Week 1

IGCSE Physics

Homework bundle for this week

本周作业合集

exercises.lol

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1. Motion, forces and energy

Starter Quiz · 课前小测

IGCSE Physics Name: ________ Score: ____

1. You measure water in a measuring cylinder. How should you read the scale?
   - ☐ eye level with the bottom of the meniscus (the curved surface)
   - ☐ eye above, looking down at the water
   - ☐ eye below, looking up at the water
   - ☐ at the very top of the cylinder
2. A runner covers 100 m in 8.0 s. What is the average speed, in m/s?

   ________ m/s
3. An astronaut travels from Earth to the Moon. What happens to their **mass** and **weight**?
   - ☐ mass stays the same; weight gets smaller
   - ☐ both stay the same
   - ☐ mass gets smaller; weight stays the same
   - ☐ both get smaller by the same amount
4. A force of 8.0 N stretches a spring by 0.040 m (within the limit of proportionality). What is the spring constant, in N/m?

   ________ N/m
5. Momentum is a vector.

   ☐ True ☐ False
6. Select **all** of these that are **energy stores**.
   - ☐ kinetic
   - ☐ chemical
   - ☐ gravitational potential
   - ☐ loud
   - ☐ fast

   Tick every correct option.
7. A box pushes down with a force of 200 N over an area of 0.50 m^2. What is the pressure, in Pa?

   ________ Pa
8. A stack of 100 sheets of paper is 12 mm tall. How thick is one sheet, in mm?

   ________ mm

9. A car speeds up from rest to 20 m/s in 4.0 s. What is its acceleration, in m/s^2?

   ________ m/s^2
10. The resultant force on a moving car is zero. What does the car do?
    - ☐ keeps moving at constant velocity (same speed, same direction)
    - ☐ speeds up
    - ☐ stops at once
    - ☐ turns around

IGCSE Physics

1. **eye level with the bottom of the meniscus (the curved surface)**

   Read at the bottom of the meniscus with your eye level with it — looking from above or below gives a parallax error (a wrong reading).

2. **12.5 m/s**

   $v = \frac{s}{t} = \frac{100}{8.0} = 12.5$ m/s.

3. **mass stays the same; weight gets smaller**

   Mass (amount of matter) never changes. Weight is the force of gravity, and the Moon's gravity is weaker, so the weight is smaller.

4. **200 N/m**

   $k = \frac{F}{x} = \frac{8.0}{0.040} = 200$ N/m.

5. **True**

   Momentum is mass × velocity, and velocity has a direction, so momentum is a vector.

6. **kinetic; chemical; gravitational potential**

   Kinetic, chemical and gravitational potential are energy stores. "Loud" and "fast" describe things, but they are not energy stores.

7. **400 Pa**

   $p = \frac{F}{A} = \frac{200}{0.50} = 400$ Pa.

8. **0.12 mm**

   Measure many and divide: $12 \div 100 = 0.12$ mm. Dividing makes the small measurement much more accurate.

9. **5 m/s^2**

   $a = \frac{\Delta v}{\Delta t} = \frac{20 - 0}{4.0} = 5.0$ m/s^2.

10. **keeps moving at constant velocity (same speed, same direction)**

    Newton's first law: with zero resultant force, an object keeps moving at constant velocity (or stays at rest).

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

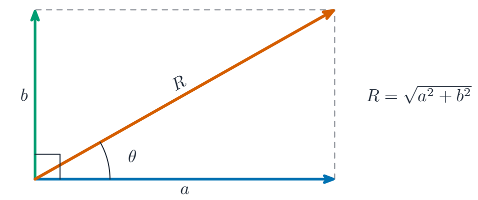
Build the skills to answer exam questions on **physical quantities and measurement 物理量与测量** — using instruments, measuring small quantities, and **scalars and vectors 标量与矢量**.

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



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

1 A student determines the diameter of a metal ball.

Which apparatus is needed to get an accurate measurement?

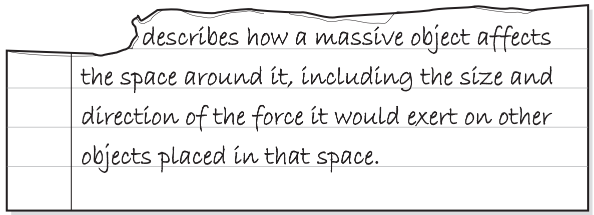
A a ruler and a protractor

B a ruler only

C a protractor and a set square

D a ruler and two rectangular blocks

3 A piece of paper torn out of an exercise book is shown.



What is being described?

A gravitational charge

B gravitational field

C gravitational mass

D gravitational potential energy

IGCSE Physics: **w25 22**

1 Which quantities are both vectors?

A acceleration and force

B acceleration and pressure

C density and force

D density and pressure

IGCSE Physics: **w25 23**

1 When a pendulum passes a marker, a timer displays 1 minute 30 seconds.

The pendulum passes the marker 12 more times from the same direction.

On the final pass, the timer displays a time of 2 minutes 18 seconds.

What is the time period of oscillation of the pendulum?

A 4.0 s **B** 4.4 s **C** 7.5 s **D** 12 s

1 **(a)** **(i)** State the difference between a scalar quantity and a vector quantity.

....

.... [1]

(ii) In the list below, draw a line under each of the quantities that is a scalar quantity.

acceleration **mass** **momentum** **electric field strength**

energy **temperature**

[2]

(b) A tennis player throws a tennis ball into the air. The mass of the tennis ball is 5.8×10^{-2} kg. The tennis ball leaves the tennis player's hand and reaches a maximum height of 5.0 m above the point of release.

(i) Show that the initial velocity of the tennis ball is 9.9 m/s upwards.

[3]

(ii) Calculate the momentum of the tennis ball as it leaves the tennis player's hand.

momentum = ... [2]

[Total: 8]

1 **(a)** Circle the vector quantities in the list.

acceleration **mass** **speed** **time** **velocity**

[1]

(b) Fig. 1.1 shows the speed–time graph for a train travelling from station A to station B.

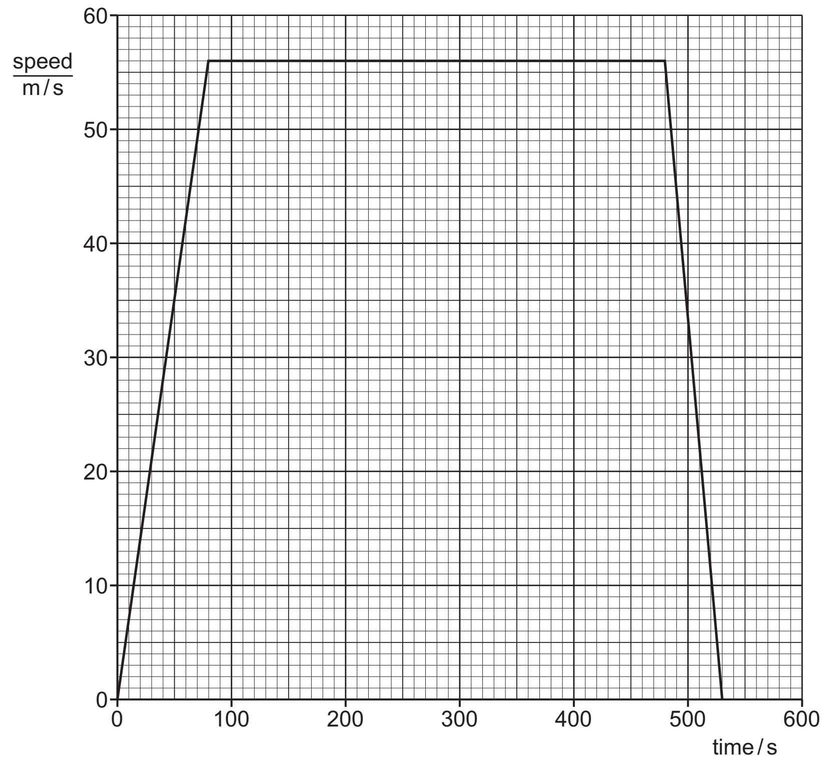


Fig. 1.1

(i) State the maximum speed of the train.

maximum speed = ... [1]

(ii) Describe the motion of the train between station A and station B.

....

....

.... [2]

(iii) Calculate the distance between station A and station B.

distance = ... [3]

(iv) On a different day, the train takes 650 s to travel between station A and station B.

Suggest **one** change to the motion of the train that leads to this longer journey time.

....

.... [1]

[Total: 8]

IGCSE Physics: **s24 21**

1 In which row are quantities correctly categorised into scalar quantities and vector quantities?

	scalar quantities	vector quantities
A	mass and energy	weight and acceleration
B	gravitational field strength and time	force and electric field strength
C	speed and momentum	distance and force
D	distance and energy	velocity and temperature

IGCSE Physics: **w23 21**

1 Which is a vector quantity?

A density

B mass

C pressure

D weight

IGCSE PHYSICS • EXERCISE SHEET

1.2 Motion

Name: ______________ Class: __________ Date: ____________ **Total: 28 marks**

KEY WORDS speed–time graph 速度-时间图 • acceleration 加速度 • terminal velocity 终极速度 • deceleration 减速 • uniform 均匀

Objective

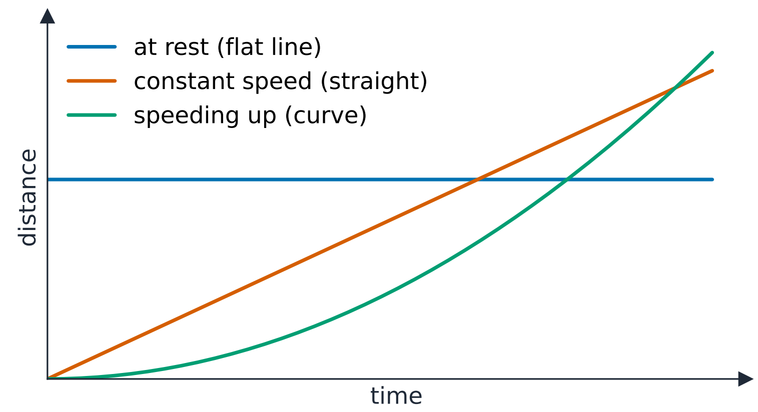
Build the skills to answer exam questions on **motion** 运动 — speed, velocity, **acceleration** 加速度, motion graphs, and **terminal velocity** 终极速度.

You must be able to:

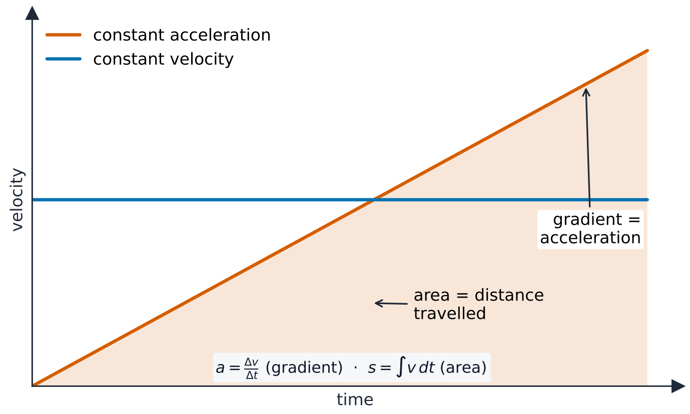
- use $v = \dfrac{s}{t}$ and $a = \dfrac{\Delta v}{\Delta t}$
- read distance–time and speed–time graphs (gradient and area)
- describe falling objects and terminal velocity

1 Worked examples

■ Graphs and acceleration



Distance–time: flat = at rest, straight slope = constant speed, rising curve = speeding up



Velocity–time: gradient = acceleration, area under the line = distance

Car $8 \to 20$ **m/s in** 4.0 **s:** $a = \dfrac{20-8}{4.0} = 3.0\ \mathrm{m/s^2}$.

Reading a speed-time graph, and deceleration

Describe each straight section of a speed–time graph by name: a horizontal line is **constant speed**; a line sloping up is **constant (uniform) acceleration**; a line sloping down is **constant deceleration**. A **deceleration** 减速 is a negative acceleration, so put a minus sign in the arithmetic: slowing from 12 m/s to 4 m/s in 4.0 s gives $a = \dfrac{4-12}{4.0} = -2.0\ \mathrm{m/s^2}$, a deceleration of 2.0 $\mathrm{m/s^2}$.

The **area under a speed-time line** is the distance travelled. Split the area into rectangles and triangles: a rectangle is speed × time; a triangle is $\frac{1}{2}$ × base × height.

Worked example (show that). A bus is at 10 m/s for 120 s, then decelerates uniformly to rest in 40 s. Show that it travels about 1400 m. Rectangle: $10 \times 120 = 1200$ m. Triangle: $\frac{1}{2} \times 40 \times 10 = 200$ m. Total 1400 m. In a "show that" question, always finish with the number the question quotes.

Near the Earth all objects fall with the same **acceleration of free fall** $g \approx 9.8\ \mathrm{m/s^2}$ while air resistance is small. As speed rises, air resistance grows until it equals the weight; the resultant force is then zero and the object falls at a steady **terminal velocity** 收尾速度.

