

Dynamics

1 Resolution of forces

Resultant force is sum of force vectors

In angle-magnitude form

Cosine rule: $c^2 = a^2 + b^2 - 2ab \cos \theta$ Sine rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

In i — j form

Vector of a N at θ to x axis is equal to $a \cos \theta \mathbf{i} + a \sin \theta \mathbf{j}$. Convert all force vectors then add.

To find angle of an $a\mathbf{i} + b\mathbf{j}$ vector, use $\theta = \tan^{-1} \frac{b}{a}$

Resolving in a given direction

The resolved part of a force P at angle θ is has magnitude $P \cos \theta$

To convert force $\|\vec{OA}$ to angle-magnitude form, find component $\perp \vec{OA}$ then $|\mathbf{r}| = \sqrt{(\|\vec{OA}\|)^2 + (\perp \vec{OA})^2}$, $\theta = \tan^{-1} \frac{\perp \vec{OA}}{\|\vec{OA}\|}$

2 Newton's laws

1. Velocity is constant without a net external velocity
2. $\frac{d}{dt}\rho \propto \Sigma F \implies \mathbf{F} = m\mathbf{a}$
3. Equal and opposite forces

Weight

A mass of m kg has force of mg acting on it

Momentum ρ

$$\rho = mv \quad (\text{units kg m/s or Ns})$$

Reaction force R

- With no vertical velocity, $R = mg$
- With upwards acceleration, $R - mg = ma$
- With force F at angle θ , then $R = mg - F \sin \theta$

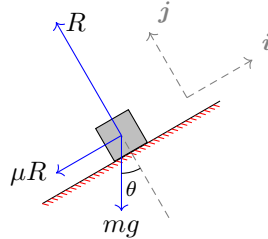
Friction

$$F_R = \mu R \quad (\text{friction coefficient})$$

3 Inclined planes

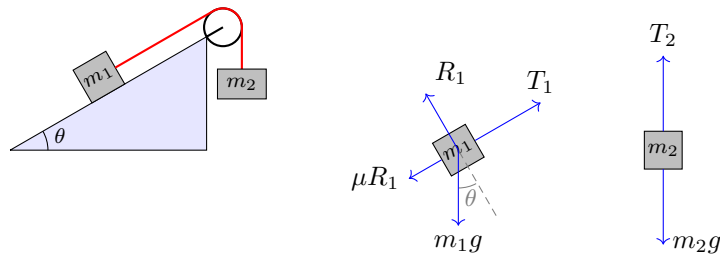
$$\mathbf{F} = |\mathbf{F}| \cos \theta \mathbf{i} + |\mathbf{F}| \sin \theta \mathbf{j}$$

- Normal force R is at right angles to plane
- Let direction up the plane be \mathbf{i} and perpendicular to plane \mathbf{j}



4 Connected particles

- **Suspended pulley:** tension in both sections of rope are equal
- **Linear connection:** find acceleration of system first
- **Pulley on edge of incline:** find downwards force W_2 and components of mass on plane



5 Equilibrium

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c} \quad \text{(Lami's theorem)}$$

Three methods:

1. Lami's theorem (sine rule)
2. Triangle of forces or CAS (use to verify)
3. Resolution of forces ($\Sigma F = 0$ - simultaneous)

On CAS: use Geometry, lock known constants.