4 Mechanics 1 – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
force			
resultant			
equilibrium			
weight			
friction			
normal reaction			
coefficient of friction			
Displacement			
velocity			
acceleration			
velocity-time graph			

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

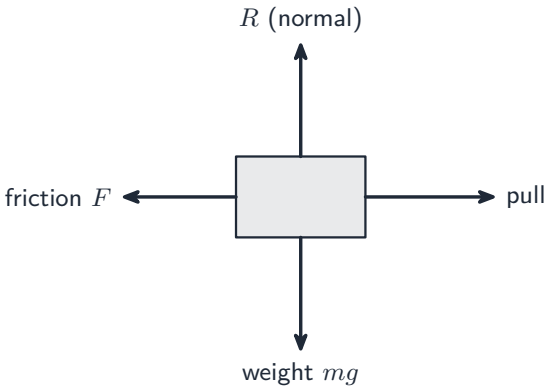
("suvat") equations. (Take $g = 10$ m s^{-2}.)

New ideas

1 Forces and equilibrium

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

A particle is in **equilibrium** when the forces are **balanced** – the resultant is zero. Its **weight** is $W = mg$ (downward). On a rough surface, **friction** opposes sliding, up to a maximum $F \leqslant \mu R$, where R is the **normal reaction** and μ the **coefficient of friction** .



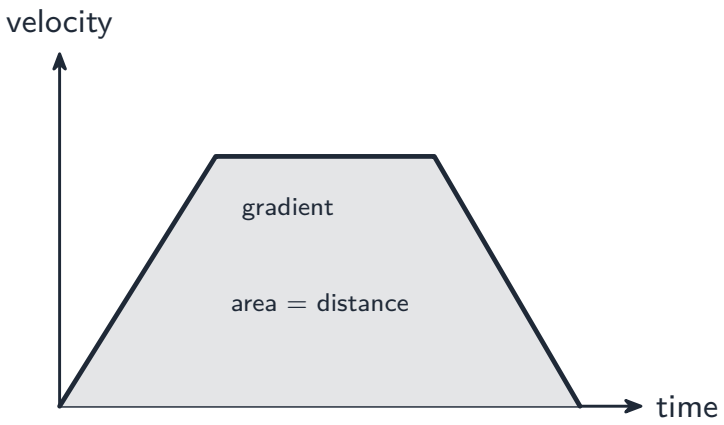
Micro-check. Find the weight of a 5 kg block (take $g = 10$ m s^{-2}). [1]

2 Kinematics

Displacement , **velocity** and **acceleration** 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** 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]