2 Practice

2.1 A runner covers 100 m in 12.5 s. Find the average speed. [2]

2.2 State what the area under a speed–time graph represents. [1]

2.3 A car slows from 18 m/s to 6.0 m/s in 4.0 s. Calculate its acceleration and state what the sign means. [3]

2.4 State how you find the distance travelled from a speed-time graph. [1]

3 Exam-style questions

3.1 On a distance–time graph, a horizontal (flat) line means the object is: [1]

- **A** accelerating
- **B** at rest
- **C** at constant speed
- **D** decelerating

3.2 A car accelerates uniformly from rest to 24 m/s in 8.0 s.

(a) Find the acceleration. [2]

(b) Find the distance travelled (area under the speed–time graph). [2]

3.3 A skydiver falls and reaches terminal velocity. Explain, in terms of forces, why the speed becomes steady. [3]

3.4 Fig. 3.1 describes the first five minutes of a bus journey. The bus is at rest until $t = 0.90$ min, speeds up uniformly to 7.5 m/s at $t = 2.9$ min, holds that speed until $t = 3.5$ min, then slows uniformly to rest at $t = 4.5$ min.

(a) Describe the motion of the bus between $t = 2.9$ min and $t = 3.5$ min, and between $t = 3.5$ min and $t = 4.5$ min. [2]

(b) Calculate the acceleration of the bus between $t = 0.90$ min and $t = 2.9$ min. [3]

(c) Show that the bus travels about 270 m while it is speeding up. [2]

(d) Calculate the deceleration of the bus in the last minute, and state what the sign of your answer means. [3]

(e) A stone is dropped from a tall building. Describe how its acceleration changes from the moment it is released until it reaches terminal velocity, and explain why. [3]

Solutions

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

2.1

- $v = s/t$

$$v = \frac{100\ \text{m}}{12.5\ \text{s}} = \mathbf{8.0}\ \text{m/s}$$

2.2

- the distance travelled

2.3

- $a = \Delta v/\Delta t$

$$a = \frac{6.0\ \text{m/s} - 18\ \text{m/s}}{4.0\ \text{s}} = \mathbf{-3.0}\ \text{m/s}^2$$

- the minus sign means the car is decelerating, so the acceleration is opposite to the motion

2.4

- find the area under the line (between the line and the time axis)

3.1 B

- a flat line on a distance–time graph means the distance is not changing — at rest

3.2

(a) $a = \Delta v/\Delta t$

$$a = \frac{24\ \text{m/s} - 0}{8.0\ \text{s}} = \mathbf{3.0}\ \text{m/s}^2$$

(b) distance = area of the triangle

$$s = \tfrac{1}{2}(8.0\ \text{s})(24\ \text{m/s}) = \mathbf{96}\ \text{m}$$

3.3

- as the diver speeds up, air resistance increases
- when air resistance equals the weight, the resultant force is zero
- so there is no acceleration and the speed stays constant (terminal velocity)

3.4

(a) between 2.9 and 3.5 min: constant speed

- between 3.5 and 4.5 min: constant (uniform) deceleration to rest

(b) time = $(2.9 - 0.90) \times 60\ \text{s} = 120\ \text{s}$

- $a = \Delta v/\Delta t$

$$a = \frac{7.5\ \text{m/s} - 0}{120\ \text{s}} = \mathbf{0.063}\ \text{m/s}^2$$

(c) distance = area of the speeding-up triangle

$$s = \tfrac{1}{2}(120\ \text{s})(7.5\ \text{m/s}) = \mathbf{450}\ \text{m}$$

- for the first 72 s of it the area is 270 m

(d) time = 60 s; $a = \Delta v/\Delta t$

$$a = \frac{0 - 7.5\ \text{m/s}}{60\ \text{s}} = \mathbf{-0.13}\ \text{m/s}^2$$

- the minus sign means the bus is slowing down, so the resultant force is opposite to the motion

(e) at first the acceleration is g, because only the weight acts

- as the stone speeds up, air resistance grows and the resultant force falls, so the acceleration decreases
- when air resistance equals the weight the resultant force and the acceleration are zero and the speed is constant

2 An athlete runs at a speed of 8 m/s for 10 s, and then at a speed of 6 m/s for 12 s.

Which calculation gives the average speed of the athlete in m/s?

A $\dfrac{8+6}{2}$

B $\dfrac{(8\times10)+(6\times12)}{22}$

C $\dfrac{(8\div10)+(6\div12)}{22}$

D $\dfrac{(10\div8)+(12\div6)}{22}$

IGCSE Physics: **w25 22**

2 How is the deceleration of an object calculated from a speed–time graph?

A It is the area under the graph.

B It is the gradient of the graph.

C It is the difference between two readings on the horizontal (x) axis.

D It is the difference between two readings on the vertical (y) axis.

IGCSE Physics: **w25 23**

2 A car driver applies the brakes to bring a car to rest with a constant deceleration of 4.0 m/s^2 in a time of 8.0 s.

What is the average speed of the car during this time?

A 4.0 m/s **B** 8.0 m/s **C** 16 m/s **D** 32 m/s

3 An object is falling in a uniform gravitational field.

After a certain time, it reaches terminal velocity.

Which row is correct?

	velocity of object	acceleration of object
A	increases then decreases	positive then negative
B	increases then decreases	positive then zero
C	increases then constant	positive then negative
D	increases then constant	positive then zero

1 (a) A hard ball is dropped vertically downwards.

Fig. 1.1 shows the speed–time graph for the ball from when it is dropped until it hits the ground.

Air resistance is ignored.

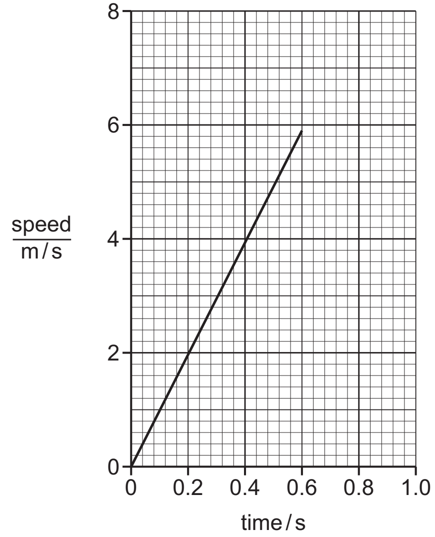


Fig. 1.1

(i) Describe the motion of the ball in Fig. 1.1.

....

.... [1]

(ii) Show that the distance travelled by the ball is 1.8 m.

[2]

(iii) The mass of the ball is 0.54 kg. Calculate the gravitational potential energy stored in the ball immediately before it is dropped.

gravitational potential energy = ... [2]

(iv) Determine the kinetic energy of the ball when it has fallen half way to the ground.

kinetic energy = ... [1]

(b) The same ball is dropped from an aeroplane. Air resistance acts on the ball.

Explain how the vertical motion of the ball changes, from when it is dropped to just before it hits the ground.

Use the idea of forces in your answer.

....

....

....

....

.... [3]

(c) A soft ball is dropped by a student so that it bounces on the ground.

Fig. 1.2 shows the height–time graph for the ball. The height is measured from the ground.

The ball bounces four times.

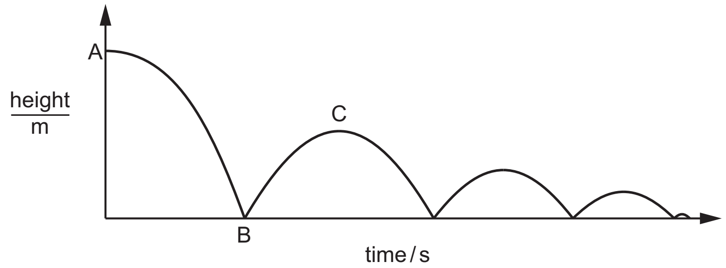


Fig. 1.2

Explain why the change in height of the ball between B and C is less than the change in height between A and B.

....

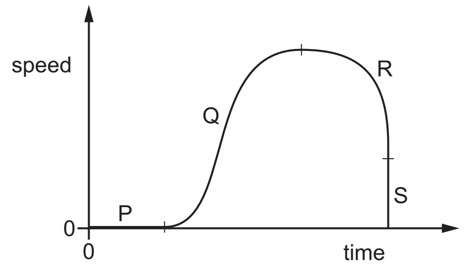
....

....

.... [2]

[Total: 11]

1 The speed–time graph for a racing car is divided into four sections, P, Q, R and S. The car starts the race but soon crashes into a wall of tyres.



Which sections of the graph show that there is an acceleration that is changing?

A P, Q, R and S

B Q, R and S only

C Q and R only

D R and S only

IGCSE Physics: **s24 21**

7 A stone is dropped from a tall tower and falls a distance of 50 m to the ground.

The stone has a mass of 3.0 kg.

At which speed does the stone hit the ground?

A 17 m/s **B** 31 m/s **C** 54 m/s **D** 150 m/s

1 A long tube contains oil. A small ball is held at rest at the surface of the oil. At time $t = 0$, the ball is released and begins to fall vertically through the oil.

Fig. 1.1 shows the ball falling through the oil.

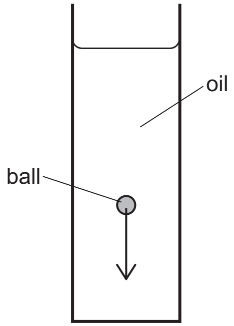


Fig. 1.1

As the ball begins to fall through the oil, it accelerates.

(a) Define acceleration.

....

.... [1]

(b) The mass of the ball is 0.0075 kg.

Calculate the resultant force acting on the ball when it is accelerating downwards at $2.8\,\text{m/s}^2$.

resultant force = ... [2]

(c) As the ball falls, its speed v is recorded. Fig. 1.2 is the speed–time graph for the falling ball.

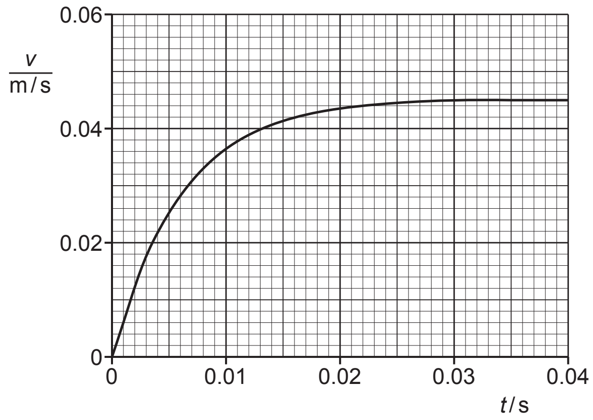


Fig. 1.2

(i) Describe what happens to the acceleration between $t = 0$ and $t = 0.040\,\text{s}$.

Explain why this happens.

....

....

....

.... [4]

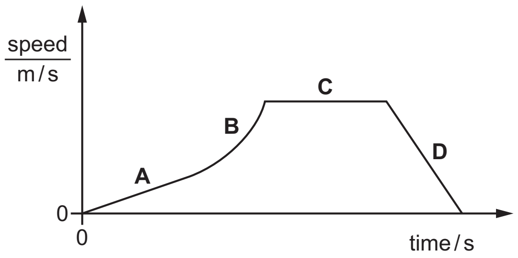
(ii) By drawing a tangent on Fig. 1.2, determine a value for the acceleration of the ball at $t = 0.010\,\text{s}$.

acceleration = ... [3]

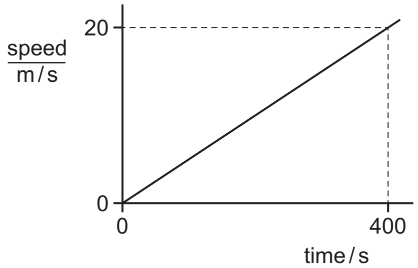
[Total: 10]

2 The graph shows the speed of a car travelling through a town.

Which section of the graph represents a period when the car is decelerating?



3 The graph represents the motion of a vehicle.



What is the distance travelled by the vehicle in 400 s?

A 20 m **B** 400 m **C** 4000 m **D** 8000 m

2 Fig. 2.1 shows a motorcyclist accelerating along a straight horizontal section of track.

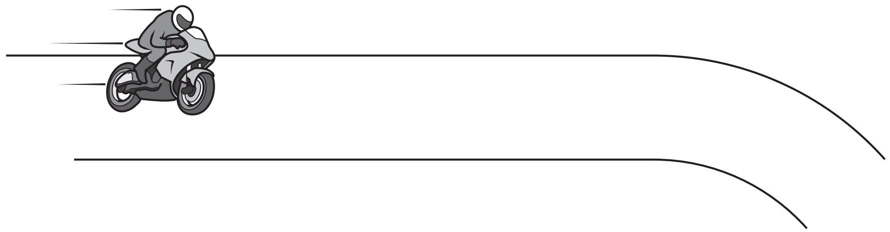


Fig. 2.1

The motorcyclist and motorcycle have a combined mass of 240 kg.

(a) On the straight horizontal section of the track, the motorcyclist accelerates from rest at $7.2\,m/s^2$.

(i) The motorcyclist reaches the end of the straight section of track in 5.3 s.

Calculate the speed of the motorcyclist at the end of the straight section.

speed = ... [2]

(ii) Calculate the resultant force on the motorcyclist and motorcycle on the straight section of track.

resultant force = ... [2]

(b) At the end of the straight section, the track remains horizontal but bends to the right, as shown in Fig. 2.1.

