4 Mechanics 1 – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	**中文**	**Write it 3 times** (English)		
force	力			
resultant	合力			
equilibrium	平衡			
weight	重力			
friction	摩擦力			
normal reaction	法向反作用力			
coefficient of friction	摩擦系数			
Displacement	位移			
velocity	速度			
acceleration	加速度			
velocity-time graph	速度时间图			

Recall

At IGCSE you used speed, force and weight. Bring this with you:

- speed = distance ÷ time; a force is a push or a pull;
- weight pulls objects downward.

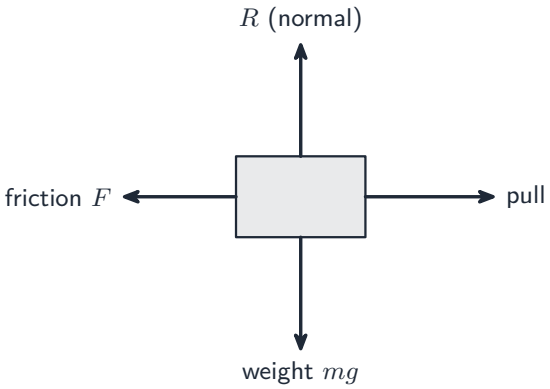
Mechanics 1 makes these exact, using forces as **vectors** and the constant-acceleration ("suvat") equations. (Take $g = 10$ m s^{-2}.)

New ideas

1 Forces and equilibrium

A **force** 力 is a push or a pull — a vector (it has size **and** direction). Several forces add to one **resultant** 合力.

A particle is in **equilibrium** 平衡 when the forces are **balanced** — the resultant is zero. Its **weight** 重力 is $W = mg$ (downward). On a rough surface, **friction** 摩擦力 opposes sliding, up to a maximum $F \leqslant \mu R$, where R is the **normal reaction** 法向反作用力 and μ the **coefficient of friction** 摩擦系数.



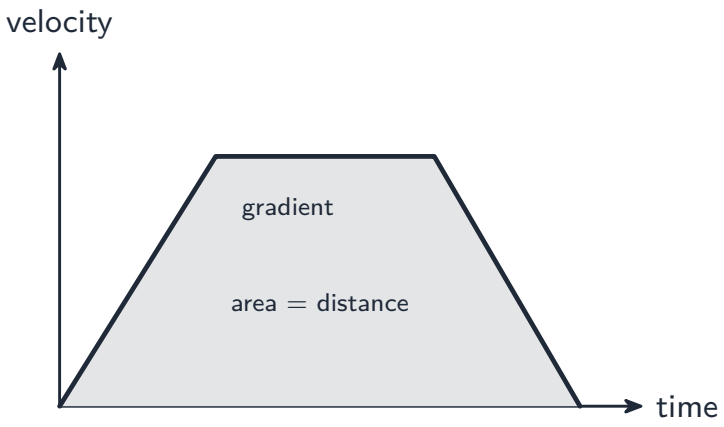
Micro-check. Find the weight of a 5 kg block (take $g = 10$ m s^{-2}). [1]

2 Kinematics

Displacement 位移, **velocity** 速度 and **acceleration** 加速度 are vectors. For **constant acceleration**, use the suvat equations:

$$v = u + at, \qquad s = ut + \tfrac{1}{2}at^2, \qquad v^2 = u^2 + 2as.$$

On a **velocity-time graph** 速度时间图 the **area** under the line is the distance, and the **gradient** is the acceleration.



Worked example. From rest ($u = 0$), $a = 2.5$ m s^{-2} for $t = 4$ s: $v = 0 + 2.5(4) = 10$ m s^{-1} and $s = \frac{1}{2}(2.5)(4^2) = 20$ m.

Micro-check. A car starts at $u = 3$ m s^{-1} and accelerates at $a = 2$ m s^{-2} for $t = 5$ s. Find v. [1]

Watch out: in equilibrium the resultant force is *zero* (the forces balance). For suvat, list u, v, a, s, t and pick the equation with only *one* unknown. On a velocity–time graph, area = distance and gradient = acceleration.

Practice

4.1 State what is true about the forces on a particle in **equilibrium**. [1]

4.2 Find the weight of a 12 kg mass ($g = 10$ m s^{-2}). [1]

4.3 A body starts from rest and accelerates at 3 m s^{-2} for 6 s. Find its final velocity. [2]

4.4 Using the same body, find the distance travelled in those 6 s. [2]

4.5 A block of weight 20 N rests on a rough surface with $\mu = 0.3$. The normal reaction is 20 N. Find the maximum friction force. [2]

4.6 Challenge. A ball is thrown straight up at 20 m s^{-1} ($g = 10$ m s^{-2}). Find the greatest height it reaches. [3]