Day 98 **S Tier 10-a-day: Model Solutions**

1 Ordering numbers

Write these numbers in order of size, starting with the smallest.

0.94, $\frac{13}{16}$, 72%, $\frac{2}{7}$

Convert each to a decimal: 0.94 = 0.94, $\frac{13}{16}$ = 0.8125, 72% = 0.72, $\frac{2}{7}$ = 0.286

In order: $\frac{2}{7}$, 72%, $\frac{13}{16}$, 0.94

Answer: $\frac{2}{7}$, 72%, $\frac{13}{16}$, 0.94

2 Pressure

A metal crate in the shape of a cuboid weighs 1110 N.

Its smallest face has area 100 cm^2. Its largest face has area 1,500 cm^2.

Pressure = force ÷ area

Work out (a) the greatest pressure and (b) the least pressure the metal crate can exert on the ground, in N/m^2.

1 m^2 = 10 000 cm^2, so 100 cm^2 = 0.01 m^2 and 1,500 cm^2 = 0.15 m^2

(a) Greatest pressure is on the smallest face: 1110 ÷ 0.01 = 111,000 N/m^2

(b) Least pressure is on the largest face: 1110 ÷ 0.15 = 7,400 N/m^2

Answer: (a) 111,000 N/m^2 (b) 7,400 N/m^2

3 Percentage change

The population of a village increased by 30% in 2023.

In 2024 the population increased by a further 40%.

Work out the overall percentage increase over the two years.

Multipliers: 1.3 and 1.4

Overall multiplier = 1.3 × 1.4 = 1.82

1.82 − 1 = 0.82, so an overall increase of 82%

Answer: 82% increase

4 Simultaneous equations

Solve the simultaneous equations

3x + 6y = −39

−3x + 4y = −1

Add the equations to eliminate x: 10y = −40

y = −4

Substitute y = −4 into (1): 3x − 24 = −39

3x = −15, so x = −5

Answer: x = −5, y = −4

5 Standard form

Work out $(4.9 \times 10^{-3}) + (8.7 \times 10^{-5})$

Give your answer in standard form.

Write the first number as a multiple of 10^{-5}: $4.9 \times 10^{-3} = 490 \times 10^{-5}$

$(490 + 8.7) \times 10^{-5} = 498.7 \times 10^{-5}$

$= 4.987 \times 10^{-3}$

Answer: 4.987×10^{-3}

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6 Quadratic inequalities

Solve $x^2 < -8x - 15$

Rearrange so that one side is 0: $x^2 + 8x + 15 < 0$

Solve $x^2 + 8x + 15 = 0$: $(x + 5)(x + 3) = 0$, so $x = -5$ or $x = -3$

The graph is a U shape crossing the x-axis at -5 and -3; it is below the axis between the roots

$-5 < x < -3$

Answer: $-5 < x < -3$

7 Angles of elevation

A point A is on level ground in line with the base of a cliff. (Calculator)
The angle of elevation of the top of the cliff from A is 58°.
B is a point on the same line, 30 m further from the cliff than A.
The angle of elevation of the top of the cliff from B is 48°.
Work out the height of the cliff. Give your answer to 1 decimal place.

Let the height be h and the distance from A to the base be x. $\tan 58° = \frac{h}{x}$, so $x = h \div \tan 58°$

From B: $\tan 48° = \frac{h}{x + 30}$, so $x + 30 = h \div \tan 48°$

Subtract: $30 = h \div \tan 48° - h \div \tan 58° = h(0.90040 - 0.62487)$

$h = 30 \div 0.27553 = 108.9$ m (1 d.p.)

Answer: 108.9 m

8 Relative speed

Tariq and Callum live 120 km apart.
At 10:00 they set off towards each other on the same road.
Tariq drives at 80 km/h and Callum drives at 40 km/h.
(a) At what time do they meet?
(b) How far from Tariq's home do they meet?

Closing speed = 80 + 40 = 120 km/h

(a) Time = 120 ÷ 120 = 1 hours = 60 minutes, so they meet at 11:00

(b) Distance = 80 × 1 = 80 km

Answer: (a) 11:00 (b) 80 km

9 Recasting solids

A solid cylinder of radius 6 cm and height 10 cm is melted down.
The metal is used to make identical solid spheres of radius 3 cm.
Work out the number of spheres that can be made.

The volume of a sphere of radius r is $\frac{4}{3}\pi r^3$.

Volume of cylinder = $\pi \times 6^2 \times 10 = 360\pi$

Volume of one sphere = $\frac{4}{3} \times \pi \times 3^3 = 36\pi$

Number of spheres = 360 ÷ 36 = 10

Answer: 10

10 Density of an alloy

An alloy is made by mixing 20 cm^3 of aluminium with 60 cm^3 of zinc.
The density of aluminium is 2.7 g/cm^3. The density of zinc is 7.1 g/cm^3.
Work out the density of the alloy.

Mass of aluminium = 20 × 2.7 = 54 g

Mass of zinc = 60 × 7.1 = 426 g

Total mass = 480 g, total volume = 80 cm^3

Density = 480 ÷ 80 = 6 g/cm^3

Answer: 6 g/cm^3