When the motorcyclist reaches the bend, she travels around the bend in a circular path at a constant speed.

(i) Velocity is a vector quantity.

State how a vector quantity differs from a scalar quantity.

....

.... [1]

(ii) Describe what happens to the velocity of the motorcyclist as she travels around the bend at constant speed.

....

.... [1]

(iii) Explain why there must be a resultant force on the motorcyclist as she travels around the bend.

....

....

.... [2]

[Total: 8]

IGCSE PHYSICS • EXERCISE SHEET

1.3 Mass and weight

Name: ____________ Class: ________ Date: __________ **Total: 10 marks**

KEY WORDS gravitational field strength 重力场强度 • mass and weight 质量与重力 • mass 质量 • weight 重力 • matter 物质

Objective

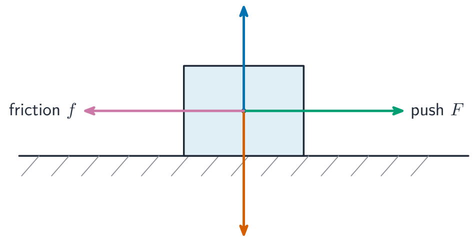
Build the skills to answer exam questions on **mass and weight 质量与重力** — the difference between them, $W = mg$, and **gravitational field strength 重力场强度**.

You must be able to:

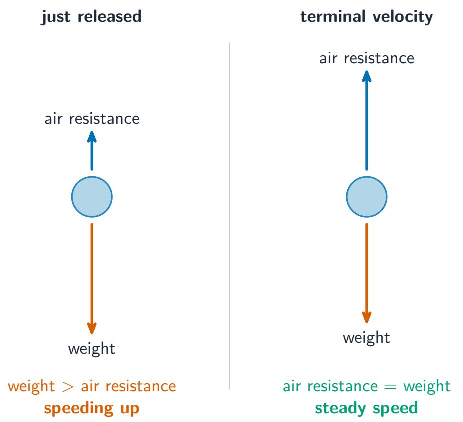
- distinguish mass (kg, constant) from weight (N, depends on gravity)
- use $W = mg$ and $g = \dfrac{W}{m}$
- explain why weight differs on the Moon

1 Worked examples

■ Mass vs weight



Weight is the downward force of gravity on a mass: $W = mg$



Weight is the downward force, balanced by drag at terminal velocity

- **mass** = amount of matter (kg), the **same** everywhere.
- **weight** = force of gravity (N); $W = mg$; smaller on the Moon (weaker gravity).
- **gravitational field strength** $g = \dfrac{W}{m}$ (≈ 10 N/kg on Earth).

2 Practice

2.1 Find the weight of a 6.0 kg bag on Earth ($g = 10$ N/kg). [2]

2.2 State the unit of weight and the unit of mass. [1]

3 Exam-style questions

3.1 When an astronaut goes to the Moon, their: [1]

- **A** mass and weight both decrease
- **B** mass stays the same but weight decreases
- **C** mass decreases but weight stays the same
- **D** mass and weight both stay the same

3.2 An object has a weight of 48 N on Earth, where $g = 10$ N/kg.

(a) Find its mass. [2]

(b) Find its weight on the Moon, where $g = 1.6$ N/kg. [2]

3.3 Explain why mass does not change when an object is taken to the Moon, but weight does. [2]

Solutions

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

2.1

- $W = mg$

$$W = (6.0\ \text{kg})(10\ \text{N/kg}) = \mathbf{60}\ \text{N}$$

2.2

- weight in newtons (N); mass in kilograms (kg)

3.1 B

- mass is unchanged; weight is less because the Moon's gravity is weaker

3.2

(a) $m = W/g$

$$m = \frac{48\ \text{N}}{10\ \text{N/kg}} = \mathbf{4.8}\ \text{kg}$$

(b) $W = mg$

$$W = (4.8\ \text{kg})(1.6\ \text{N/kg}) = \mathbf{7.7}\ \text{N}$$

3.3

- mass is the amount of matter, which does not change with location
- weight is the force of gravity, which is smaller on the Moon because its gravitational field strength is weaker

3 A space probe that has a mass of 600 kg is on the planet Mars.

The acceleration of free fall on Mars is $4.0\,\text{m/s}^2$.

What is the weight of the space probe on Mars?

A 60 N **B** 150 N **C** 2400 N **D** 6000 N

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4 Which measuring instrument is used to compare masses?

A balance

B protractor

C stop-watch

D voltmeter

2 Table 2.1 contains information about the planet Mars.

Table 2.1

mass	6.4×10^{23} kg
gravitational field strength at surface	3.7 N/kg
average density	3900 kg/m^3

(a) Define gravitational field strength.

....

.... [1]

(b) **(i)** An object has a weight of 42 N at the surface of the Earth.

Calculate the weight of the object at the surface of Mars.

weight = ... [2]

(ii) Calculate the volume of Mars.

volume = ... [2]

(c) Fig. 2.1 shows a space buggy that is tested on Earth. The buggy is travelling at a constant speed in a straight line. The driving force on the buggy is 30 N.

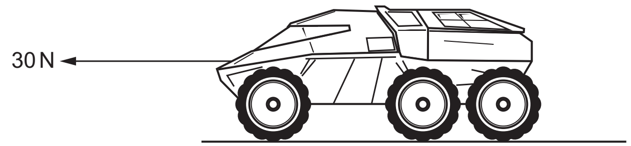


Fig. 2.1

(i) Draw and label **one** arrow on Fig. 2.1 to show the size and direction of the resistive forces on the buggy. [2]

(ii) Air resistance on Mars is less than air resistance on Earth.
The same driving force, 30 N, is exerted on the buggy on Mars.

1. State the effect this has on the resultant force on the buggy on Mars.

....

2. State the relationship between resistive forces, driving force and resultant force.

....
[1]

[Total: 8]

2 Which name is given to the quantity of matter in an object?

A density

B mass

C volume

D weight

3 A body is moved from place X to place Y where the gravitational field strength is different.

What happens to its mass and to its weight due to the move?

	mass	weight
A	changes	changes
B	changes	stays the same
C	stays the same	changes
D	stays the same	stays the same

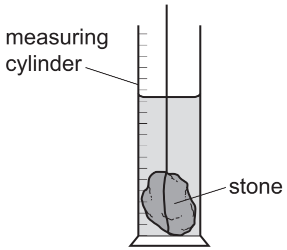
4 On the Earth, a spring stretches by 5.0 cm when a mass of 3.0 kg is suspended from one end.

The gravitational field strength on the Moon is $\frac{1}{6}$ of that on the Earth.

Which mass, on the Moon, would stretch the spring by the same extension?

A 0.50 kg **B** 3.0 kg **C** 5.0 kg **D** 18 kg

6 A student determines the density of an irregularly shaped stone. The stone is slowly lowered into a measuring cylinder partly filled with water.



Which other apparatus does the student need to calculate the density of the irregularly shaped stone?

A a balance

B a thermometer

C a metre rule

D a stop-watch

IGCSE PHYSICS • EXERCISE SHEET

1.4 Density

Name: ____________ Class: ________ Date: __________ **Total: 25 marks**

KEY WORDS density 密度 • floats 漂浮 • displacement method 排水法 • mass 质量 • measurement 测量

Objective

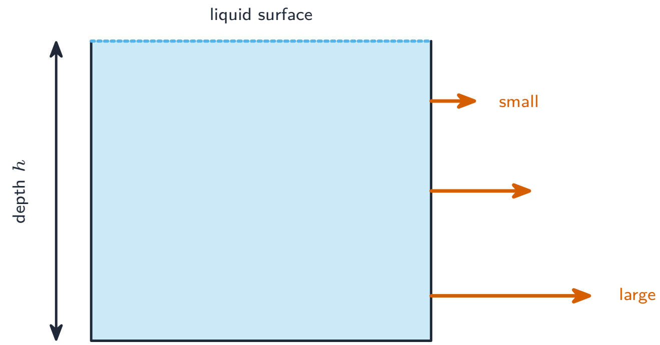
Build the skills to answer exam questions on **density 密度** — using $\rho = \frac{m}{V}$, finding volume (incl. the **displacement method 排水法**), and floating/sinking.

You must be able to:

- use $\rho = \frac{m}{V}$ with consistent units
- find the volume of a regular and an irregular solid
- predict floating or sinking from densities

1 Worked examples

Density and the displacement method



Density ρ is mass per unit volume; a denser liquid also gives a greater pressure with depth

Stone, mass 54 g, water rises 20 → 40 cm³: volume = 20 cm³; $\rho = \frac{54}{20} =$

$2.7\ g/cm^3$.

Float/sink: floats if its density < the liquid's density.

Which floats, and finding the density of a liquid

An object **floats** in a liquid when its density is **less** than the liquid's density, and sinks when it is greater. The same rule decides which of two liquids floats on the other, provided they do not mix: the less dense liquid lies on top. Oil ($\approx 800\ kg/m^3$) floats on water ($1000\ kg/m^3$).

Density of a liquid. Weigh an empty measuring cylinder; pour in the liquid and read its volume; weigh again. The mass of the liquid is the difference between the two readings, and $\rho = \frac{m}{V}$.

Worked example. An empty cylinder has a mass of 84.0 g. With 50 cm³ of a liquid it has a mass of 124.0 g. Mass of liquid = 124.0 − 84.0 = 40.0 g, so $\rho = \frac{40.0}{50} = 0.80\ g/cm^3$. This liquid floats on water, whose density is $1.0\ g/cm^3$.

△ Watch the units: $1\ g/cm^3 = 1000\ kg/m^3$, because $1\ m^3 = 10^6\ cm^3$ and $1\ kg = 1000\ g$.

2 Practice

2.1 A block has mass 240 g and volume 30 cm³. Find its density. [2]

2.2 State how to find the volume of a small irregular stone. [1]

2.3 Four liquids that do not mix have densities 0.79, 1.00, 1.26 and 0.92 g/cm³. State the order in which they settle, from the top of the container downwards. [2]

2.4 Convert a density of $2.7\ g/cm^3$ into kg/m^3. [2]

3 Exam-style questions

3.1 An object floats on water (density $1.0\ g/cm^3$) if its density is: [1]

- **A** greater than $1.0\ g/cm^3$
- **B** less than $1.0\ g/cm^3$
- **C** exactly $1.0\ g/cm^3$ only
- **D** any value

3.2 A rectangular metal block measures 2.0 cm × 3.0 cm × 5.0 cm and has mass 216 g.

(a) Find its volume. [1]

(b) Find its density. [2]

3.3 A liquid of density $0.80\ g/cm^3$ is poured onto water. State, with a reason, which liquid floats on top. [2]

3.4 A student finds the density of a liquid and of an irregular metal object.

(a) Describe how she finds the density of the liquid, naming her measurements. [3]

(b) Her empty measuring cylinder has a mass of 76.0 g. With 80 cm^3 of the liquid it has a mass of 140.0 g. Calculate the density of the liquid. [3]

(c) She lowers the metal object into the cylinder. The level rises from 80 cm^3 to 105 cm^3 and the balance now reads 337.5 g. Calculate the density of the metal. [3]

(d) State, with a reason, whether the metal would float in the liquid. [2]

(e) Explain why the displacement method could not be used for a small cube of sugar.[1]

Solutions

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

2.1

- $\rho = m/V$

$$\rho = \frac{240\ \text{g}}{30\ \text{cm}^3} = \mathbf{8.0}\ \text{g/cm}^3$$

2.2

- lower it into water in a measuring cylinder; the rise in water level is its volume

2.3

- 0.79, 0.92, 1.00, 1.26 g/cm^3 from the top down
- the least dense liquid floats on top of the denser ones

2.4

- $\times 1000$ to convert g/cm^3 to kg/m^3

$$2.7\ \text{g/cm}^3 \times 1000 = \mathbf{2700}\ \text{kg/m}^3$$

3.1 B

- it floats if its density is less than that of water

3.2

(a) $V = 2.0 \times 3.0 \times 5.0 = \mathbf{30}\ \text{cm}^3$

(b) $\rho = m/V$

$$\rho = \frac{216\ \text{g}}{30\ \text{cm}^3} = \mathbf{7.2}\ \text{g/cm}^3$$

3.3

- the liquid of density 0.80 g/cm^3 floats
- because its density is less than that of water (1.0 g/cm^3)

3.4

(a) measure the mass of the empty measuring cylinder

- pour in the liquid and read its volume from the scale, at the bottom of the meniscus with the eye level
- measure the mass again and subtract to get the mass of the liquid, then divide mass by volume

(b) mass of liquid = 140.0 g − 76.0 g = 64.0 g

- $\rho = m/V$

$$\rho = \frac{64.0\ \text{g}}{80\ \text{cm}^3} = \mathbf{0.80}\ \text{g/cm}^3$$

(c) volume of the metal $= 105\text{ cm}^3 - 80\text{ cm}^3 = 25\text{ cm}^3$

- mass of the metal $= 337.5\text{ g} - 140.0\text{ g} = 197.5\text{ g}$

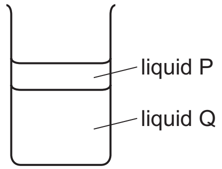
$$\rho = \frac{197.5\text{ g}}{25\text{ cm}^3} = \mathbf{7.9}\text{ g/cm}^{\mathbf{3}}$$

(d) **no**, it sinks

- its density of 7.9 g/cm^3 is far greater than the liquid's 0.80 g/cm^3

(e) sugar dissolves in the liquid, so the level would not give its volume

4 The diagram shows one liquid floating on top of another liquid.



Which statement explains why liquid P floats on top of liquid Q?

