} \Rightarrow \boxed{v^2 = v_1^2 + v_2^2}$$

Other conservation laws?

Momentum is conserved:

$$p = m \cdot v + 0 \qquad \Big| \qquad p = p'$$
$$p' = m v_1 + m v_2$$

$$\Rightarrow \boxed{v = v_1 + v_2} \longrightarrow \boxed{v_2 = v - v_1}$$

$$\begin{cases} v = v_1 + v_2 \\ v^2 = v_1^2 + v_2^2 \end{cases} \qquad v^2 = (v_1 + v_2)^2 = \\ = v_1^2 + v_2^2$$

$$\Rightarrow \cancel{v_1^2} + 2 v_1 v_2 + \cancel{v_2^2} = \cancel{v_1^2} + \cancel{v_2^2}$$

$$\boxed{v_1 \cdot v_2 = 0} \Rightarrow \checkmark\ v_1 = 0 \text{ or } \underline{v_2 = 0} \quad \times$$

After the collision: $\begin{cases} v_1 = 0 \\ v_2 = v \end{cases}$

<u>Next</u>: inelastic collision.