18/10/2020

Laws of Motion

① first law = Law of Inertia (not moment of inertia)

② second law

$$\vec{F} = \frac{d\vec{p}}{dt} \qquad F_{av} = \frac{\Delta \vec{p}}{\Delta t}$$

- Momentum: $\vec{p} = m\vec{v}$

⇒ Liquid - jet

① after striking wall, jet splashed.

$$F_{jet} = -\rho A v^2$$

$$F_{wall} = +\rho A v^2$$

$\frac{m}{dt} \Rightarrow \rho A v$ (mass of liquid flow/time)

$\frac{V}{dt} \Rightarrow Av$ (rate of flow)

② Liquid jet bounces back

$$F_{jet} = -2\rho A v^2$$

$$F_{wall} = +2\rho A v^2$$

③ Liquid jet strikes obliquely.

$$F_{jet} = -2\rho A v^2 \cos\theta$$

- रस्सी वेगवाली की tension वेगवाले.

$a = g\sin\theta$ | $mg\cos\theta = N$

③ Lift problems

$N = mg$

Reading of weighing machine = True wt

- acch not determine the direct of object, (Velocity determines).

a) $N = m(g+a)$ (a up ⇑, g up)

b) a downward ⇒ $N = m(g-a)$

c) Free fall ⇒ $N = 0$

- जहाँ inclined force बोलते वहाँ $N = mg$ direct बोलते.

$N = mg\cos\theta$, $A = g\sin\theta$ | $N = mg\cos\theta$, $A = g\tan\theta$

For only inclined plane

$A = g\sin\theta$ | $N = mg\cos\theta$

for relative slipping (when block & plane move)

$A = g\tan\theta$ | $N = mg\cos\theta$

④ Monkey - problems.

$$T_{breaking} = m(g + a_{max})$$

- when monkey climbs up the rope

$$t_{min} = \frac{\ell}{\sqrt{a_{max}}} \qquad \tan\theta = \frac{A}{g}$$

(pendulum in lift)

- throughout chapter using mostly system boundry tech. (No relative slipping)

⑤ Lami's theorem

$$\frac{F_1}{\sin\alpha} = \frac{F_2}{\sin\beta} = \frac{F_3}{\sin\gamma}$$

⑥ Impulse

- suddenly changing linear momentum.

⇒ Impulsive force

$$F_{imp} = \frac{dp}{dt}$$

a) collision of ball with Gd.

Impulse: $m(v_1 + v_2)$

Av. Impulsive force: $\frac{\Delta p}{\Delta t}$

$v_1 = \sqrt{2gh_1}$

$v_2 = \sqrt{2gh_2}$

b) perfectly elastic collision.

Impulse ⇒ $2mv$

and, Impulsive force: $\frac{2mv}{\Delta t}$

c) oblique elastic collision.

Impulse: $2mv\cos\theta$

Av. Impulsive force: $\frac{2mv\cos\theta}{\Delta t}$

⑦ Bullet – Plate

① $\Delta P = 2mv$.

② $F_{av} = \dfrac{\Delta P}{\Delta t} = \boxed{\dfrac{2mv}{\Delta t}}$

③ $\boxed{F_{total} = 2nmv.}$ → $\frac{N}{t}$

④ $\boxed{2nmv = mg}$

⑧ tension trick

$$W = F.S.\cos\theta$$

$$P = F.V.\cos\theta$$

for tension force and Normal force.

$$\Sigma W = 0$$

$$\Sigma P = 0$$

— NO energy store.

Collision

$e = 1 \Rightarrow$ perfectly elastic
$e = 0 \Rightarrow$ perfectly inelastic
$0 < e < 1 \Rightarrow$ Inelastic

in one dimension

1. perfectly elastic collisn.
2. Inelastic collisn.
3. perfectly Inelastic collisn.

① Inelastic collisn.

→ F_{ext} is zero
→ momentum is conserved.

$$P_i = P_f$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

1) coeff. of Restitution.

$$e = \frac{v_2 - v_1}{u_1 - u_2} \quad \begin{matrix} \text{separation} \\ \text{approach} \end{matrix}$$

⇒ when v_1 & v_2 not given in question.
then use formula.

$$v_1 = \frac{(m_1 - em_2)u_1 + (1+e)m_2u_2}{(m_1 + m_2)}$$

$$v_2 = \frac{(1+e)m_1u_1 + (m_2 - em_1)u_2}{(m_1 + m_2)}$$

2) Loss in K.E: $\Delta K_f = K_i - K_f$

$$\Delta K = \frac{1}{2}\frac{m_1m_2}{(m_1+m_2)}(u_1-u_2)^2(1-e^2)$$

② Perfectly elastic collisn

$$(K.E)_{final} = (K.E)_{initial}$$

1) K.E. transfer during head on elastic collisn

$$\frac{\Delta K}{K} = 1 - \left[\frac{m_1 - m_2}{m_1 + m_2}\right]^2 = \frac{4m_1m_2}{(m_1+m_2)^2}$$

③ Perfectly inelastic collisn

$$P_i = P_f$$

$$m_1u_1 + m_2u_2 = (m_1+m_2)V$$

$$V = \frac{m_1u_1 + m_2u_2}{(m_1+m_2)}$$

$$\text{Heat} = \frac{1}{2}\frac{c_1c_2}{(c_1+c_2)}(v_1-v_2)^2$$

$$\Delta K = \frac{1}{2}\frac{m_1m_2}{(m_1+m_2)}(u_1-u_2)^2$$

④ max. elongation & compression in spring

— same as perfectly inelastic collisn

$$V_{common} = \frac{m_1u_1 + m_2u_2}{m_1+m_2}$$

$$\frac{1}{2}\frac{m_1m_2}{(m_1+m_2)}(u_1-u_2)^2 = \frac{1}{2}kx^2$$

⑤ Bouncing of Ball

$$v_n = e^n v_0 \qquad v_0 = \sqrt{2gh_0}$$

$$H_n = e^{2n}h_0$$

$$\text{Total dist} = h_0\left(\frac{1+e^2}{1-e^2}\right)$$

$$\text{total time} = \left[\frac{1+e}{1-e}\right]\sqrt{\frac{2h_0}{g}}$$

inelastic collisn में mass (m) add हो जाती है
and in perfectly elastic में v_1 transfer another body पर होता है.