A The mass of liquid Q is greater than the mass of liquid P.

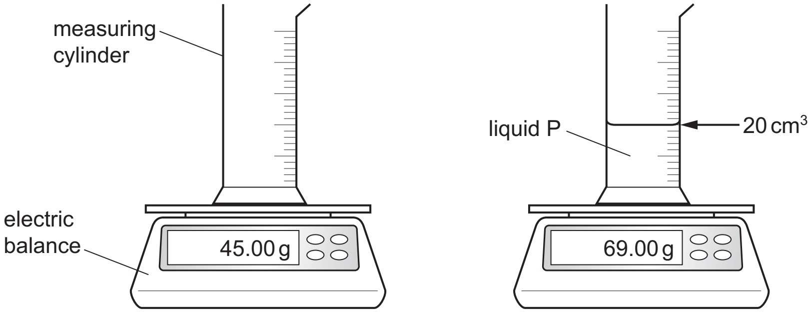
B The mass of 1 cm^3 of liquid Q is greater than the mass of 1 cm^3 of liquid P.

C The volume of liquid Q is greater than the volume of liquid P.

D The volume of 1 g of liquid Q is greater than the volume of 1 g of liquid P.

4 Students are asked to predict the order in which three liquids, P, Q and R, will float on each other. They are told that the liquids will **not** mix.

The diagrams show how the density of liquid P is determined.



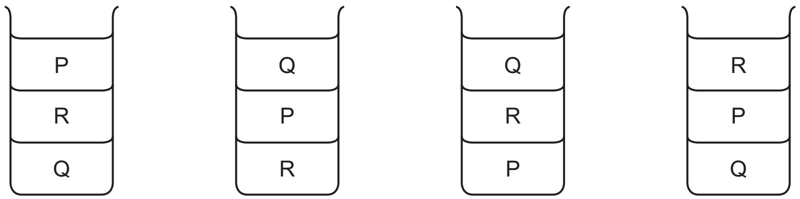
The table shows the densities of Q and R.

liquid	density g/cm³
Q	0.75
R	1.1

The liquids are poured gently into a tall beaker and allowed to settle.

Which diagram shows the liquids settled in the correct order?

A **B** **C** **D**



5 Three different liquids are poured into a tall beaker. The liquids do **not** mix.

The liquid densities are shown in the table.

liquid	density g/cm³
P	1.8
Q	2.4
R	1.2

What is the correct order of the liquids from the top of the beaker to the bottom?

A P → Q → R **B** Q → P → R **C** Q → R → P **D** R → P → Q

4 **(a)** **(i)** A rectangular glass tank contains 3.0 m^3 of liquid. The mass of the liquid is 2800 kg. Calculate the density of the liquid.

density = ... [1]

(ii) A metal block is placed in the tank and it sinks to the bottom. The top surface of the block is 1.1 m below the surface of the liquid.

Fig. 4.1 shows the block on the bottom of the tank.

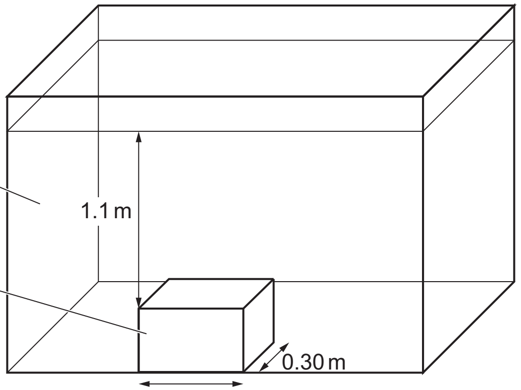


Fig. 4.1

Calculate the force exerted by the liquid on the top of the block.

force on top of the block = ... [4]

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(b) Fig. 4.2 shows part of a steel railway track. There are small gaps between sections of the rail.

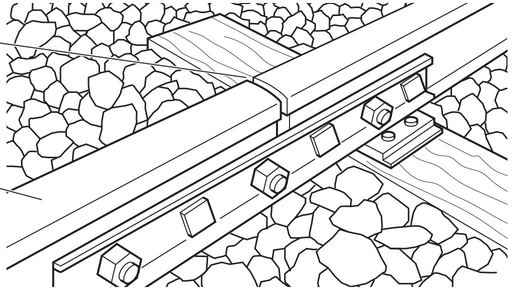


Fig. 4.2

State why gaps are needed between the sections of rail. Explain your answer in terms of particles.

statement ....

explanation ....

.... [2]

(c) Fig. 4.3 shows a saucepan of boiling water on the heating ring of an electric cooker.

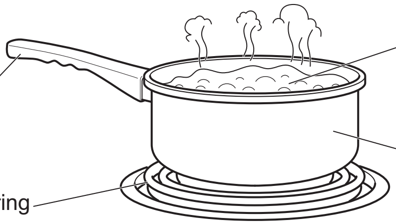


Fig. 4.3

The handle is made from plastic.
Explain why this material is suitable.

....

....

.... [2]

[Total: 9]

1 A student determines the volume of a block of modelling clay by two methods.

Method 1

He measures the block of modelling clay shown full size in Fig. 1.1.

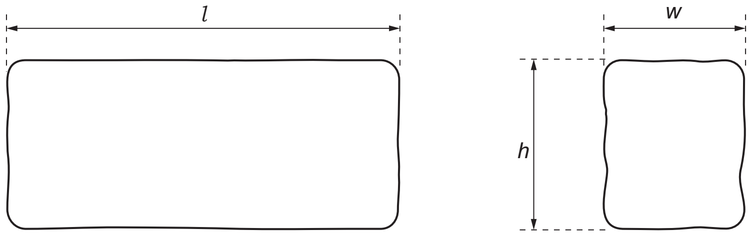


Fig. 1.1

(a) **(i)** Measure the length l, width w and height h of the block of modelling clay on Fig. 1.1. Record your values in centimetres to the nearest millimetre.

length l = ... cm

width w = ... cm

height h = ... cm
[2]

(ii) Calculate a value V_A for the volume of the block. Use your measurements from **(a)(i)** and the equation:

$$V_A = l \times w \times h.$$

V_A = ... cm^3 [1]

(b) Suggest why V_A is only an approximate value for the volume of the block.

Describe how the accuracy of V_A can be improved.

suggestion ....

....

improvement ....

....
[2]

(c) Another student measures the dimensions of a block of clay which is much smaller than the block in **(a)**. Suggest why these measurements may not be as accurate as yours, even if they are done carefully.

....

....

.... [1]

Method 2

(d) **(i)** The student pours water into a measuring cylinder.

Record the volume V_1 of the water in the measuring cylinder shown in Fig. 1.2.

V_1 = ... cm^3 [1]

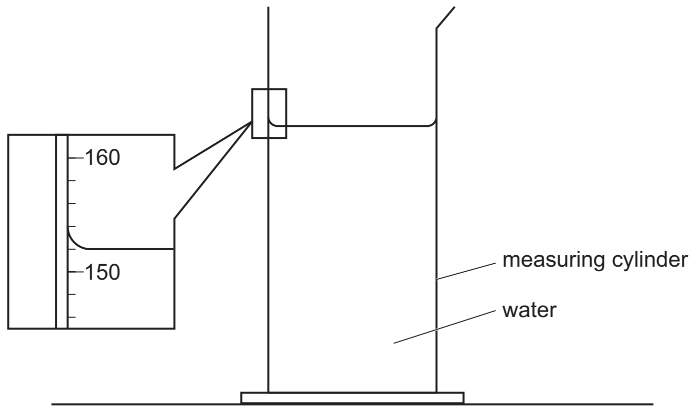


Fig. 1.2

(ii) Describe briefly how a measuring cylinder is read to obtain an accurate value for the volume of water.

....

.... [1]

(e) The student lowers the modelling clay into the water using a loop of thread, as shown in Fig. 1.3.

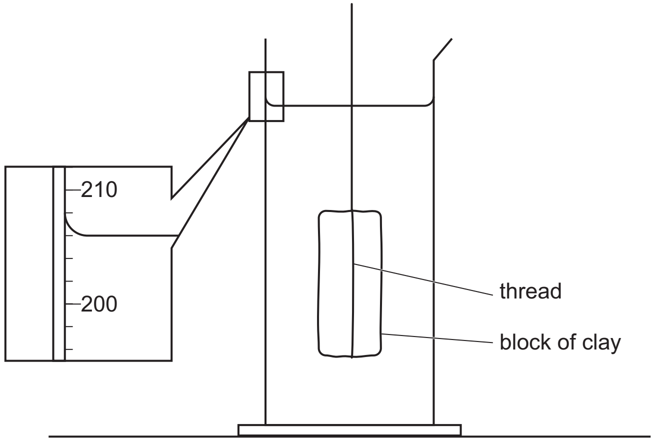


Fig. 1.3

Record the new reading V_2 shown on the measuring cylinder scale in Fig.1.3.

V_2 = ... cm^3

Calculate another value V_B for the volume of the block.

Use your measurements from **(d)(i)** and **(e)** and the equation: $V_B = (V_2 - V_1)$.

V_B = ... cm^3
[1]

(f) Suggest **one** possible source of inaccuracy in Method 2 and suggest **one** improvement to reduce its effect.

source of inaccuracy ....

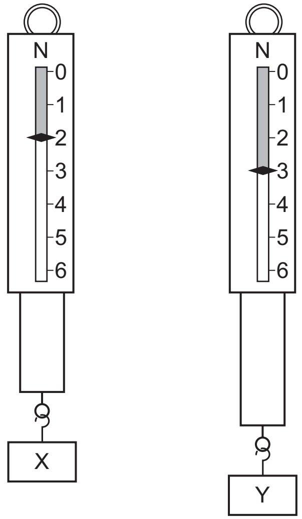
....

improvement ....

....
[2]

[Total: 11]

3 The diagrams show two metal blocks, X and Y, suspended from identical force meters. X and Y have identical dimensions.



Which statement about X and Y is correct?

A They have different volumes and different weights.

B They have different volumes and equal weights.

C They have equal volumes and equal weights.

D They have equal volumes and different weights.

1 A student determines the density of a ball.

(a) He places the ball between two wooden blocks, as seen from above in Fig. 1.1.

He takes two measurements, d_1 and d_2.

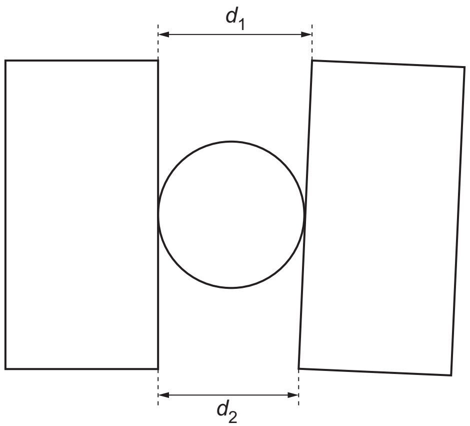


Fig. 1.1

(i) On Fig. 1.1, measure the lengths d_1 and d_2.

d_1 = ... cm

d_2 = ... cm
[1]

(ii) Using your measurements, calculate the diameter d of the ball. Show your working.

d = ... cm [1]

(iii) Explain why this method is used to measure the diameter of the ball.

....

.... [2]

(b) Calculate the volume V of the ball using the equation $V = 0.52d^3$.

Include the unit.

V = ... [2]

(c) The student measures the mass m_D of a dish.

m_D = ...102.5.......................... g

He places the ball in the dish and measures the combined mass m_C of the dish and the ball.

Fig. 1.2 shows the dish and the ball on a balance.

Record the reading shown on the balance.

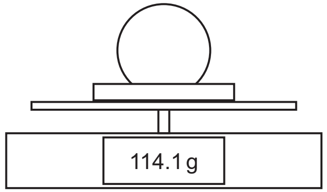


Fig. 1.2

m_C = ... g

Calculate the mass m_B of the ball. Show your working.

m_B = ... g
[2]

(d) Calculate the density ρ of the ball using the equation:

$$\rho = \frac{m_B}{V}.$$

Give your answer to a suitable number of significant figures for this experiment. Include the unit.

ρ = ... [3]

[Total: 11]

4 The mass of an object is 2.5 kg. The volume of the object is 480 cm^3.

What is the density of the object?

A 5.2×10^{-3} g / cm^3

B 5.2 g / cm^3

C 190 g / cm^3

D 1.2×10^{3} g / cm^3

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4 The table shows the mass and volume of three different liquids, X, Y and Z.

liquid	mass / g	volume / cm^3
X	120	200
Y	80	67
Z	100	120

The liquids are placed in the same container. The liquids do not mix.

