London

1l = 108·9p

£1 = $1·46

×1·938

£1·938 = $2·83

New York

1 US gallon = $2·83

1 US gallon = 3·785l

3·785l = $2·83

3·785l = £1·938 ✓

3·785l = 193·8p

(÷3·785) (÷3·785)

1l = 51·2p ✓

New York ✓ because 1l of petrol in London costs 108·9p, whereas 1l in New York costs 51·2p

1. A gold bar has a mass of 12.5 kg.

The density of gold is 19.3 g/cm^3

Work out the volume of the gold bar.
Give your answer correct to 3 significant figures.

volume = mass / density

1kg = 1000g

×12·5 ×12·5

12·5kg = 12500g

Volume = 12500 / 19·3

= 647·67 cm^3

= 648 cm^3 ✓✓

648 ✓ cm^3

(Total for Question is 3 marks)

• Draw the line $y=-2$ onto the graph (1)

• Find the x values of the 2 points at which the line $y=-2$ and the curve $y=2x^2-x-6$ cross

$y=2x^2-x-6$

-1.6 and 2.6 (1)

2. A force of 70 newtons acts on an area of $20\,cm^2$

The force is increased by 10 newtons.
The area is increased by $10\,cm^2$

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Helen says,

"The pressure decreases by less than 20%"

Is Helen correct?
You must show how you get your answer.

Initial Pressure:

$P = \frac{F}{A} = \frac{70}{20} = 3.5$ (1)

These values both have the same unit (Ncm^{-1})

New Pressure:

$P = \frac{F}{A} = \frac{70+10}{20+10} = \frac{80}{30} = 2.\dot{6}$

20% less than the initial pressure = 80% of initial pressure

80%

$3.5 \times 0.8 = 2.8$ (1)

80% of initial > new pressure

$2.8 > 2.\dot{6}$ (1)

No, Helen is incorrect. The decrease is greater than 20%

(Total for Question is 3 marks)

3. Jackson is trying to find the density, in g/cm^3, of a block of wood.
The block of wood is in the shape of a cuboid.

He measures
the length as 13.2 cm, correct to the nearest mm
the width as 16.0 cm, correct to the nearest mm
the height as 21.7 cm, correct to the nearest mm

He measures the mass as 1970 g, correct to the nearest 5 g.

By considering bounds, work out the density of the wood.
Give your answer to a suitable degree of accuracy.

You must show all your working and give a reason for your final answer.

$m_U = 1972.5$ (1) $m_L = 1967.5$ $\frac{5}{2} = 2.5$g Mass = 1970 ± 2.5g

$V = l \times w \times h$ $V_U = l_U \times w_U \times h_U$ ← The product of larger numbers is a larger number

	3SF	UB	LB
l	13.2	13.25	13.15
w	16.0	16.05	15.95
h	21.7	21.75	21.65

$V_{UB} = 13.25 \times 16.05 \times 21.75$
$= 4\,625.4\ldots$

$V_{LB} = 4540.9\ldots$ (1)

$d = \frac{m}{V}$

greater numerator → $d_U = \frac{m_U}{V_L}$ ← lower denominator = largest value

$d_L = \frac{m_L}{V_U}$

$d_U = \frac{1972.5}{4540.9\ldots} = 0.4344\ldots$ $d_L = \frac{1967.5}{4\,625.4\ldots} = 0.4254\ldots$ (1)

0.43 g/cm^3 Both the upper and lower bounds for density round to 0.43 to 2 dp. (1)

(Total for Question is 5 marks)

120 × 5 = 600 minutes
1 tap takes 600 minutes
600 ÷ 3 = 200 minutes ✓

200 ✓

Each tap fills up pool at the same rate ✓

4. A plane travels at a speed of 213 miles per hour.

(a) Work out an estimate for the number of seconds the plane takes to travel 1 mile.

213 → 200

200 miles per 1 hour
200 miles per 60 minutes
200 miles per 3600 seconds ✓
÷200 ÷200
1 mile per 18 seconds ✓

18 ✓ seconds

(3)

(b) Is your answer to part (a) an underestimate or an overestimate?
Give a reason for your answer.

