

1.1 Physical quantities

Name: _____ Class: _____ Date: _____

Total: 9 marks

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:

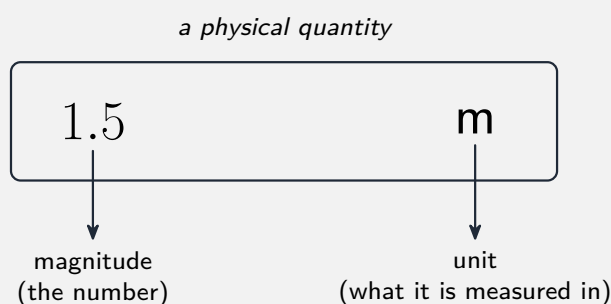
- state that every physical quantity has a **magnitude** 大小 and a **unit** 单位
- make reasonable **estimates** 估算 of common quantities
- give an answer to the right **order of magnitude** 数量级 (power of ten)

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.

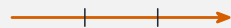
■ Magnitude and unit

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:



— scale: 1 unit represents 5 m s^{-1}

N
↑
S



(a) 15 m s^{-1} , due east



(b) 10 m s^{-1} ,
due south

■ 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 (7 kg). To estimate the seconds in a day: $24 \times 60 \times 60 = 86\,400 \approx 9 \times 10^4$, 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 $\approx 0.02 \text{ m}^2$, so

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

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** 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** 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** $1.4 \times 10^4 \text{ Pa}$
 - **B** $3.5 \times 10^4 \text{ Pa}$
 - **C** $3.5 \times 10^6 \text{ Pa}$
 - **D** $1.4 \times 10^7 \text{ Pa}$
-

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **1.1 Physical quantities** past-paper sheet in the Library, or try these in **Practice mode**:

- 9702/12 J25 —Q1 (physical quantity and unit)
- 9702/14 J25 —Q3 (making an estimate)
- 9702/11 N25 —Q15 (order of magnitude)
- 9702/12 N25 —Q1 (physical quantities)

Solutions

2.1 A **unit** (it has a magnitude but no unit).

2.2 About 0.1 kg (100 g) —any value ~ 0.05 –0.2 kg.

2.3 10^8 m s^{-1} .

2.4 About 2.5 m —any value ~ 2 –3 m with a unit.

3.1 **D** —a magnitude and a unit.

3.2 **B** —about 70 kg.

3.3 $24 \times 60 \times 60 = 86\,400 \text{ s}$; $\approx 10^5 \text{ s}$.

3.4 $t = 1000/30 \approx 33 \text{ s}$; order of magnitude 10^1 s .

3.5 **B** — $p = 700/0.02 = 3.5 \times 10^4 \text{ Pa}$.