Which liquid is at the top of the container and which liquid is at the bottom?

	liquid at top	liquid at bottom
A	X	Y
B	X	Z
C	Y	X
D	Y	Z

IGCSE PHYSICS • EXERCISE SHEET

1.5 Forces

Name: ____________ Class: ________ Date: __________ **Total: 41 marks**

KEY WORDS forces 力 • equilibrium 平衡 • resultant force 合力 • limit of proportionality 比例极限 • stability 稳定性 • resultant force 合力 • moments 力矩 • friction 摩擦力 • limit of proportionality 比例极限 • principle of moments 力矩原理

Objective

Build the skills to answer exam questions on **forces** 力: **Hooke's law** 胡克定律 and the load–extension graph, **resultant force** 合力 and $F = ma$, **solid friction** 固体摩擦, **moments** 力矩 and **equilibrium** 平衡, and the **centre of gravity** 重心.

You must be able to:

- describe the load–extension experiment, sketch the graph and use $k = \dfrac{F}{x}$
- find the resultant of forces on a straight line and use $F = ma$
- describe solid friction and drag, and explain motion in a circle
- use the principle of moments, and state the two conditions for equilibrium
- state what the centre of gravity is, find it for a lamina, and explain stability

1 Worked examples

■ Forces change shape, speed or direction

A force can change an object's **shape** 形状, its speed, or its direction. **Solid friction** 固体摩擦 is the force between two surfaces that touch: it acts against the motion, tries to stop it, and heats the surfaces. Drag is friction in a liquid or a gas (air resistance).

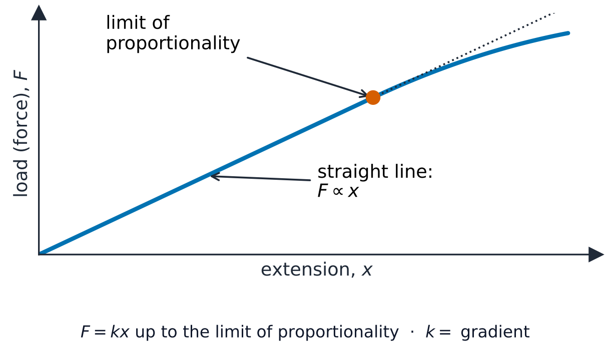
A resultant force at right angles to the motion changes only the direction, so the object moves in a circle at a steady speed. A bigger force is needed for a faster speed or a smaller radius, and for a bigger mass.

■ Hooke's law and the load–extension experiment

Hang the spring from a clamp with a ruler beside it. Read the position of the bottom of the spring with no load: that is the original length. Add loads one at a time and record the new length each time; the **extension** 伸长量 is the new length minus the original length. Plot load (y) against extension (x).

The graph is a straight line through the origin up to the **limit of proportionality** 比例极限, then it curves away. The **spring constant** 弹簧常数 is the force per unit extension:

$$k = \frac{F}{x}$$



Load is proportional to extension up to the limit of proportionality; the gradient of the straight part is k

Worked example 1. A spring stretches 4.0 cm under a load of 20 N. Then $k = \frac{20}{4.0} = 5.0$ N/cm.

■ Resultant force and $F = ma$

Add forces on a straight line with signs: one direction positive, the other negative. If the resultant is zero, the object stays at rest or keeps moving in a straight line at constant speed. If it is not zero, the object accelerates in the direction of the resultant:

$$F = ma$$

Worked example 2. A car of mass 1200 kg has a driving force of 3000 N and friction of 600 N.

1. Resultant: $3000 - 600 = 2400$ N.
2. $a = \frac{F}{m} = \frac{2400}{1200} = 2.0$ m/s^2.

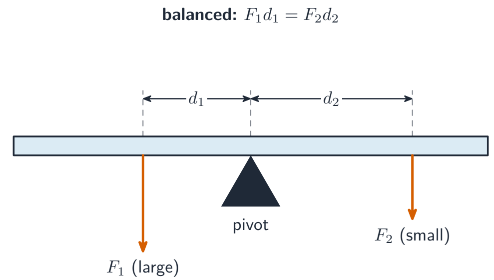
If the question asks why the engine must produce more force than $F = ma$ suggests, the answer is friction and air resistance: some of the driving force is used against them.

■ Moments and equilibrium

The **moment** 力矩 of a force is its turning effect about a **pivot** 支点:

$$\text{moment} = \text{force} \times \text{perpendicular distance from the pivot}$$

Principle of moments: for a balanced object, total clockwise moment = total anticlockwise moment. An object is in equilibrium when there is **no resultant force and no resultant moment**.



Balanced: clockwise moment equals anticlockwise moment

Worked example 3. A 30 N weight sits 0.20 m left of a pivot. How far right must a 20 N weight sit?

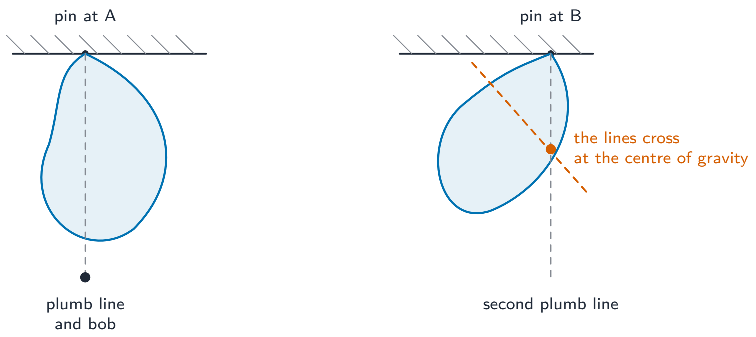
$30 \times 0.20 = 20 \times d$, so $d = \frac{6.0}{20} = 0.30$ m.

The experiment. Balance a metre rule at its centre. Hang a known weight each side and move them until it balances again. Measure both distances. Force × distance on the left equals force × distance on the right within the measurement errors, so a balanced object has no resultant moment.

■ Centre of gravity and stability

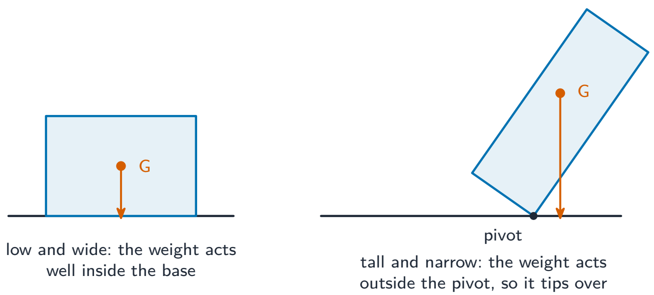
The **centre of gravity** is the single point where all the weight of an object seems to act.

Finding it for a lamina 薄片 (a flat shape): hang the shape from a pin at a point near its edge and let it settle. Hang a plumb line from the same pin and draw the vertical line on the shape. Repeat from a second point. The centre of gravity is where the two lines cross. (A third line is a useful check.)



The two vertical lines cross at the centre of gravity

Stability 稳定性 depends on where the centre of gravity is and how wide the base is. A low centre of gravity and a wide base make an object stable. It tips over once a vertical line down from the centre of gravity falls outside the base.



While the weight acts inside the base the object settles back; once it acts outside the pivot corner the object tips over

2 Practice

2.1 A spring stretches 4.0 cm under a 20 N load. Find the spring constant in N/cm. [2]

2.2 State the principle of moments. [1]

2.3 Describe what is meant by solid friction, and state one effect it has besides slowing an object down. [2]

2.4 State the two conditions for an object to be in equilibrium. [2]

2.5 A spring of original length 12.0 cm stretches to 15.5 cm under a load of 7.0 N. Calculate its spring constant in N/cm. (Hint: use the extension, not the whole length.) [3]

2.6 State what is meant by the centre of gravity of an object. [1]

2.7 A ball on the end of a string is whirled in a horizontal circle at a steady speed. State the direction of the resultant force on the ball, and state what the force changes. [2]

3 Exam-style questions

3.1 A car is travelling along a straight road at a constant speed. Which statement about the forces on the car is correct? [1]

- **A** The driving force is larger than the total resistive force.
- **B** The driving force is equal to the total resistive force.
- **C** There is no driving force and no resistive force.
- **D** The driving force is smaller than the total resistive force.

3.2 Two objects, X and Y, have the same mass and the same height. X has a wide base and Y has a narrow base. Which is more stable, and why? [1]

- **A** X, because its centre of gravity is further from the ground.
- **B** X, because the weight stays inside its base for a bigger tilt.
- **C** Y, because it is narrower and lighter at the top.
- **D** They are equally stable, because they have the same mass.

3.3 A train has a total mass of 520 000 kg. It accelerates uniformly along a straight, level track.

(a) Define acceleration. [1]

(b) The train speeds up from 15 m/s to 28 m/s with an acceleration of 1.1 m/s^2. Calculate the time this takes. [2]

(c) Calculate the resultant force needed to produce this acceleration. [2]

(d) The force produced by the train's motors is larger than the value in (c). Explain why. [1]

(e) The driver then applies the brakes and the train slows down. State how the direction of the resultant force compares with the direction of motion. [1]

3.4 A uniform beam of weight 12 N and length 1.2 m rests on a pivot at its centre. A 40 N weight hangs 0.30 m to the left of the pivot.

(a) Explain why the weight of the beam itself has no turning effect about this pivot. [1]

(b) A weight W is hung 0.50 m to the right of the pivot so that the beam balances. Calculate W. [3]

(c) The 40 N weight is now moved to 0.45 m from the pivot. State and explain what happens to the beam. [2]

(d) Describe an experiment that shows there is no resultant moment on a balanced beam. [3]

3.5 A student investigates how a spring stretches.

(a) Describe how she should carry out the experiment, including the measurements she takes. [3]

(b) Sketch the load–extension graph she obtains, continuing the line beyond the limit of proportionality. Label the limit of proportionality on your sketch. [3]

(c) Her spring stretches 2.5 cm for a load of 10 N, within the straight part of the graph. Calculate the extension for a load of 6.0 N. [3]

(d) Explain why her method for the load of 60 N gives an extension larger than the calculation predicts. [1]

Solutions

2.1 $k = \dfrac{F}{x} = \dfrac{20}{4.0} = 5.0$ N/cm.

2.2 For a balanced object, the total clockwise moment about the pivot equals the total anticlockwise moment.

2.3 The force between two surfaces that touch, which acts against (impedes) the motion; it also produces heating of the surfaces.

2.4 No resultant force and no resultant moment.

2.5 Extension = 15.5 − 12.0 = 3.5 cm; $k = \dfrac{7.0}{3.5} = 2.0$ N/cm.

2.6 The single point at which all of the weight of the object appears to act.

2.7 Towards the centre of the circle; it changes the direction of the velocity, not the speed.

3.1 **B**. Constant speed in a straight line means zero resultant force, so the driving force balances the resistive forces. A would make it accelerate and D would make it slow down; C cannot be right because friction and air resistance always act.

3.2 **B**. A wide base means the object can tilt further before the vertical line from the centre of gravity leaves the base. A has the reasoning the wrong way round, C is untrue, and D ignores the shape.

3.3 (a) The change in velocity per unit time.
(b) $t = \dfrac{\Delta v}{a} = \dfrac{28 - 15}{1.1} = 12$ s.
(c) $F = ma = 520\,000 \times 1.1 = 570\,000$ N.
(d) Extra force is needed to overcome friction (or air resistance / drag), because $F = ma$ gives only the resultant force.
(e) The resultant force is in the opposite direction to the motion.

3.4 (a) The beam is uniform, so its centre of gravity is at its centre, directly above the pivot; the perpendicular distance is zero, so its moment is zero.
(b) Clockwise moment = anticlockwise moment: $40 \times 0.30 = W \times 0.50$; $12 = 0.50W$; $W = 24$ N.
(c) The anticlockwise moment becomes $40 \times 0.45 = 18$ N m, which is larger than the clockwise $24 \times 0.50 = 12$ N m, so the beam turns anticlockwise: the left-hand side goes down.
(d) Balance a metre rule at its centre on a pivot; hang a known weight on each side and adjust the distances until it balances, then measure both distances; show that force × distance is the same on both sides, within the measurement errors.

3.5 (a) Hang the spring from a clamp with a ruler fixed beside it and record the position of the bottom with no load; add loads one at a time, recording the load and the new length each time; calculate the extension as new length minus original length.
(b) A straight line through the origin; a marked point where the line stops being straight, labelled "limit of proportionality"; beyond it the line curves so that extension grows faster than load.
(c) $k = \dfrac{10}{2.5} = 4.0$ N/cm; $x = \dfrac{F}{k} = \dfrac{6.0}{4.0} = 1.5$ cm.

(d) A load of 60 N is beyond the limit of proportionality, so extension is no longer proportional to load.

2 **(a)** Define acceleration.

....

.... [1]

(b) A train has a total mass of 520 000 kg. The train accelerates at 1.1 m/s^2.

(i) Calculate the time taken for the train to increase its speed from 15 m/s to 28 m/s.

time = ... [2]

(ii) Calculate the force required to produce an acceleration of 1.1 m/s^2 for this train.

force = ... [2]

(iii) The train uses electric motors.

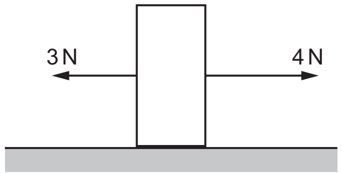
Explain why the force on the train due to the motors is greater than the value calculated in **(ii)**.

....

