IGCSE PHYSICS • EXERCISE SHEET

1.1 Physical quantities and measurement

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS vector quantity 矢量 • resultant 合矢量 • physical quantities and measurement 物理量与测量 • scalars and vectors 标量与矢量 • resultant force 合力

Objective

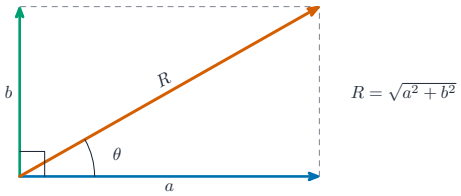
Build the skills to answer exam questions on **physical quantities and measurement** 物理量与测量 — using instruments, measuring small quantities, and **scalars and vectors** 标量与矢量.

You must be able to:

- measure length, volume and time correctly (read the meniscus; avoid parallax)
- find a small length or short time by measuring many and dividing
- tell scalars from vectors and add two perpendicular vectors

1 Worked examples

Vectors at right angles



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

Two vectors at right angles add to a resultant R, the diagonal of the rectangle

- **scalar** = size only (distance, speed, mass, energy); **vector** = size **and** direction (force, velocity, momentum).
- two perpendicular vectors: $R = \sqrt{a^2 + b^2}$.
- **small quantity:** time 20 swings and divide by 20; measure 100 sheets and divide.

Measuring time, and the vector list

Use a **stopwatch** 秒表 or a **digital timer** 数字计时器 for a short interval and a clock for a long one. A hand-started stopwatch carries a **reaction time** 反应时间 error of about 0.2 s, so time a **long** interval, or time many repeats and divide.

Worked example. A pendulum takes 28.4 s for 20 complete swings. One period is $\frac{28.4}{20} = 1.42$ s. The reaction-time error of about 0.2 s is shared over 20 swings, so its effect on one period is only about 0.01 s.

The full syllabus lists: **scalars** are distance, speed, time, mass, energy and temperature; **vectors** are force, weight, velocity, acceleration, momentum, electric field strength and gravitational field strength.

2 Practice

2.1 State the difference between a scalar and a vector. [1]

2.2 A student measures the time for 20 swings of a pendulum as 30 s. Find the period (time for one swing). [2]

2.3 A student times 20 swings of a pendulum as 31.0 s. Calculate the period, and explain why timing 20 swings is better than timing one. [3]

2.4 From this list, write down the vectors: mass, weight, energy, velocity, temperature, momentum, gravitational field strength. [2]

3 Exam-style questions

3.1 Which is a vector quantity? [1]

- **A** mass
- **B** energy
- **C** velocity
- **D** temperature

3.2 Two forces of 3.0 N and 4.0 N act at right angles on a point.

(a) Find the magnitude of the resultant force. [2]

(b) State why a force is a vector. [1]

3.3 Describe how to measure the thickness of one sheet of paper accurately, using a ruler and a book. [2]

3.4 A student measures the period of a pendulum and the thickness of a sheet of paper.

(a) Describe how she should measure the period accurately, naming the instrument she uses. [3]

(b) She times 20 swings as 25.6 s. Calculate the period. [2]

(c) Explain why her method reduces the effect of her reaction time. [2]

(d) She measures a stack of 100 sheets of paper as 9.0 mm thick. Calculate the thickness of one sheet in mm, and state why she did not measure one sheet directly. [3]

Solutions

Each answer shows the steps, then the **result**.

2.1

- a scalar has size only; a vector has size **and** direction

2.2

- period = total time / number of swings

$$T = \frac{30\ \text{s}}{20} = \mathbf{1.5}\ \text{s}$$

2.3

- period = total time / number of swings

$$T = \frac{31.0\ \text{s}}{20} = \mathbf{1.55}\ \text{s}$$

- the timing error is shared between 20 swings, so its effect on one period is 20 times smaller

2.4

- weight, velocity, momentum, gravitational field strength

3.1 C

- velocity has both size and direction

3.2

(a) Pythagoras on the 3.0 N and 4.0 N sides

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

(b) it has both a size and a direction

3.3

- measure the total thickness of a known large number of sheets (e.g. 100) with the ruler
- divide the total thickness by the number of sheets

3.4

(a) use a stopwatch or digital timer

- start it as the pendulum passes the centre of its swing and count from zero
- time 20 complete swings and repeat, then take an average

(b) T = total time / number of swings

$$T = \frac{25.6\ \text{s}}{20} = \mathbf{1.28}\ \text{s}$$

(c) her reaction time affects the total once, at the start and the stop

- dividing by 20 divides that error by 20 as well, so each period is far more accurate

(d)

$$\frac{9.0\ \text{mm}}{100} = \mathbf{0.090}\ \text{mm}$$

- one sheet is far thinner than the smallest division on the ruler, so measuring it directly would give a very large percentage error