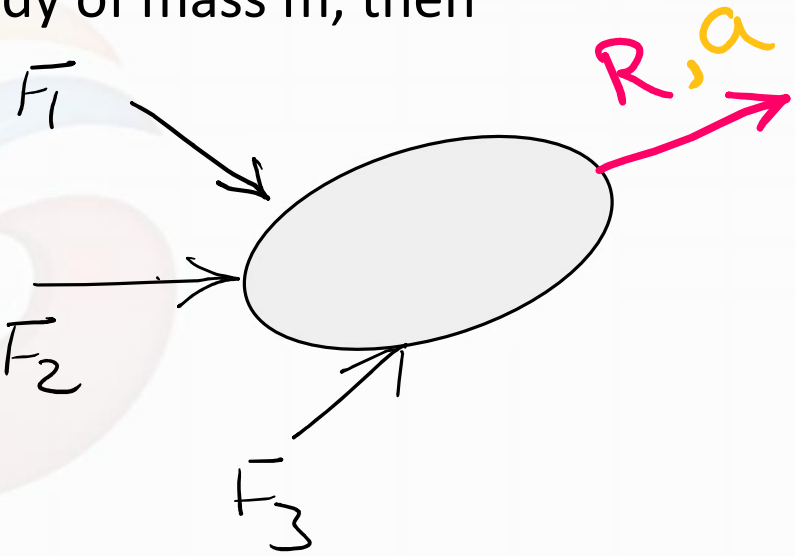
UNIT-5
IMPLUSE MOMENTUM METOD

RECAP – Methods for solving kinetic problems

- D'Alembert's Principle (Force and acceleration)
- Work-Energy Method (Force, velocity and displacement)
- Impulse-Momentum Method (Force, time and velocity)

Linear Impulse and Momentum

- R is the resultant force acting on the body of mass m, then



$$\int \quad = \int$$

$$\int \quad = \int \quad = \quad [\quad - \quad]$$

Continued

- $\int$ is called Impulse.
- The unit of impulse is N-s.
- Mass* Velocity is called momentum of the body in N-s.
- u is initial velocity of the body.
- v is the final velocity of body after time ‘t’
- Thus

$$= \quad -$$

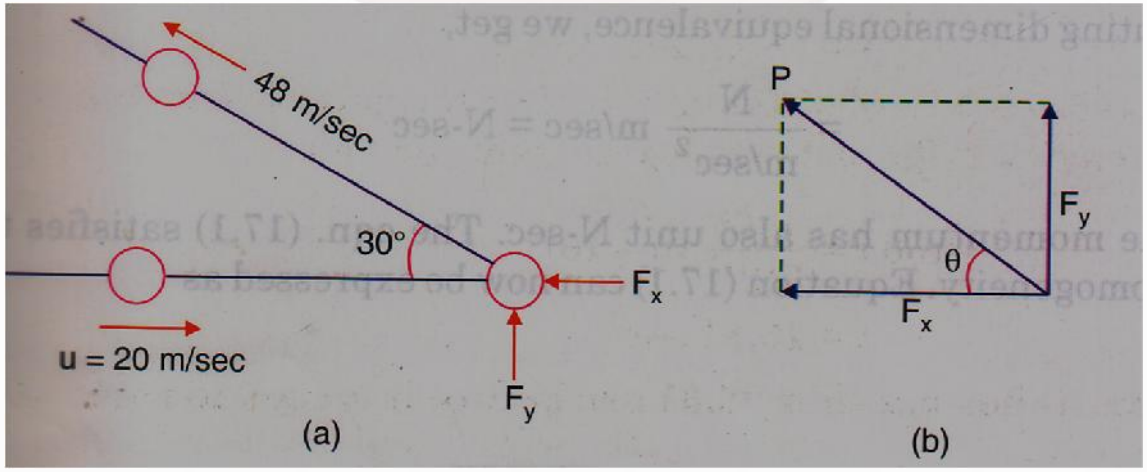
- The impulse momentum equation holds good if the direction of u, v and R are same

I M equation - Component wise

- **"The components of a resultant linear impulse along any direction is equal to change in the component of momentum in that direction."**

Practice Problem [Ref : Engineering Mechanics – SS Bhavikatti]

- A 1 N cricket ball is bowled to the batsman. The velocity of ball was 20 m/s horizontally just before the batsman hit it. After hitting, it went with a velocity of 48 m/s at an inclination of 30° upwards from horizontal. Find the average force exerted on the ball by the bat if the impact lasts for 0.02 sec.



Solution

- IM equation in X-direction

$$\times 0.02 = \frac{1}{9.81}[48\cos 30 \quad -(-20)]$$

$$= 331 \cdot 81$$

- IM in Y-direction

$$\times \ 0.02 = \frac{1}{9.81}[48\sin 30° \ - 0]$$

$$= 122.32$$

Solution

Resultant Force $= \sqrt{\quad + \quad}$ =336.81 N

$= \tan \left(\frac{\quad}{\quad}\right)$ = 21.30° to the horizontal

Summary

- If the quantities of interest in kinetics problem are force, time and velocity, Impulse momentum equation is a handy tool for solution.

Question

- Sometimes in the IPL matches, when a bowler himself stops the ball hit by the batsman for boundary gets hurt. What goes wrong? Relate your answer to IM equation.

Text Book

Text Book:

- Engineering Mechanics by S. S. Bhavikatti and K G Rajashekharappa, Seventh Multi Color edition, 2019. New Age International Publisher, Delhi, ISBN: 978-93-87788-49-7

Reference Books:

- J. V. Rao, D. H. Young, S. Timoshenko, Sukumar Pati (2013), Engineering Mechanics, Tata McGraw Hill Education. ISBN: 978-1-259-06266-7.
- P. Ferdinand, E. Beer and J. Russell (2010), Vector Mechanics for Engineers, 9th Edition, McGraw-Hill International Edition. ISBN: 978-0-079-12637-5
- Irving H. Shames (2012), Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice-Hall of India Private limited. ISBN: 978-8-131-72883-3

Thanks!