.... [1]

[Total: 6]

2 The diagram shows a solid object on a flat surface, with two forces acting on the object.



What is the resultant force on the object?

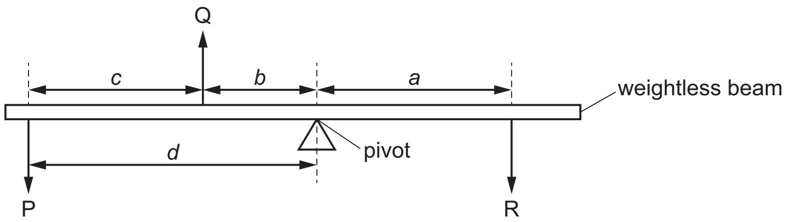
A 1 N to the left

B 1 N to the right

C 7 N to the left

D 7 N to the right

6 A weightless beam is balanced on a pivot as shown. Forces P, Q and R act on the beam.



Which equation is correct?

A $(\mathrm{P} \times c) + (\mathrm{Q} \times b) = (\mathrm{R} \times a)$

B $(\mathrm{P} \times c) - (\mathrm{Q} \times b) = (\mathrm{R} \times a)$

C $(\mathrm{P} \times d) + (\mathrm{Q} \times b) = (\mathrm{R} \times a)$

D $(\mathrm{P} \times d) - (\mathrm{Q} \times b) = (\mathrm{R} \times a)$

1 **(a)** Fig. 1.1. is a speed–time graph for the first 5 minutes of a bus journey.

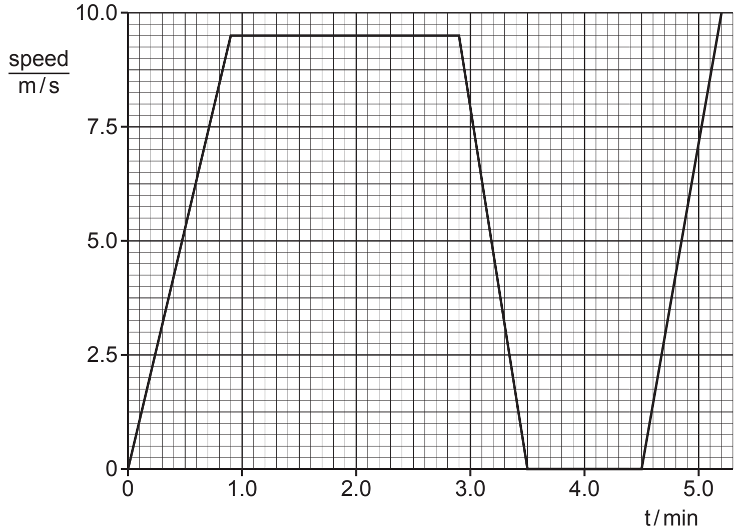


Fig. 1.1

Describe the motion between:

1. t = 0.90 min and t = 2.9 min ....

2. t = 2.9 min and t = 3.5 min ....

3. t = 3.5 min and t = 4.5 min ....

[3]

(b) Another bus travels at a speed of 8.9 m/s. The brakes apply a constant force and the bus stops in a distance of 23 m. This bus has a mass of 18 000 kg.

(i) Calculate the kinetic energy of the bus before the brakes are applied.

kinetic energy = ... [2]

(ii) Calculate the force applied to stop the bus.

force = ... [3]

[Total: 8]

2 **(a)** Define impulse.

....

.... [1]

(b) Fig. 2.1 shows a rocket and its exhaust gases.

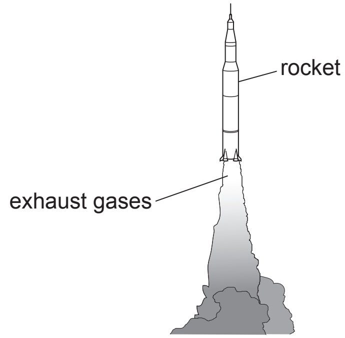


Fig. 2.1

The exhaust gases are emitted from the rocket with a velocity of 1400 m/s and at a rate of 2800 kg/s.

(i) Show that the force exerted on the rocket by the exhaust gases is 3900 kN.

State the equation you use.

[2]

(ii) Calculate the maximum mass that this force can lift from the ground. Ignore air resistance.

maximum mass = ... [3]

[Total: 6]

IGCSE PHYSICS • EXERCISE SHEET

1.6 Momentum

Name: __________ Class: _______ Date: ________ **Total: 11 marks**

KEY WORDS momentum 动量 • impulse 冲量 • conservation of momentum 动量守恒 • force 力 • mass 质量

Objective

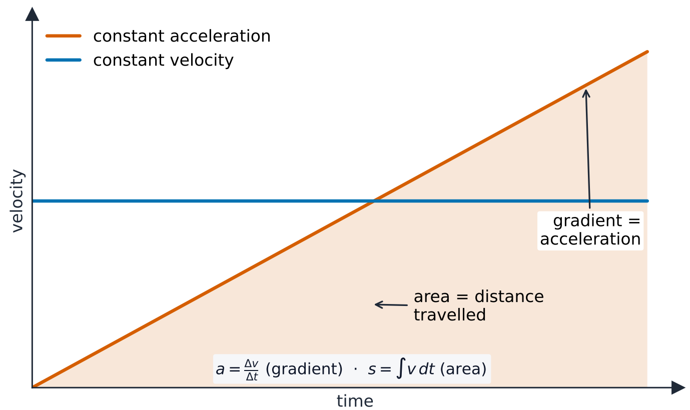
Build the skills to answer exam questions on **momentum 动量** — $p = mv$, $F = \dfrac{\Delta p}{\Delta t}$, and the **conservation of momentum 动量守恒**.

You must be able to:

- calculate momentum $p = mv$ (a vector — mind the direction)
- use $F = \dfrac{\Delta p}{\Delta t}$ (impulse)
- apply conservation of momentum to a collision

1 Worked examples

■ **Conservation of momentum**



Momentum $p = mv$ combines mass and velocity; in a collision the total is conserved

2.0 kg at 3.0 m/s hits stationary 1.0 kg, they stick: $(2.0 \times 3.0) + (1.0 \times 0) =$

$(3.0)v \Rightarrow v = 2.0$ m/s.

2 Practice

2.1 Find the momentum of a 0.40 kg ball moving at 5.0 m/s. [2]

2.2 State the principle of conservation of momentum. [1]

3 Exam-style questions

3.1 The momentum of an object is its mass multiplied by its: [1]

- **A** acceleration
- **B** velocity
- **C** weight
- **D** density

3.2 A 3.0 kg trolley moving at 4.0 m/s collides with a stationary 1.0 kg trolley and they move off together.

(a) Find the total momentum before the collision. [2]

(b) Find their common velocity after the collision. [2]

3.3 A force acts on a 2.0 kg ball for 0.10 s and changes its velocity from 0 to 6.0 m/s. Find the force. [3]

Solutions

2.1 $p = mv = 0.40 \times 5.0 = 2.0$ kg m/s.

2.2 when no external force acts, the total momentum before a collision equals the total momentum after.

3.1 B. Momentum = mass × velocity.

3.2 (a) before $= 3.0 \times 4.0 + 1.0 \times 0 = 12$ kg m/s.
(b) $12 = (3.0 + 1.0)v \Rightarrow v = 3.0$ m/s.

3.3 $F = \dfrac{\Delta p}{\Delta t} = \dfrac{2.0 \times 6.0}{0.10} = \dfrac{12}{0.10}; = 120$ N.

7 The momentum of a car changes from 10 000 kg m / s to 15 000 kg m / s in a time of 8.0 s.

What is the resultant force acting on the car?

A 630 N **B** 3100 N **C** 40 000 N **D** 200 000 N

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6 Diagram 1 shows a ball X of mass 0.15 kg travelling horizontally with a velocity of 2.1 m / s towards ball Y travelling at 0.4 m / s in the opposite direction.

Diagram 2 shows the velocities of the balls immediately after they collide.

diagram 1

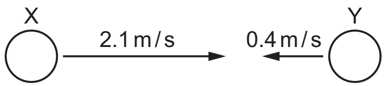
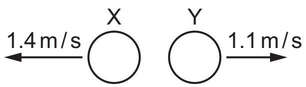


diagram 2



What is the mass of ball Y?

A 0.15 kg **B** 0.19 kg **C** 0.35 kg **D** 0.79 kg

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8 A ball is at rest on the ground. A boy kicks the ball. The boy's boot is in contact with the ball for a time of 0.040 s.

The average force on the ball is 200 N. The ball leaves the boy's boot with a speed of 20 m / s.

Which row gives the impulse of the boot on the ball and the average acceleration of the ball during the time of 0.040 s?

	impulse on ball / N s	average acceleration of ball / m / s^2
A	8	0.8
B	8	500
C	5000	0.8
D	5000	500

2 A cricket ball is travelling at a speed of 25 m / s horizontally through the air. The mass of the ball is 0.14 kg.

A player catches the ball and the ball comes to rest.

(a) Calculate the change in momentum of the ball during the catch.

change in momentum = ... [2]

(b) The player's hands are in contact with the moving ball for 9.7 ms.

Calculate the horizontal force exerted by her hands to bring the ball to rest.

force = ... [3]

[Total: 5]

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6 A ball of mass m falls vertically and hits a hard surface.

Its speed on hitting the surface is v_1.

It rebounds vertically upwards with speed v_2.

What is the change in momentum of the ball?

A mv_1 **B** mv_2 **C** $m(v_1 + v_2)$ **D** $m(v_2 - v_1)$

2 Fig. 2.1 shows two identical trolleys, P and Q, held at rest on a frictionless horizontal surface. A load is fixed to trolley P.

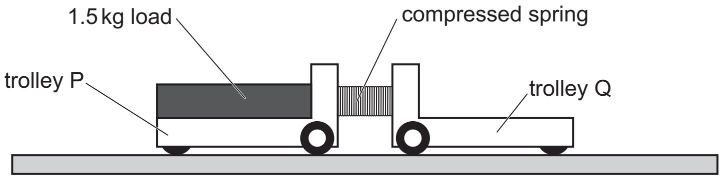


Fig. 2.1

There is a compressed spring between trolley P and trolley Q.

The trolleys are released. As the spring expands, it pushes the trolleys apart.

Trolley Q moves to the right at a constant speed of 0.36 m/s.

The mass of each trolley is 1.2 kg. The mass of the load on trolley P is 1.5 kg.

The spring has negligible mass.

(a) Calculate:

(i) the speed at which trolley P moves to the left

speed of P = ... [3]

(ii) the kinetic energy of trolley Q when it moves at 0.36 m/s.

kinetic energy of Q = ... [3]

(b) State the energy transfer that takes place as the spring expands.

....

....

.... [2]

[Total: 8]

7 A sphere X collides head on with a second identical sphere Y which is stationary.

The mass of each sphere is 0.15 kg.

Sphere X is travelling at a velocity of 2.0 m/s before the collision and produces an impulse of 0.21 N s on sphere Y.

What is the velocity of sphere X after collision?

A 0.60 m/s in the opposite direction to Y

B 0.60 m/s in the same direction as Y

C 1.4 m/s in the opposite direction to Y

D 1.4 m/s in the same direction as Y

1 A girl holds a rubber ball out of a window of a tall building. The mass of the ball is 0.20 kg. The ball is at rest 10 m above a concrete path.

(a) Calculate the gravitational potential energy of the ball relative to the concrete path.

gravitational potential energy = ... [2]

(b) The girl releases the ball and it falls towards the path. The ball strikes the path and bounces vertically upwards.

Fig. 1.1 shows the ball falling towards the path.

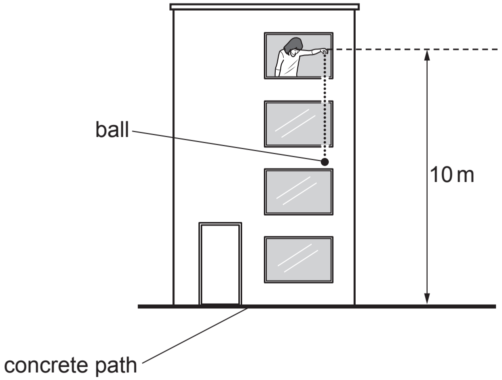


Fig. 1.1

The speed of the ball immediately **before** it strikes the path is 14 m / s.

The speed of the ball immediately **after** it strikes the path is 12 m / s.

(i) Calculate the kinetic energy of the ball immediately **after** it strikes the concrete path.

kinetic energy = ... [2]

(ii) Show that the change in momentum of the ball when it bounces off the path is 5.2 kg m / s.

[3]

(iii) The ball is in contact with the path for 0.25 s.

Calculate the average resultant force on the ball when it is in contact with the path.

force = ... [2]

[Total: 9]

IGCSE PHYSICS • EXERCISE SHEET

1.7 Energy, work and power

Name: ____________ Class: ________ Date: __________ **Total: 41 marks**

KEY WORDS kinetic 动能 • energy resources 能量资源 • power 功率 • gravitational potential 重力势能 • efficiency 效率 • efficiency 效率 • power 功率 • kinetic 动能 • energy 能量 • work done 做功

Objective

Build the skills to answer exam questions on **energy, work and power 能量、功与功率**: the energy stores and the transfers between them, E_k and ΔE_p, the **principle of conservation of energy 能量守恒定律**, **energy resources 能量资源**, $W = Fd$, $P = \dfrac{W}{t}$ and **efficiency 效率**.

