A-LEVEL PHYSICS • EXERCISE SHEET

1.1 Physical quantities

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS physical quantities 物理量 • magnitude 大小 • unit 单位 • order of magnitude 数量级 • derived quantity 导出量

Objective

Build the skills to answer exam questions on **physical quantities** 物理量 — magnitude and unit, and making sensible estimates.

You must be able to:

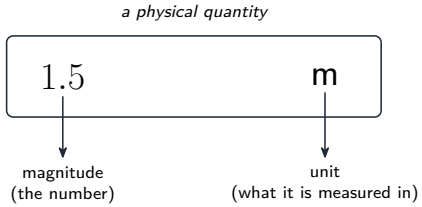
- state that every physical quantity has a **magnitude** 大小 and a **unit** 单位
- make reasonable **estimates** 估算 of common quantities
- give an answer to the right **order of magnitude** 数量级 (power of ten)

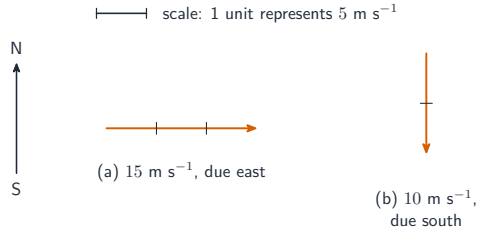
1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Magnitude and unit

A physical quantity needs **both** a number and a unit. "The length is 1.5" means nothing; "the length is 1.5 m" is complete:





Quantities are scalars or vectors

■ Making estimates

Learn these rough values so you can check whether an answer is sensible:

quantity	estimate
mass of an adult	~ 70 kg
height of an adult	~ 1.7 m
mass of an apple	~ 0.1 kg (weight ≈ 1 N)
speed of sound in air	~ 340 m s^{-1}
speed of light (vacuum)	3.0×10^8 m s^{-1}
free-fall acceleration	$g \approx 9.81$ m s^{-2}

■ Order of magnitude

The **order of magnitude** is the nearest power of ten. A good estimate has the right power of ten: an adult's mass is $\sim 10^2$ kg (70 kg), **not** 10^1 kg (7 kg). To estimate the seconds in a day, keep the units so they cancel:

$$24\ \text{h} \times \frac{60\ \text{min}}{1\ \text{h}} \times \frac{60\ \text{s}}{1\ \text{min}} = 86\,400\ \text{s} \approx 9 \times 10^4\ \text{s},$$

so the order of magnitude is 10^5 s.

■ Estimating a derived quantity

Combine sensible estimates. The **pressure** a standing person exerts on the floor: weight ≈ 700 N, area of two feet ≈ 0.02 m^2. Substitute with the units still attached:

$$p = \frac{F}{A} \approx \frac{700\ \text{N}}{0.02\ \text{m}^2} = 3.5 \times 10^4\ \text{N m}^{-2} = 3.5 \times 10^4\ \text{Pa}.$$

2 Practice

Now apply the methods above.

2.1 A student writes "the mass is 60". State what is **missing** to make it a physical quantity. [1]

2.2 Estimate the **mass of an apple**, giving a unit. [1]

2.3 State the **order of magnitude** of the speed of light in a vacuum, in m s^{-1}. [1]

2.4 Estimate the **height of a typical room** (floor to ceiling), giving a unit. [1]

3 Exam-style questions

3.1 What must all physical quantities have? [1]

A B
C D

A a direction and a magnitude
B a direction and a unit
C a magnitude and a prefix
D a magnitude and a unit

3.2 Which is the best estimate of the **mass of an adult human**? [1]

A B
C D

A 7 kg
B 70 kg
C 700 kg
D 7000 kg

3.3 Estimate the number of **seconds in one day**. Give your answer to an **order of magnitude**. [2]

3.4 A car travels at about 30 m s^{-1}. Estimate the time it takes to travel 1 km, and state the **order of magnitude** of that time in seconds. [2]

3.5 A person of weight 700 N stands on both feet, total contact area about 0.02 m^2. Which is the best estimate of the pressure on the floor? [1]

A B
C D

A 1.4×10^4 Pa
B 3.5×10^4 Pa
C 3.5×10^6 Pa
D 1.4×10^7 Pa