# Dynamics

## 1 Resolution of forces

**Resultant force** is sum of force vectors

### 1.1 In angle-magnitude form

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

### 1.2 In $\boldsymbol{i}$—$\boldsymbol{j}$ form

Vector of $a$ N at $\theta$ to $x$ axis is equal to $a\cos\theta\boldsymbol{i} + a\sin\theta\boldsymbol{j}$. Convert all force vectors then add.
To find angle of an $a\boldsymbol{i} + b\boldsymbol{j}$ vector, use $\theta = \tan^{-1}\frac{b}{a}$

### 1.3 Resolving in a given direction

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

## 2 Newton's laws

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

### 2.1 Weight

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

### 2.2 Momentum $\rho$

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

### 2.3 Reaction force $R$

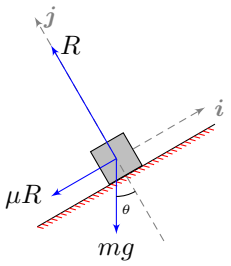
- With no vertical velocity, $R = mg$
- With upwards acceleration, $R - mg = ma$
- With force $F$ at angle $\theta$, then $R = mg - F\sin\theta$

### 2.4 Friction

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

# 3 Inclined planes

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




## 3.1 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