

Problem-solving Pack

These problems are designed to challenge you. Read each question carefully. Show all your reasoning — a correct answer without working receives no credit.

1**PROBLEM 1 OF 12**

The weighing problem. You have a balance scale and four weights: 1 g, 3 g, 9 g, and 27 g. You can place weights on **either** side of the scale.

- (a) Can you measure exactly 5 g? Show how.
- (b) Can you measure exactly 11 g? Show how.
- (c) What is the heaviest whole-number mass (in grams) you **cannot** measure using these four weights?
- (d) How many different whole-number masses from 1 g to 40 g can you measure?

Working space

Unit conversion chain. A snail moves at 0.048 km/h.

- (a) Convert this speed to metres per minute.
- (b) Convert to centimetres per second.
- (c) How far (in mm) does the snail travel in 5 seconds?

Working space

Perimeter and algebra. Three rectangles are placed end to end along their lengths to form one large rectangle. Each small rectangle has the same width w cm. Their lengths are 3.2 cm, 4.7 cm, and 5.1 cm.

The total perimeter of the large rectangle is 35.4 cm. Find w .

Working space

Repeating decimal mystery. Without a calculator, work out the decimal expansions of the following fractions by doing the long division. Then explain the pattern.

(a) $\frac{1}{7}$

(b) $\frac{2}{7}$

(c) $\frac{3}{7}$

(d) Without calculating, write down the decimal expansions of $\frac{4}{7}$, $\frac{5}{7}$, and $\frac{6}{7}$. Explain why they follow a cycle.

Working space

Best buy with decimals. Three brands of olive oil:

Brand	Size	Price
Alpha	500 ml	£2.40
Beta	750 ml	£3.45
Gamma	1.2 litres	£5.16

Which brand offers the best value for money? Show your method clearly.

Working space

Missing digits. Each box represents a single decimal digit (0–9):

$$3.\square 7 + \square.4\square = 9.03$$

Find the missing digits. Show your working column by column.

Working space

Directed decimals and temperature. A freezer is at -18.5°C . The room is at 23.7°C .

- (a) What is the difference in temperature between the room and the freezer?
- (b) After a power cut, the freezer warms up at 2.4°C per hour. How long until the inside reaches 0°C ? Give your answer in hours and minutes.
- (c) How long until it reaches the room temperature?

Working space

L-shape perimeter. A shape is made by removing a rectangular notch from the top-right corner of a rectangle.

Outer rectangle: 8.4 cm wide, 6.2 cm tall.

Notch removed: 3.1 cm wide, 2.5 cm tall (from the top-right corner).

Find the perimeter of the L-shaped figure.

Working space

Painted cube investigation. A cube measuring $4 \times 4 \times 4$ is painted blue on all six faces, then cut into $1 \times 1 \times 1$ small cubes.

- (a) How many small cubes are there in total?
- (b) How many small cubes have **exactly 3** painted faces?
- (c) How many small cubes have **exactly 2** painted faces?
- (d) How many small cubes have **exactly 1** painted face?
- (e) How many small cubes have **0** painted faces?
- (f) Verify that your answers to (a)–(e) add up to the total from (a).

Working space

Rounding and bounds. A plank of wood is measured as 2.4 m to the nearest 0.1 m.

- (a) Write the lower and upper bounds of the true length.
- (b) Planks are cut into shelves each exactly 0.8 m long. Using the upper bound, how many complete shelves can be cut?
- (c) Using the lower bound, how many complete shelves can be cut?
- (d) What does this tell you about the reliability of the answer to (b)?

Working space

Tiling a hall. A school hall floor measures 24.5 m by 18.6 m. It is being tiled with square tiles each 0.5 m $\times$ 0.5 m, costing £3.80 each. A 10% wastage allowance must be added to the number of tiles ordered.

Calculate the total cost of the tiles. Give your answer to the nearest pound.

Working space

Calendar arithmetic. 1 January 2024 is a Monday.

- (a) What day of the week is 1 February 2024? (January has 31 days.)
- (b) What day of the week is 1 March 2024? (2024 is a leap year, so February has 29 days.)
- (c) What day of the week is 1 July 2024?
- (d) Explain why the day of the week advances by 1 for each non-leap year, but by 2 for each leap year.

Working space