DYNAMICS

Planar Kinetics of a Rigid Body (Translation)

by:

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Planar Kinetics – Translation

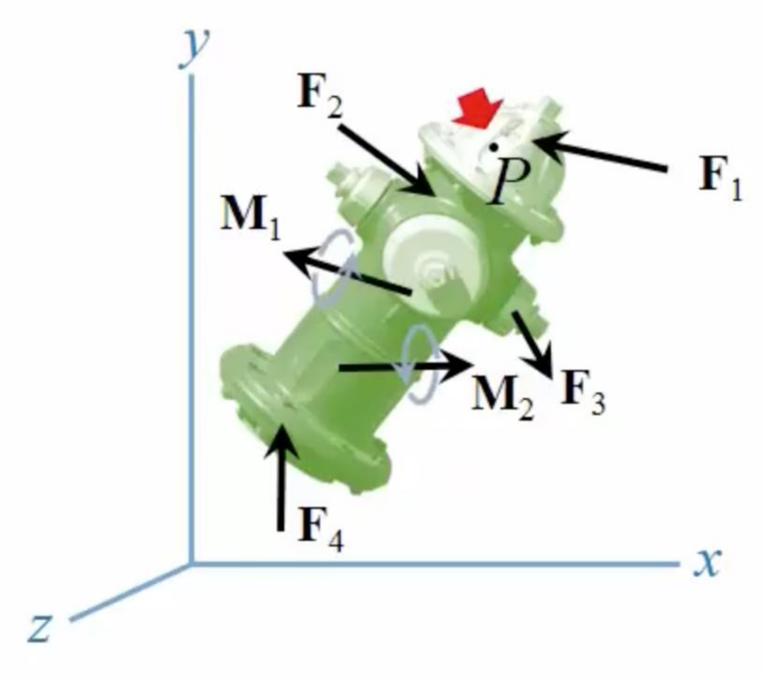
- Aims
  - To draw the free body diagram of a rigid body in motion.
  - To draw the kinetic diagram of a rigid body in motion.
  - To determine the forces and moments of a translating rigid body.

- Expected Outcomes
  - Students are able to draw the free body diagram and kinetic diagram of a rigid body in motion.
  - Students are able to determine the forces and moments of a translating rigid body.

- References
  - Engineering Mechanics: Dynamics 12th Edition, RC Hibbeler, Prentice Hall