Overestimate, because we rounded the speed down ✓

(1)

(Total for Question is 4 marks)

5. In May 2019, the distance between Earth and Mars was 3.9×10^7 km.

In May 2019, a signal was sent from Earth to Mars.
Assuming that the signal sent from Earth to Mars travelled at a speed of 3×10^5 km per second,

(a) how long did the signal take to get to Mars?

$$\text{speed} = \frac{\text{distance}}{\text{time}} \quad \therefore \quad \text{time} = \frac{\text{distance}}{\text{speed}}$$

$$\text{time} = \frac{3.9 \times 10^7}{3 \times 10^5} \quad \therefore \quad \text{time} = 130 \text{ seconds}$$

(1) (1)

130 seconds

(2)

The speed of the signal sent from Earth to Mars in May 2019 was actually less than 3×10^5 km per second.

(b) How will this affect your answer to part (a)?

The answer to part (a) will be bigger. (1)

(1)

(Total for Question is 3 marks)

6. The density of ethanol is 1.09 g/cm^3
The density of propylene is 0.97 g/cm^3

60 litres of ethanol are mixed with 128 litres of propylene to make 188 litres of antifreeze.

Work out the density of the antifreeze.
Give your answer correct to 2 decimal places.

1 litre = 1000 cm^3

Density = $\frac{\text{mass}}{\text{volume}}$

60 l of ethanol = 60,000 cm^3

128 l of propylene = 128,000 cm^3

Find mass of 60 l of ethanol :

mass = density x volume (1)

= 1.09 × 60,000 = 65,400 g

Find mass of 128 l of propylene :

mass = 0.97 × 128,000 = 124,160 g (1)

∴ total mass of antifreeze (1)

= 65,400 + 124,160 = 189,560 g

Density of antifreeze

= $\frac{\text{mass of antifreeze}}{\text{volume of antifreeze}}$ = $\frac{189,560}{188,000}$ (1)

= 1.00829787... g/cm^3 ≈ 1.01 g/cm^3 (2 dp)

1.01 ..... g/cm^3

(Total for Question is 4 marks)

7. The accurate scale drawing shows the positions of port P and a lighthouse L.

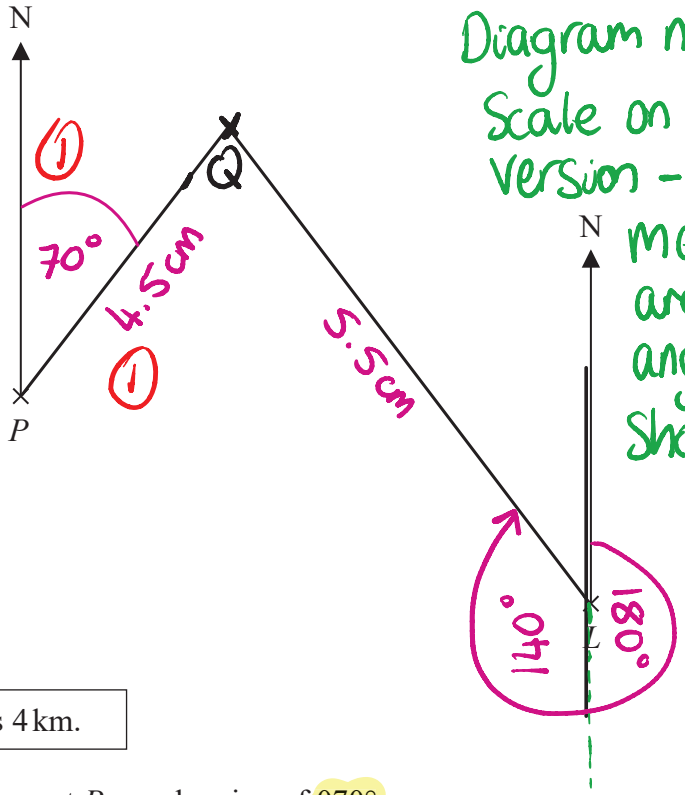


Diagram not drawn to scale on this digital version - purple measurements are lengths and angles that they should be

Scale: 1 cm represents 4 km.

