1 Physical quantities and units – 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)		
physical quantity	物理量			
magnitude	大小			
unit	单位			
base quantity	基本量			
derived unit	导出单位			
prefix	词头			
homogeneous	量纲一致			
scalar	标量			
vector	矢量			
resultant	合矢量			
perpendicular	垂直			

Recall

You already did a lot of this at IGCSE. Bring it with you:

- You measured things: **length** in metres (m), **time** in seconds (s), **mass** in kilograms (kg).
- Every measurement is a number together with a unit — "5" means nothing, "5 m" is a length.
- You met speed, force and energy. At AS we look more carefully at **units** and at **direction**.

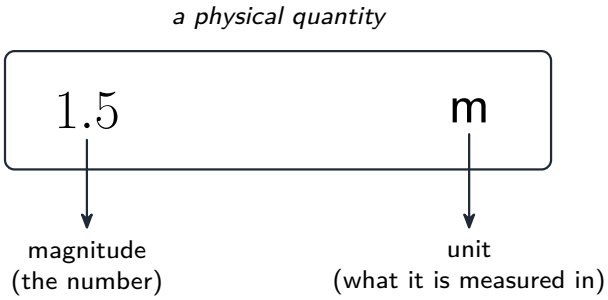
This sheet gets you ready. Nothing here is harder than IGCSE — it just lines up the ideas the AS course starts with.

New ideas

Read these first. Each idea has a short worked example. Once you have read them you can do the Practice below.

1 Every quantity = magnitude + unit

A **physical quantity** 物理量 is anything you can measure. It always has two parts: a **magnitude** 大小 (the number) and a **unit** 单位 (what it is measured in).



So "the mass is 60" is not complete. "The mass is 60 kg" is a real physical quantity.

2 Base units and derived units

The whole SI system is built from a few **base quantity** 基本量 measures. You only need these:

base quantity	unit	symbol
mass	kilogram	kg
length	metre	m
time	second	s
electric current	ampere	A
temperature	kelvin	K
amount of substance	mole	mol

Every other unit is a **derived unit** 导出单位 — built by multiplying or dividing base

units.

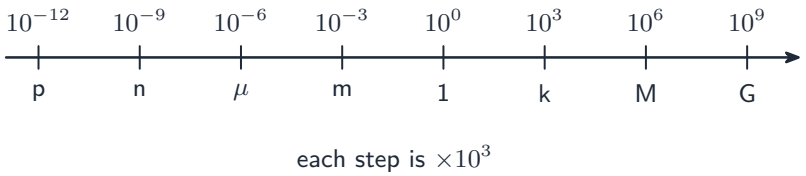
Worked example. Speed $= \dfrac{\text{distance}}{\text{time}}$, so its unit is $\dfrac{\text{m}}{\text{s}} = \text{m s}^{-1}$. Force is $F = ma$, so its unit is $\text{kg} \times \text{m s}^{-2} = \text{kg m s}^{-2}$. We give this the name **newton** (N).

■ 3 Prefixes and powers of ten

A **prefix** 词头 is a letter put in front of a unit. It multiplies the unit by a power of ten.

prefix	symbol	factor
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}

Worked example. $45\ \mu\text{m} = 45 \times 10^{-6}\ \text{m} = 4.5 \times 10^{-5}\ \text{m}$. And $2\ \text{GW} = 2 \times 10^{9}\ \text{W}$.



Watch out: a prefix changes only the size, not the quantity — 1 km and 1000 m are the same length. Convert prefixes to powers of ten *before* calculating.

■ 4 Checking units (homogeneous equations)

An equation is **homogeneous** 量纲一致 when both sides have the **same units**. If the units do not match, the equation must be wrong — a quick and powerful check.

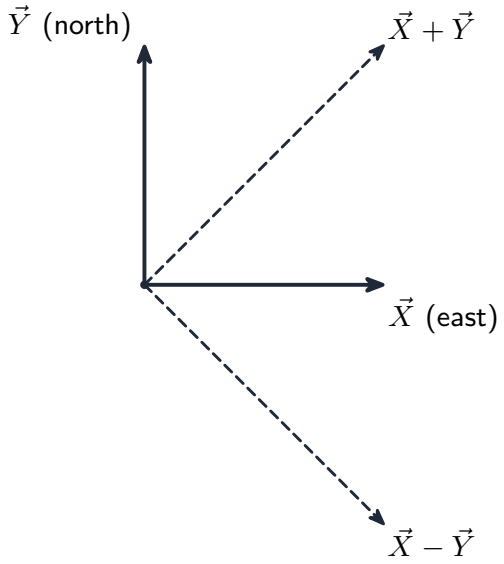
Worked example. Check $v = u + at$. Left side v: a velocity, units m s^{-1}. Right side: u is m s^{-1}, and $at = (\text{m s}^{-2})(\text{s}) = \text{m s}^{-1}$. Both sides are m s^{-1}, so the equation is homogeneous.

■ 5 Scalars and vectors

A **scalar** 标量 has magnitude only — mass, time, energy, temperature. A **vector** 矢量 has magnitude **and** direction — force, velocity, displacement.

When two vectors act at right angles, their combined effect is the **resultant** 合矢量. Because they are **perpendicular** 垂直 (at 90°), you find its size with Pythagoras:

$$R = \sqrt{a^2 + b^2}.$$



Worked example. A force of 3.0 N east and 4.0 N north:

$$R = \sqrt{3.0^2 + 4.0^2} = \sqrt{25} = 5.0 \text{ N}.$$

Practice

Try these in order. They get a little harder. The methods are all above.

2.1 A student writes "the time is 12". State what is missing to make it a physical quantity. [1]

2.2 Give the SI base unit of (a) mass, (b) length, (c) time. [3]

2.3 Show that the derived unit of speed is m s^{-1}, starting from speed = distance ÷ time. [1]

2.4 Write each length in metres, using a power of ten: (a) 3 km, (b) 25 mm, (c) 7 μm. [3]

2.5 The kinetic energy equation is $E_k = \frac{1}{2}mv^2$. The unit of energy is the joule, J = kg $m^2\,s^{-2}$. Show that the right-hand side mv^2 has these same units (so the equation is homogeneous). [2]

2.6 State whether each quantity is a scalar or a vector: (a) mass, (b) velocity, (c) energy, (d) force. [2]

2.7 A swimmer heads north at 1.2 m s^{-1} across a river. The current flows east at 0.5 m s^{-1}. These velocities are perpendicular. Find the magnitude of the swimmer's resultant velocity. [2]