Contents

Rigid Body Equilibrium

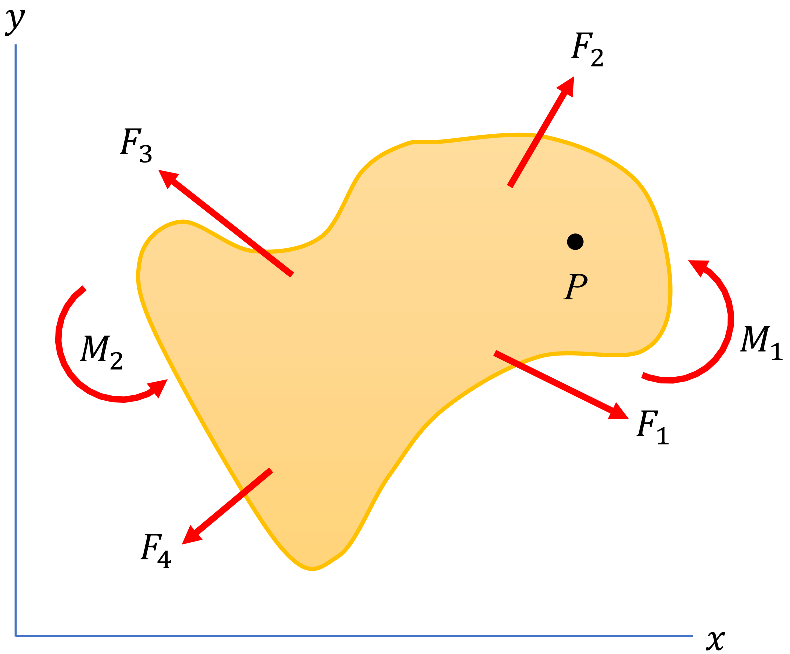


$$\vec{F}_R = \sum \vec{F} = 0$$

$$\vec{M}_{R,P} = \sum \vec{M}_{F,P} + \sum \vec{M}$$

Three-dimensional

Rigid Body Equilibrium



$$\sum F_x = 0$$

$$\sum F_y = 0$$

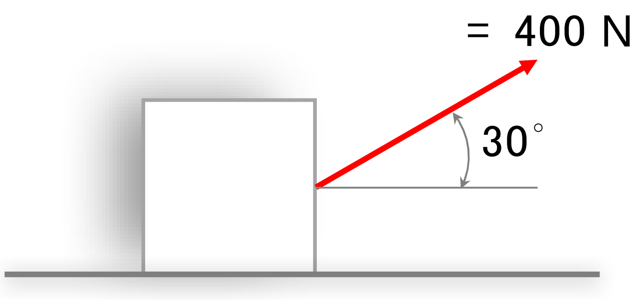
$$\sum M_P = \sum M_{F,P} + \sum M = 0$$

Two-dimensional

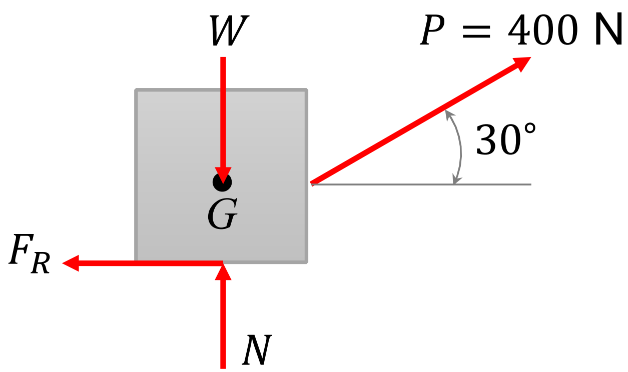
Free Body Diagram & Kinetic Diagram

- **FBD**: To identify external forces acting on the rigid body.
- **Kinetic Diagram**: To show the effect of acceleration component ($m\vec{a}$) on the object.

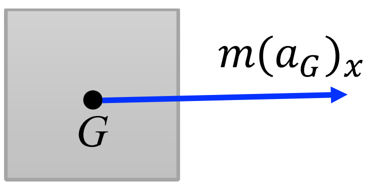
The 50-kg crate shown rests on a horizontal plane for which the coefficient of friction is $\mu_k = 0.3$. The crate is subjected to a towing force of magnitude 400 N and moves to the right without tipping over. Draw the free-body and kinetic diagrams of the crate.