Aleena sails her boat from port P on a bearing of 070°

She sails for $1\frac{1}{2}$ hours at an average speed of 12 km/h to a port Q.

Find

(i) the distance, in km, of port Q from lighthouse L,

(ii) the bearing of port Q from lighthouse L.

i) distance = speed x time

distance = 12 x 1.5 = 18 km (1)

1 cm : 4 km
x4.5 ↓ ↓ x4.5
4.5cm : 18 km

1 cm : 4 km
x5.5 ↓ ↓ x5.5
5.5 cm : 22 km

ii) bearing of port Q from lighthouse L

180° + 140° = 320°

distance QL = 22 (1) km

bearing of Q from L = 320 (1) °

8. A car travels for 18 minutes at an average speed of 72 km/h.

(a) How far will the car travel in these 18 minutes?

distance = speed x time (1)

60 minutes = 1 hour
÷60 ↓ 1 minute = $\frac{1}{60}$ hours ↓ ÷60
x18 ↓ 18 minutes = $\frac{18}{60}$ hours ↓ x18

Need to be working in same units so converting 18 minutes to hours

distance = $72 \times \frac{18}{60}$

$= 72 \times \frac{9}{30}$

$= 72 \times \frac{3}{10}$

72 x 3 = 216

$= \frac{72 \times 3}{10} = \frac{216}{10} = 21.6$ km

21.6 (1) km

(2)

David says,

"72 kilometres per hour is faster than 20 metres per second."

(b) Is David correct?
You must show how you get your answer.

Convert 72 km/h to m/s

$\frac{km}{h} \rightarrow \frac{m}{s}$ { $\times \frac{1000}{60 \times 60} = \frac{10}{6 \times 6} = \frac{10}{36} = \frac{5}{18}$

x1000 gets from m to km

x60x60 gets from s to h

To convert from km/h to m/s need to $\times \frac{5}{18}$

$72 \times \frac{5}{18} = \frac{72 \times 5}{18} = \frac{360}{18} = 20$ m/s

(2)

No because 72 km/h = 20 m/s

$1\text{ cm} = 10\text{ mm}$

$1^3\text{ cm}^3 = 10^3\text{ mm}^3$

$1\text{ cm}^3 = 1000\text{ mm}^3$ ×37

$1\text{ cm}^3 = 1000\text{ mm}^3$ ×37

$37\text{ cm}^3 = 37000\text{ mm}^3$ (1)

37000

9. Nimer was driving to a hotel.
He looked at his Sat Nav at 13 30

Time	13 30
Distance to destination	65 miles

Nimer arrived at the hotel at 14 48

Work out the average speed of the car from 13 30 to 14 48
You must show all your working.

14 - 13 (1) 48 - 30

Between 13:30 18 there is 1 hour 18 minutes

Convert everything to h (1)

1 hour 18 minutes → 1 hour + $\frac{18}{60}$ hours → $1 + \frac{18}{60}$ hours → 1.3 hours

Speed = $\frac{\text{distance}}{\text{time}}$ (1)

Speed = $\frac{65}{1.3}$ = 50 mph

50 (1) ..... mph

10. Liquid A and liquid B are mixed together in the ratio 2 : 13 by volume to make liquid C.

Liquid A has density 1.21 g/cm^3
Liquid B has density 1.02 g/cm^3

A cylindrical container is filled completely with liquid C.
The cylinder has radius 3 cm and height 25 cm.

Work out the mass of the liquid in the container.
Give your answer correct to 3 significant figures.
You must show all your working.

