

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:

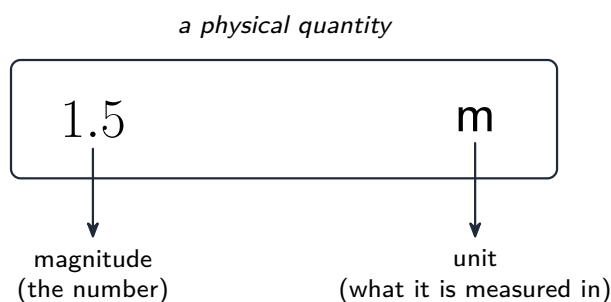
- state that every physical quantity has a **magnitude** 大小 and a **unit** 单位
- make reasonable **estimates** 估算 of common quantities
- give an answer to the right **order of magnitude** 数量级 (power of ten)

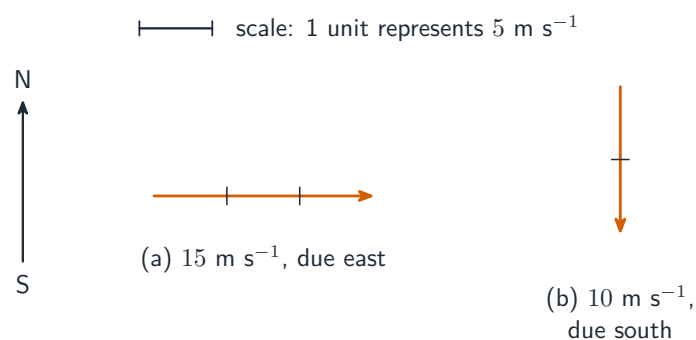
1 Worked examples

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

■ 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 $\sim 10^2 \text{ kg}$ (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 $\approx 700 \text{ N}$, area of two feet $\approx 0.02 \text{ m}^2$. 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 $1.4 \times 10^4 \text{ Pa}$

B $3.5 \times 10^4 \text{ Pa}$

C $3.5 \times 10^6 \text{ Pa}$

D $1.4 \times 10^7 \text{ Pa}$