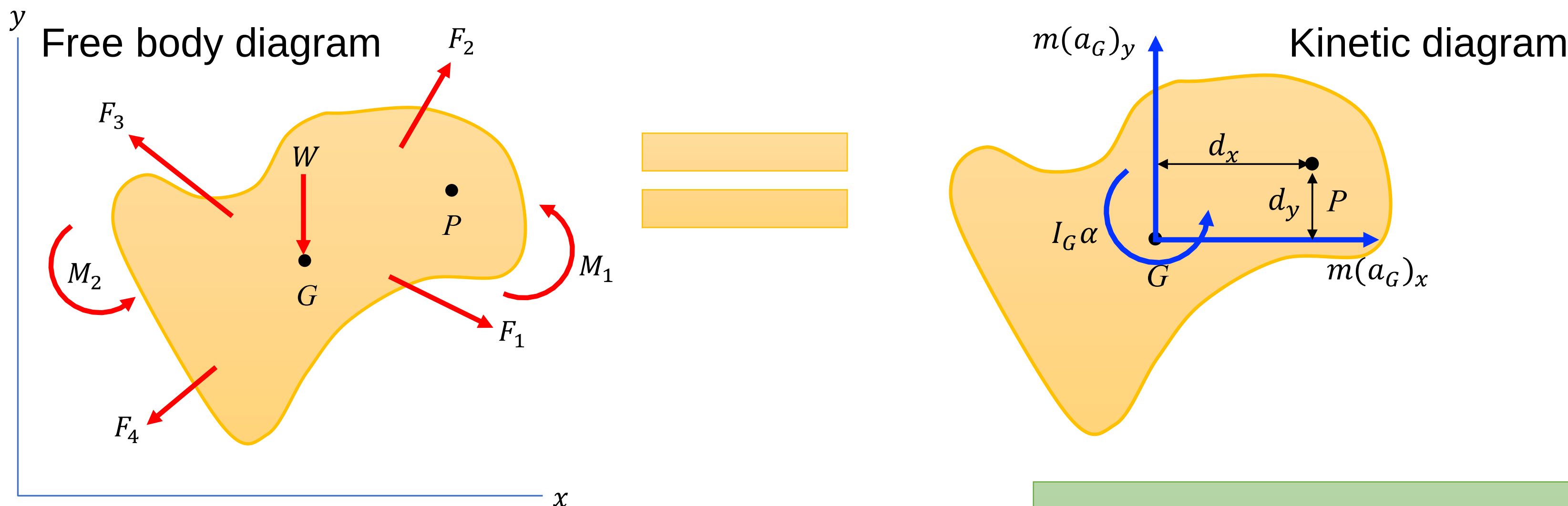
Free body diagram



Kinetic diagram



General Equation of Motion



$$\sum F_x = m(a_G)_x$$

$$\sum F_y = m(a_G)_y$$

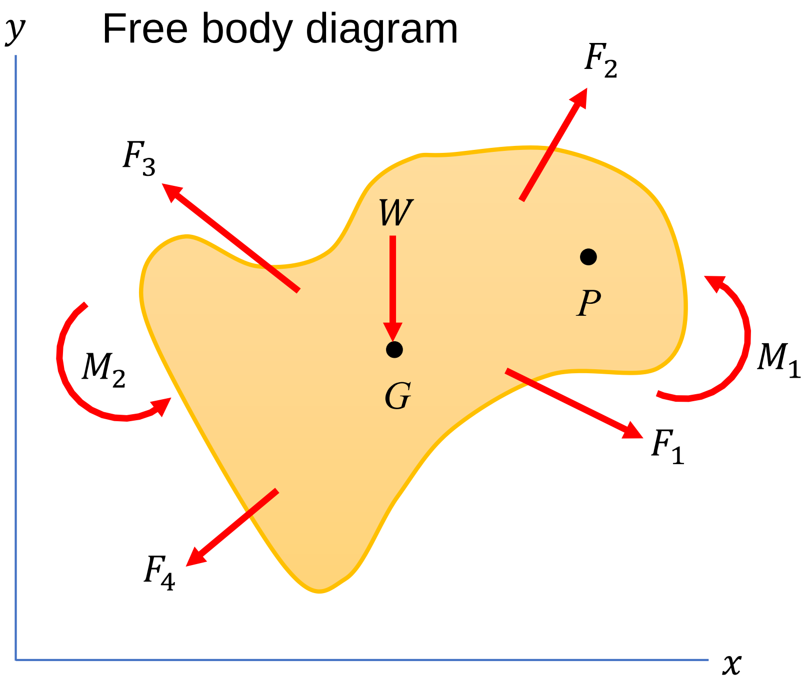
$$\sum M_P = \sum M_{F,P} + \sum M = \sum (\mathscr{M}_k)_P$$