Volume cylinder $= \pi r^2 h$ (height, radius) (1)

Volume cylinder $= \pi(3)^2 25 = 225\pi \text{ cm}^3$

split into ratio 2 : 13

$2 + 13 = 15$

$\frac{225\pi}{15} = 15\pi$

$2 \times 15\pi : 13 \times 15\pi$

$30\pi : 195\pi$

∴ Within cylinder we have

$30\pi \text{ cm}^3$ of liquid A (1)

$195\pi \text{ cm}^3$ of liquid B

density $= \frac{\text{mass}}{\text{volume}}$ so mass = density x volume

In the cylinder → liquid A, liquid B

Mass $= 1.21 \times 30\pi$
$= 36.3\pi \text{ g}$

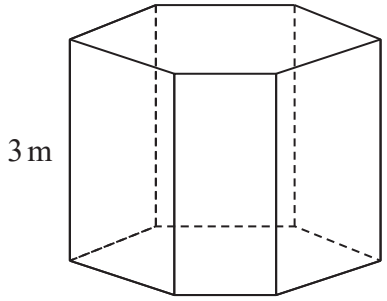
Mass $= 1.02 \times 195\pi$
$= 198.9\pi \text{ g}$

Therefore mass of container (1)

$36.3\pi + 198.9\pi = 235.2\pi \text{ g} = 738.90259... = 739 \text{ g (3sf)}$ (1)

739 ..... g

11. The diagram shows a prism placed on a horizontal floor.

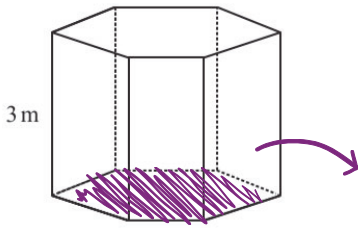


$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

The prism has height 3 m
The volume of the prism is 18 m^3

The pressure on the floor due to the prism is 75 newtons/m^2

Work out the force exerted by the prism on the floor.



$$\text{pressure} = \frac{\text{force}}{\text{cross-sectional area}}$$

cross-sectional area

Work out cross-sectional area:

$$\text{cross-sectional area} = \frac{\text{volume}}{\text{height}} = \frac{18}{3} = 6\ m^2$$

Work out force:

$$\text{pressure} = \frac{\text{force}}{\text{cross-sectional area}}$$

$$75 = \frac{\text{force}}{6}$$

$$\therefore \text{Force} = 75 \times 6 = \underline{\underline{450\ N}}$$

450 ..... newtons

(Total for Question is 3 marks)

12. Liquid **A** and liquid **B** are mixed to make liquid **C**.

Liquid **A** has a density of 70 kg/m^3
Liquid **A** has a mass of 1400 kg

Liquid **B** has a density of 280 kg/m^3
Liquid **B** has a volume of 30 m^3

Work out the density of liquid **C**.

density = mass / volume

$$5 \overline{)980} = 196$$

Vol. Liquid A $\rightarrow$ Vol = mass / density = 1400 kg / 70 kgm^{-3} = 20 m^3 ✓1

mass. Liquid B $\rightarrow$ mass = density × Vol = 280 kgm^{-3} × 30 m^{-3} = 8400 kg

mass. Liquid C = 1400 kg + 8400 kg = 9800 kg

Vol. Liquid C = 20 m^3 + 30 m^3 = 50 m^3

density. Liquid C = 9800 kg / 50 m^3 = 196 kg m^{-3} ✓2

196 ✓3 ..... kg/m^3

(Total for Question is 3 marks)

13. Liquid **A** has a density of 1.8 g/cm^3
Liquid **B** has a density of 1.2 g/cm^3

80 cm^3 of liquid **A** is mixed with 40 cm^3 of liquid **B** to make 120 cm^3 of liquid **C**.

Work out the density of liquid **C**.

density = mass / volume

Liquid A (1)

$1.8 = \frac{\text{mass A}}{80}$

mass A = 80 × 1.8 = 144 g

Liquid B

$1.2 = \frac{\text{mass B}}{40}$

mass B = 1.2 × 40 = 48 g

liquid C

$\text{density} = \frac{144 + 48}{80 + 40} = \frac{192}{120} = 1.6 \text{ g/cm}^3$ (1)

(1) 1.6 g/cm^3