You must be able to:

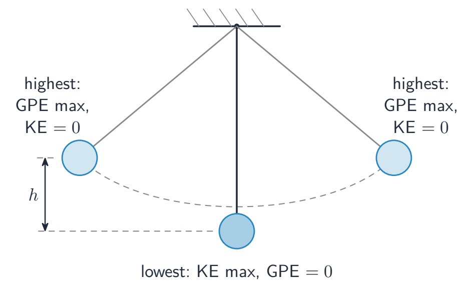
- name the energy stores and describe the transfers in an event
- use $E_k = \frac{1}{2}mv^2$ and $\Delta E_p = mg\,\Delta h$
- apply conservation of energy, including to a falling object
- describe how electricity is generated from each resource and compare them
- use $W = Fd$, $P = \dfrac{W}{t}$ and both efficiency formulas

1 Worked examples

Stores and transfers

Energy is **stored** as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal). It is **transferred** between stores by forces doing mechanical work, by electric currents, by heating, and by waves.

To describe an event, name the store it starts in, the store it ends in, and any store in between. For a ball dropped onto the ground and not bouncing: gravitational potential energy before it falls, transferred to kinetic energy as it falls, then transferred to internal (thermal) energy of the ball and the ground when it lands.



A swinging pendulum moves energy between the gravitational potential store (highest points) and the kinetic store (lowest point)

The **principle of conservation of energy** says energy is never created or destroyed, only transferred between stores. The total stays the same.

The two energy equations

$$E_k = \tfrac{1}{2}mv^2 \qquad \Delta E_p = mg\,\Delta h$$

Worked example 1. A ball of mass 0.50 kg is dropped from 1.8 m. Find its speed just before it lands ($g = 10$ m/s^2), ignoring air resistance.

1. All the gravitational potential energy becomes kinetic energy: $\frac{1}{2}mv^2 = mg\,\Delta h$.
2. The mass cancels: $v^2 = 2g\,\Delta h = 2 \times 10 \times 1.8 = 36$.
3. $v = \sqrt{36} = 6.0$ m/s.

Worked example 2 (mass from kinetic energy). Wind carries 11 000 J of kinetic energy each second at a speed of 6.3 m/s. Show that about 550 kg of air passes each second.

Rearrange $E_k = \frac{1}{2}mv^2$ to $m = \dfrac{2E_k}{v^2} = \dfrac{2 \times 11\,000}{6.3^2} = \dfrac{22\,000}{39.7} = 554$ kg, which is about 550 kg.

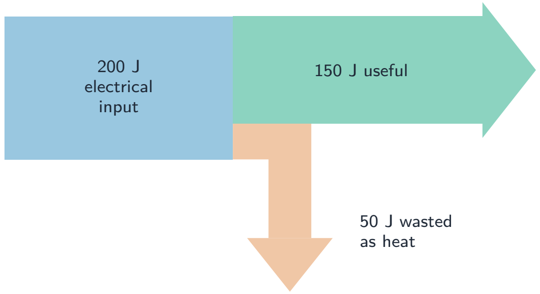
Work, power and efficiency

$$W = Fd = \Delta E \qquad P = \frac{W}{t} = \frac{\Delta E}{t}$$

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\% = \frac{\text{useful power output}}{\text{total power input}} \times 100\%$$

Worked example 3. A wind turbine receives 11 000 J each second and produces 6000 J of electrical energy each second. Efficiency $= \dfrac{6000}{11\,000} \times 100\% = 55\%$.

Efficiency is always below 100%: some energy is always transferred to the surroundings, usually as heat.



A Sankey diagram: the band widths are proportional to the energy, so the wasted branch shows what is lost

■ **Energy resources**

Most power stations spin a **turbine** 涡轮机 that drives a **generator** 发电机. Fossil fuels, nuclear fuel, geothermal energy and biofuels do it by boiling water to make steam; hydroelectric, wave, tidal and wind power turn the turbine directly with moving water or air. **Solar cells** make electricity from sunlight directly, and solar panels heat water.

Compare resources with five ideas: **renewability** 可再生性, **availability** 可用性, **reliability** 可靠性, **scale** 规模 and **environmental impact** 环境影响.

Most resources trace back to the Sun: fossil fuels are ancient stored sunlight, and wind and waves come from solar heating. The exceptions are **geothermal**, **nuclear** and **tidal**. Research continues into using **nuclear fusion** 核聚变 to generate electricity on a large scale, but no fusion reactor yet gives out more electrical energy than it uses.

2 Practice

2.1 A 2.0 kg object moves at 3.0 m/s. Find its kinetic energy. [2]

2.2 A force of 25 N moves a box 4.0 m in the direction of the force. Find the work done. [2]

2.3 Name three energy stores, and state one way energy can be transferred between stores. [2]

2.4 A lift raises a 60 kg person through 9.0 m. Take $g = 10$ N/kg. Find the gain in gravitational potential energy. [2]

2.5 State two energy resources for which radiation from the Sun is the main source of energy, and two for which it is not. [2]

2.6 A kite of mass 0.80 kg falls 5.0 m from rest. Ignoring air resistance and taking $g = 10\ \text{m/s}^2$, calculate its speed just before it lands. [3]

2.7 Suggest one reason why tidal energy is more useful than wind energy, ignoring the cost of building the station. [1]

3 Exam-style questions

3.1 A motor lifts a load. It is supplied with 500 J of electrical energy and gives the load 300 J of gravitational potential energy. What is the efficiency of the motor, and what happens to the rest of the energy? [1]

- **A** 60%; the rest is destroyed
- **B** 60%; the rest is transferred to the surroundings, mostly as heat
- **C** 167%; the rest is created by the motor
- **D** 40%; the rest is stored in the load

3.2 A student drops a heavy ball from a height of 1.8 m above the ground. It does not bounce.

(a) Describe the energy transfers from the moment the ball begins to fall to the moment it stops on the ground. [3]

(b) The mass of the ball is 0.40 kg and $g = 10$ N/kg. Calculate the gravitational potential energy it loses. [2]

(c) Calculate the speed of the ball just before it hits the ground, assuming no air resistance. [3]

(d) In practice the ball lands slightly more slowly than your answer to (c). Explain why. [1]

3.3 A wind turbine has blades that sweep a circle of air. The kinetic energy of the air arriving each second is 11 000 J and the wind speed is 6.3 m/s.

(a) Show that the mass of air arriving each second is approximately 550 kg. [2]

(b) The turbine generates 6.0 kW of electrical power. Calculate its efficiency. [2]

(c) Explain, in terms of energy transfer, why the efficiency cannot be 100%. [2]

(d) Compare wind with a coal-fired power station using two of: renewability, reliability and environmental impact. [3]

3.4 A crane lifts a 2400 N load through a height of 15 m in 12 s.

(a) Calculate the work done on the load. [2]

(b) Calculate the useful output power of the crane. [2]

(c) The crane's motor takes 5.0 kW of electrical power. Calculate its efficiency. [2]

(d) The crane then lifts the same load through the same height in 6.0 s. State and explain what happens to the work done and to the power. [2]

Solutions

2.1 $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 2.0 \times 3.0^2 = 9.0$ J.

2.2 $W = Fd = 25 \times 4.0 = 100$ J.

2.3 Any three of: kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic, internal (thermal). Any one of: by a force doing mechanical work; by an electric current; by heating; by waves.

2.4 $\Delta E_p = mg\,\Delta h = 60 \times 10 \times 9.0 = 5400$ J.

2.5 From the Sun, any two of: fossil fuels, biofuels, wind, waves, hydroelectric, solar. Not from the Sun, any two of: geothermal, nuclear, tidal.

2.6 $\frac{1}{2}mv^2 = mg\,\Delta h$, so $v^2 = 2g\,\Delta h = 2 \times 10 \times 5.0 = 100$; $v = 10$ m/s.

2.7 The tides follow a regular, predictable pattern, so tidal power is reliable, while the wind may drop.

3.1 B. Efficiency $= \dfrac{300}{500} \times 100\% = 60\%$, and the missing 200 J is transferred to the surroundings as heat (and sound). A breaks conservation of energy, C inverts the fraction, and D subtracts the wrong way round.

3.2 (a) The ball starts with energy in the gravitational potential store; as it falls this is transferred to the kinetic store, which increases; when it lands the kinetic energy is transferred to the internal (thermal) store of the ball and the ground.
(b) $\Delta E_p = mg\,\Delta h = 0.40 \times 10 \times 1.8 = 7.2$ J.
(c) $\frac{1}{2}mv^2 = 7.2$ J, so $v^2 = \dfrac{2 \times 7.2}{0.40} = 36$; $v = 6.0$ m/s.
(d) Some energy is transferred to the air by air resistance, so less becomes kinetic energy.

3.3 (a) $E_k = \frac{1}{2}mv^2$, so $m = \dfrac{2E_k}{v^2}$; $m = \dfrac{2 \times 11\,000}{6.3^2} = \dfrac{22\,000}{39.7} = 554$ kg ≈ 550 kg.
(b) Efficiency $= \dfrac{6000}{11\,000} \times 100\% = 55\%$.
(c) Not all the energy of the air is transferred to the blades: the air still moves after passing them, and energy is also transferred to the surroundings by friction and heating in the generator.
(d) Any two comparisons, each developed: wind is renewable while coal will run out; wind is unreliable because it needs the wind to blow, while a coal station runs whenever it is needed; wind releases no carbon dioxide during use while coal releases carbon dioxide and other pollution.

3.4 (a) $W = Fd = 2400 \times 15 = 36\,000$ J.
(b) $P = \dfrac{W}{t} = \dfrac{36\,000}{12} = 3000$ W.
(c) Efficiency $= \dfrac{3000}{5000} \times 100\% = 60\%$.
(d) The work done is unchanged at 36 000 J, because the force and the distance are the same; the power doubles to 6000 W, because the same energy is transferred in half the time.

3 **(a)** State **two** energy resources for which radiation from the Sun is the main source of energy.

1 ....

2 .... [2]

(b) A wind turbine is used to generate electricity.
The useful output from the turbine in 1.0 s is 6000 J. The kinetic energy of the wind hitting the turbine in 1.0 s is 11 000 J. The velocity of the wind hitting the turbine is 6.3 m / s.

(i) Show that the mass of air hitting the turbine each second is approximately 550 kg.

[2]

(ii) Calculate the efficiency of the turbines. You may assume that all the kinetic energy stored in the wind is transferred to the turbine.

efficiency = ... % [2]

(c) Tidal energy and wind energy are both renewable energy resources.
Suggest **one** reason why tidal energy is a more useful energy resource than wind energy.

Ignore the costs of construction and maintenance.

....

.... [1]

[Total: 7]

13 The temperature of the water at the bottom of a waterfall is greater than the temperature of the water at the top.

The energy in the gravitational potential store of the water at the top is transferred to the thermal store at the bottom.

The specific heat capacity of water is 4200 J / (kg °C).

What is the temperature difference for a waterfall of height 21 m?

A 0.0050 °C **B** 0.049 °C **C** 20 °C **D** 200 °C

IGCSE Physics: **s24 42**

3 A student drops a heavy ball from a vertical height of 1.8 m above the ground. The ball then falls to the ground. It does **not** bounce after hitting the ground.

(a) Describe the transfers of energy of the ball between stores from when the ball begins to fall to when it reaches the ground.

....

....

....

....

.... [3]

(b) Calculate the maximum speed of the ball. Ignore air resistance.

Show your working.

maximum speed = ... [3]

[Total: 6]

3 A ball is falling towards the ground.

Which transfer between energy stores is taking place?

A elastic energy to kinetic energy

B gravitational potential energy to elastic energy

C gravitational potential energy to kinetic energy

D kinetic energy to gravitational potential energy

IGCSE Physics: **m24 42**

1 **(a)** Fig. 1.1. is a speed–time graph for the first 5 minutes of a bus journey.

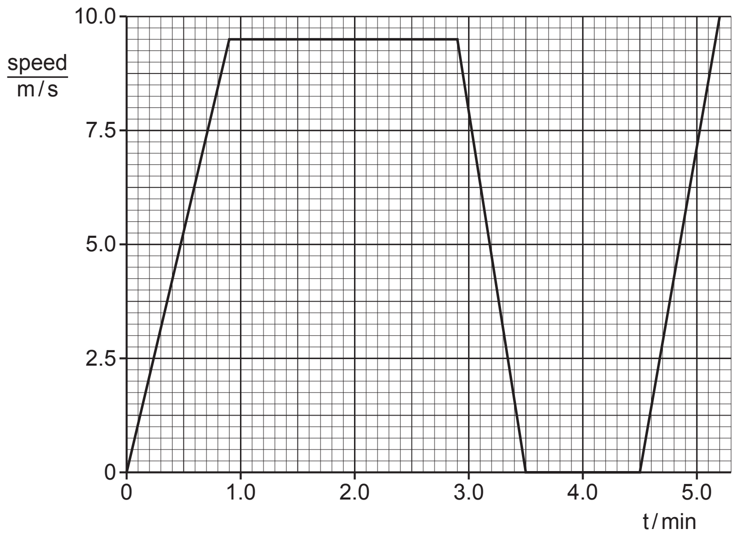


Fig. 1.1

Describe the motion between:

1. t = 0.90 min and t = 2.9 min ....