$$\sum (\mathscr{M}_k)_P = m(a_G)_x \cdot d_y - m(a_G)_y \cdot d_x + I_G\alpha$$

Sum of kinetic moment about Point *P*

About Point *P*

General Equation of Motion



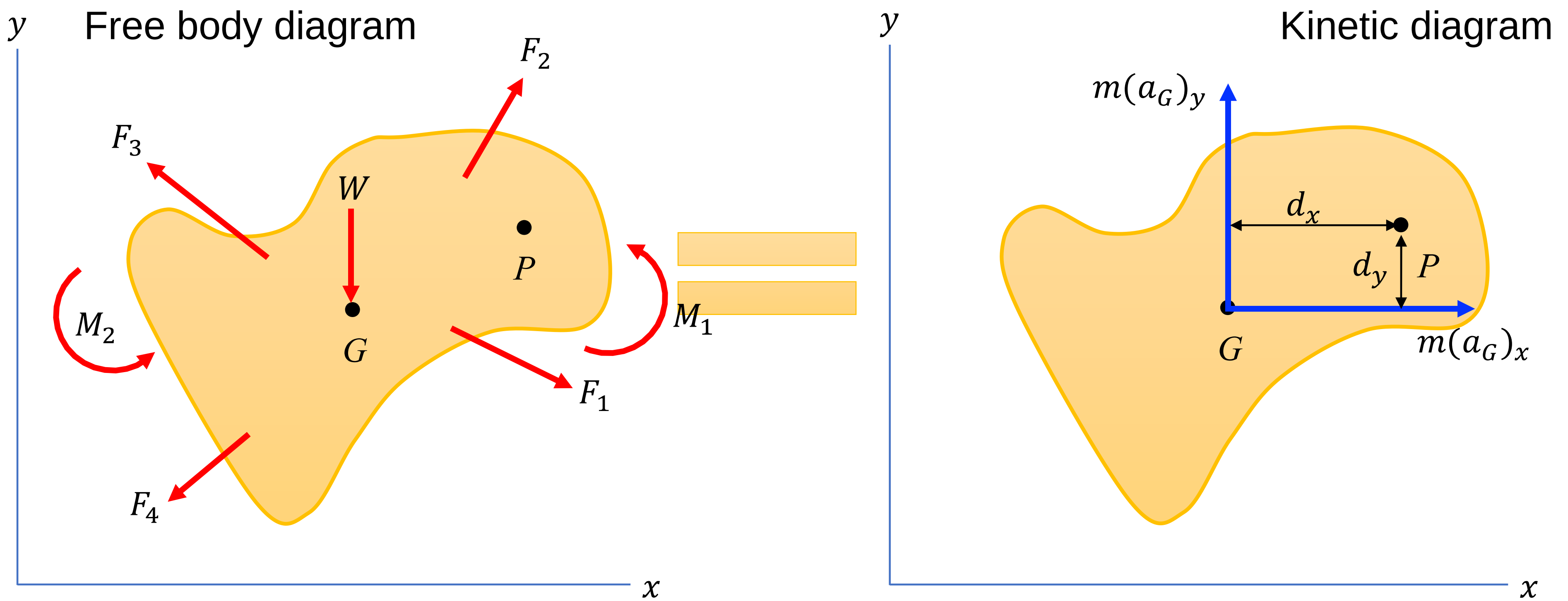
$$\sum F_x = m(a_G)_x$$

$$\sum F_y = m(a_G)_y$$

$$\sum M_G = \sum M_{F,G} + \sum M = I_G \alpha$$

About Centre of Gravity G

Equation of Motion – TRANSLATION



$$\sum F_x = m(a_G)_x$$

$$\sum F_y = m(a_G)_y$$

$$\sum M_G = 0$$

Conclusions

- When solving a planar kinetics problem, the free body diagram and kinetic must be drawn.
- Free body diagram shows the external forces acting on the body, while the kinetic diagram shows the effect of the acceleration component on the body.
- For translational motion, the sum of moments about centre of gravity *G* is equal to zero.

Planar Kinetics of a Rigid Body (Translation)

“To every action there is always opposed an equal reaction.”

– Sir Isaac Newton