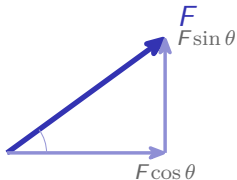


Mechanics

A-Level Mathematics ■ Topic 4

A-Level Mathematics



What we will cover

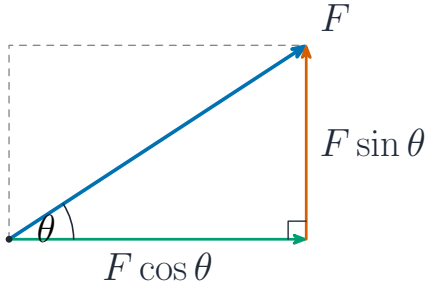
- 1 Forces & equilibrium
- 2 Kinematics
- 3 Momentum
- 4 Newton's laws
- 5 Energy work & power
- 6 Recap



1

Forces

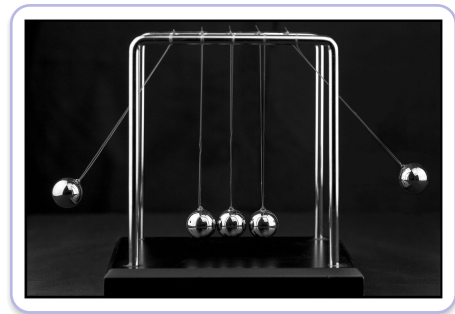
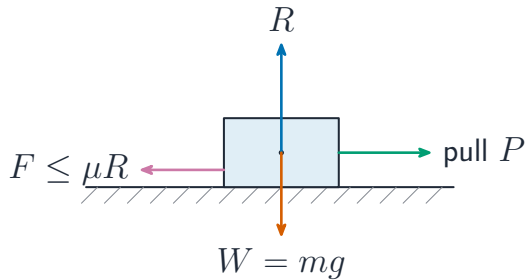
Forces and equilibrium



Climber

forces

Friction

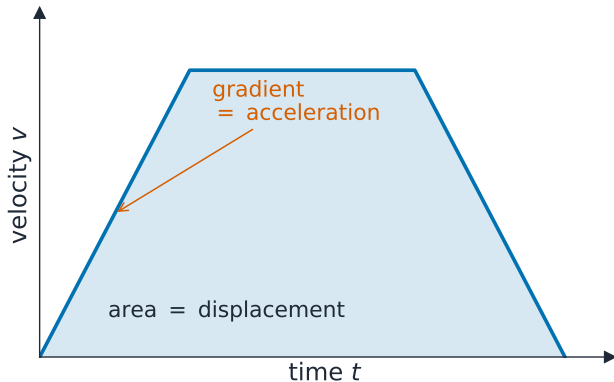


Momentum

2

Kinematics and momentum

Kinematics



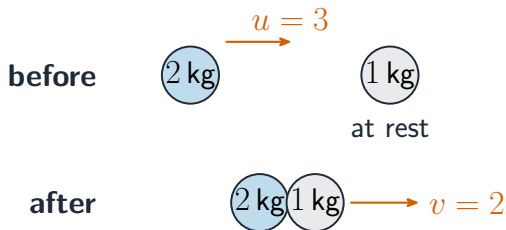
v - t graph: area = displacement,
gradient = acceleration.

$$v = u + at, \quad s = ut + \frac{1}{2}at^2, \quad v^2 = u^2 + 2as$$

Rest, $a = 2.5$, $t = 4$ s

$v = 10$ m/s, $s = 20$ m

Momentum



$$2(3) + 1(0) = (2 + 1)v$$

Conservation of momentum 动量守恒:

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2.$$

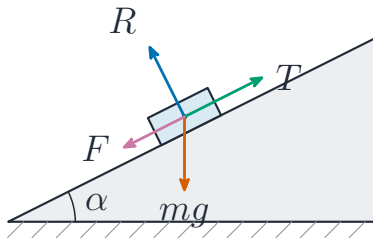
2 kg at 3 hits still 1 kg, stick

$$v = \frac{6}{3} = 2 \text{ m/s}$$

3

Newton and energy

Newton's laws



$$F = ma, \quad W = mg.$$

On an **inclined plane** 斜面: resolve along and perpendicular to the slope, then apply $F = ma$.

Pull 12 kg up a 20° rough slope

$$T \approx 110 \text{ N}$$

Energy, work and power

$$W = Fd \cos \theta, \quad \text{KE} = \frac{1}{2}mv^2, \quad \text{PE} = mgh.$$

No friction $\Rightarrow$ total energy conserved. Power
 $P = Fv$.

12 kW engine at 20 m/s

$$F = \frac{P}{v} = 600 \text{ N}$$

4

Recap

Topic 4 – key takeaways

1

Forces

resolve into components; $F \leq \mu R$

2

Kinematics

suvat; v - t area & gradient

3

Newton

$F = ma$; resolve on a slope

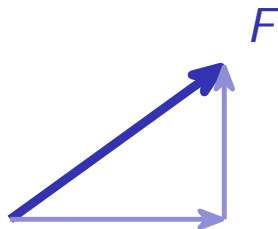
4

Energy

$\frac{1}{2}mv^2$, mgh ; $P = Fv$

Check yourself

- 1 Maximum friction before slipping?
- 2 What does the area under a $v-t$ graph give?
- 3 Driving force of a 10 kW engine at 25 m/s?
- 4 Quantity conserved in a collision?



Answers 1. μR 2. displacement 3. $P/v = 400 \text{ N}$ 4. momentum