2. t = 2.9 min and t = 3.5 min ....

3. t = 3.5 min and t = 4.5 min ....

[3]

(b) Another bus travels at a speed of 8.9 m/s. The brakes apply a constant force and the bus stops in a distance of 23 m. This bus has a mass of 18 000 kg.

(i) Calculate the kinetic energy of the bus before the brakes are applied.

kinetic energy = ... [2]

(ii) Calculate the force applied to stop the bus.

force = ... [3]

[Total: 8]

IGCSE PHYSICS • EXERCISE SHEET

1.8 Pressure

Name: ____________ Class: ________ Date: __________ **Total: 23 marks**

KEY WORDS pressure 压强 • depth 深度 • density 密度 • force 力 • weight 重力

Objective

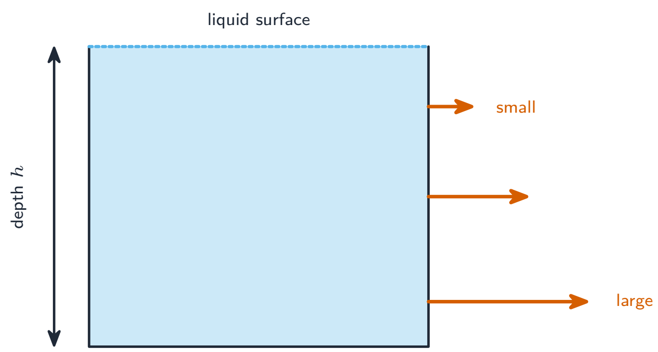
Build the skills to answer exam questions on **pressure 压强** — $p = \frac{F}{A}$, and **pressure in a liquid** $\Delta p = \rho g \Delta h$.

You must be able to:

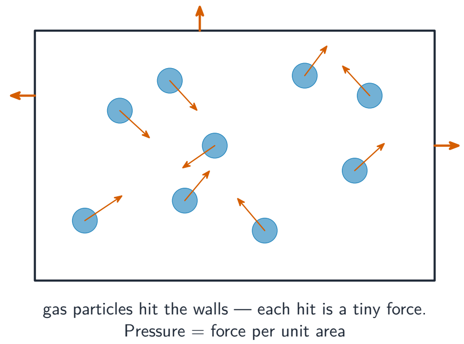
- use $p = \frac{F}{A}$ and explain area effects (sharp knife, snowshoes)
- use $\Delta p = \rho g \Delta h$ for pressure with depth
- state that liquid pressure acts in all directions and grows with depth

1 Worked examples

Pressure in a liquid



Pressure increases with depth and with density: $\Delta p = \rho g \Delta h$



Gas pressure comes from particles colliding with the walls

Depth 2.0 **m in water** ($\rho = 1000$, $g = 10$)**:** $\Delta p = 1000 \times 10 \times 2.0 = 20\,000$ Pa.

Area effect: a small area under a force gives a large pressure.

Choosing the right pressure equation

Use $p = \frac{F}{A}$ for a **solid pressing on a surface**: the force is the weight (or the push) and the area is the area in contact. Use $\Delta p = \rho g\,\Delta h$ for the pressure **inside a liquid** at a depth: it does not depend on the shape or the width of the container, only on the depth and the density.

△ Convert areas before substituting. An area given in cm^2 must become m^2 by dividing by 10 000, because 1 m^2 = 100 × 100 = 10 000 cm^2.

Worked example 1 (solid). A block of weight 16 N rests on a face measuring 4.0 cm by 5.0 cm.

1. Area $= 4.0 \times 5.0 = 20$ cm^2 $= 20 \div 10\,000 = 0.0020$ m^2.
2. $p = \frac{F}{A} = \frac{16}{0.0020} = 8000$ Pa.

Worked example 2 (liquid, then force). An oil tank has a base of area 2.5 m^2 and holds oil of density 800 kg/m^3 to a depth of 1.2 m. Take $g = 10$ N/kg.

1. Pressure at the base: $\Delta p = \rho g\,\Delta h = 800 \times 10 \times 1.2 = 9600$ Pa.
2. Force on the base: rearrange $p = \frac{F}{A}$ to $F = pA = 9600 \times 2.5 = 24\,000$ N.

Pressure in a liquid acts in **all directions** and grows with depth, which is why a dam is thicker at the bottom.

2 Practice

2.1 A force of 200 N acts on an area of 0.50 m^2. Find the pressure. [2]

2.2 State why a sharp knife cuts more easily than a blunt one. [1]

2.3 A box of weight 60 N stands on a base of 0.25 m^2. Calculate the pressure on the floor. [2]

2.4 A block rests on a face of 20 cm^2. Convert this area into m^2. [1]

3 Exam-style questions

3.1 The pressure in a liquid increases with: [1]

- **A** depth only
- **B** density only
- **C** both depth and density
- **D** neither

3.2 A diver is 15 m below the surface of sea water of density 1030 kg/m^3 ($g = 10$ N/kg).

(a) Find the extra pressure due to the water. [2]

(b) State the direction(s) in which this pressure acts on the diver. [1]

3.3 A box weighing 240 N stands on the ground on a base of area 0.30 m^2. Find the pressure it exerts on the ground. [2]

3.4 A rectangular water tank has a base of area 3.0 m^2 and is filled with water to a depth of 1.5 m. The density of water is 1000 kg/m^3 and $g = 10$ N/kg.

(a) Calculate the pressure due to the water at the base of the tank. [2]

(b) Calculate the force the water exerts on the base. [2]

(c) A second tank has the same depth of water but twice the base area. State and explain how the pressure at its base compares with your answer to (a). [2]

(d) A concrete block of weight 750 N stands on the ground on a face measuring 50 cm by 30 cm. Calculate the pressure it exerts on the ground. [3]

(e) Explain why the walls of a dam are made thicker at the bottom than at the top. [2]

Solutions

2.1 $p = \dfrac{F}{A} = \dfrac{200}{0.50} = 400$ Pa.

2.2 its edge has a very small area, so the same force gives a very large pressure.

2.3 $p = \dfrac{F}{A} = \dfrac{60}{0.25} = 240$ Pa.

2.4 $20 \div 10\,000 = 0.0020$ m^2.

3.1 **C**. Liquid pressure increases with both depth and density.

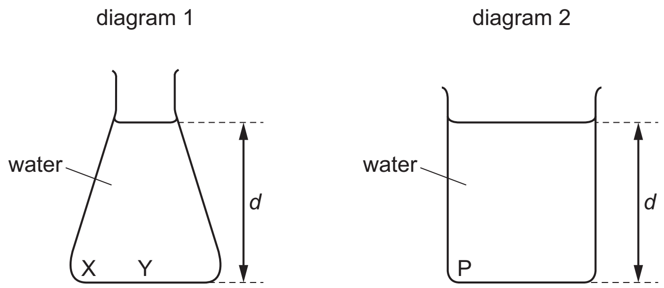
3.2 (a) $\Delta p = \rho g \Delta h = 1030 \times 10 \times 15 = 154\,500$ Pa.
(b) in all directions.

3.3 $p = \dfrac{F}{A} = \dfrac{240}{0.30} = 800$ Pa.

3.4 (a) $\Delta p = \rho g\, \Delta h = 1000 \times 10 \times 1.5 = 15\,000$ Pa.
(b) $F = pA = 15\,000 \times 3.0 = 45\,000$ N.
(c) The pressure is the same, because $\Delta p = \rho g\, \Delta h$ depends only on the depth and the density, not on the area or shape of the container.
(d) Area $= 50 \times 30 = 1500$ cm^2 $= 0.15$ m^2; $p = \dfrac{750}{0.15} = 5000$ Pa.
(e) The pressure in the water increases with depth, so the wall must be thicker at the bottom to withstand the greater outward force there.

9 Diagram 1 shows a conical flask containing water.

Diagram 2 shows a beaker with the same base area as the flask and containing water of the same depth *d*.



Which statement is correct?

A The pressure at P is equal to the pressure at X.

B The pressure at P is greater than the pressure at Y.

C The pressure at P is greater than the pressure at X.

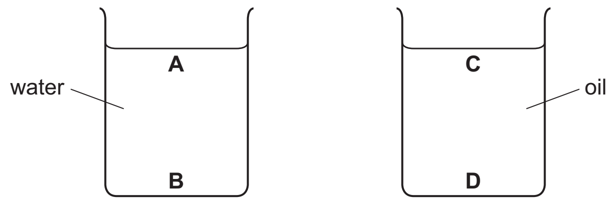
D The pressure at Y is greater than the pressure at X.

IGCSE Physics: **w25 22**

9 Two beakers are filled to the same depth, one with water and one with oil.

The density of water is 1000 kg / m^3. The density of oil is 920 kg / m^3.

In which position is the pressure the greatest?



4 Fig. 4.1 shows gas trapped in a cylinder by a piston.

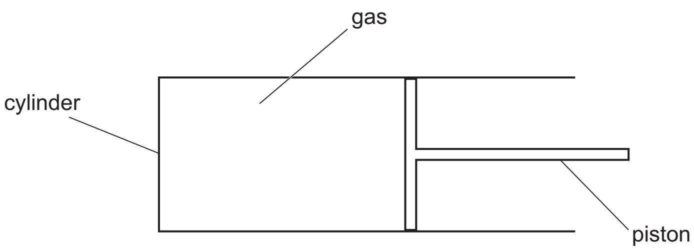


Fig. 4.1

(a) The volume of gas is $240\,cm^3$.
The piston is pushed to the left and is held in its new position.

(i) The pressure of the gas increases from $1.0 \times 10^5\,Pa$ to $1.4 \times 10^5\,Pa$.

The temperature of the gas remains constant.

Calculate the volume of the gas when the piston is in its new position.

volume = ... cm^3 [3]

(ii) The area of the piston in contact with the gas is $1.9 \times 10^{-3}\,m^2$.

Calculate the force exerted on the piston by the gas when the piston is held in its new position.

force = ... [2]

(iii) The distance moved by the piston is 0.036 m. The average force exerted by the piston as it moves is 220 N.

Calculate the mechanical work done by the piston. State the equation you use.

work done = ... [2]

(b) Explain, in terms of particles, why gases can be compressed but liquids cannot.

....

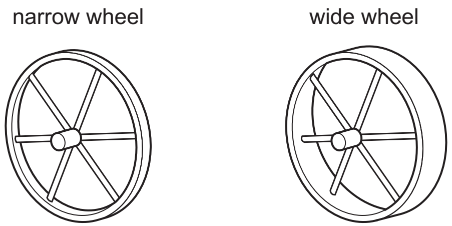
....

.... [1]

[Total: 8]

IGCSE Physics: **s25 21**

9 A farmer has two carts. The carts have the same weight, but one has four narrow wheels and the other has four wide wheels.



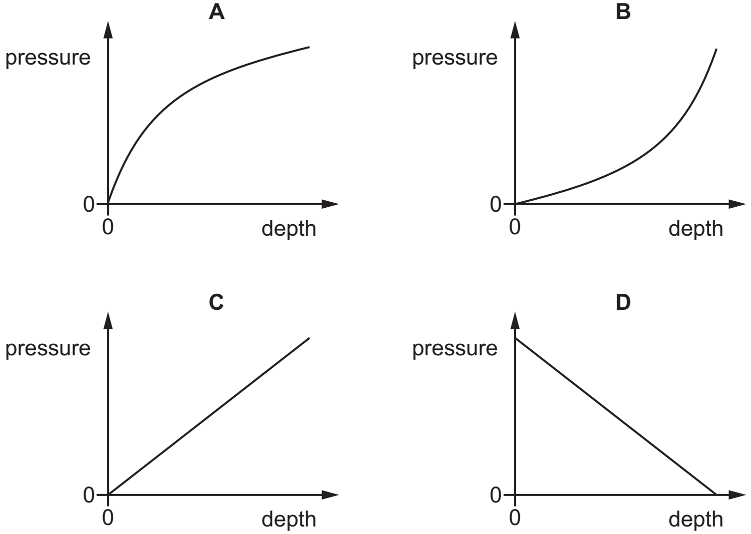
Which cart wheels sink less into soft ground and what is the reason?

	cart wheels	reason
A	narrow	greater pressure on the ground
B	narrow	less pressure on the ground
C	wide	greater pressure on the ground
D	wide	less pressure on the ground

11 The water in a swimming pool exerts a pressure at the bottom of the pool.

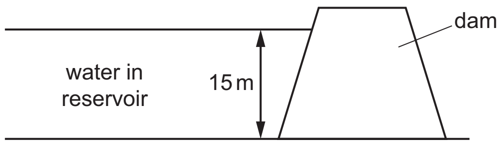
Which graph shows the relationship between the pressure exerted by the water and the depth of water in the pool?

(Assume the density of water is constant.)



IGCSE Physics: **s23 21**

13 A dam holds water in a reservoir. The height of the water in the reservoir is 15 m.



The density of water is 1000 kg / m^3.

What is the pressure due to the water at the bottom of the dam?

A 6.8 Pa **B** 1500 Pa **C** 15 000 Pa **D** 150 000 Pa