Q1

First divide 180 by 1000 to find out how many cubic metres Henry uses each day.

$$180 \div 1000 = 0.18 \text{ cubic metres}$$

[1]

Now multiply by 91.22p to find the cost per day with the water meter.

$$0.18 \times 91.22 = 16.4196\text{p} = £0.164196$$

[1]

Then multiply by 365 (the number of days in a normal year) to find the price for water used per year.
(You don't need to worry about leap years here!)

$$0.164196 \times 365 = £59.93154$$

[1]

Add £28.20 to find the total cost with a water meter per year.

$$59.93154 + 28.20 = 88.13154 = £88.13 \text{ (nearest penny)}$$

[1]

And finally interpret your results in the context of the question.

It will cost Henry £88.13 per year with the water meter, which is cheaper than the £107 without the meter. Therefore he should have a water meter. [1]

Q2

Start by finding the volume of the pond.
It is in the form of a prism with its cross-section being a trapezium (the front face in the diagram).
Use the Area = $\frac{1}{2}(a+b)h$ formula to find the area of the trapezium.
Then use the Volume = Area of Cross-section × Length formula to find the volume of the prism.

$$\frac{1}{2} \times (1.3 + 0.5) \times 2 = 1.8 \text{ m}^2$$

$$1.8 \times 1 = 1.8 \text{ m}^3$$

[1]

Now find the volume of water that goes out in the first 30 minutes.
The volume of the water lost is in the form of a 2 m by 1 m by 20 cm cuboid.
Use the formula Volume of Cuboid = Length × Width × Height.
Don't forget to turn 20 cm into metres first, so the units all match!

$$20 \div 100 = 0.2 \text{ m}$$

$$2 \times 1 \times 0.2 = 0.4 \text{ m}^3$$

[1]

Now turn that into a rate of water lost per hour.

$$0.4 \text{ m}^3 \text{ in 30 minutes} = 0.8 \text{ m}^3/\text{hour}$$

[1]

Be careful now.
The question asks for how much **more** time it will take to empty the pond.
So subtract 0.4 from 1.8 to find the volume of water left in the pond after 30 minutes.

$$1.8 - 0.4 = 1.4 \text{ m}^3 \text{ remaining}$$

[1]

Every hour 0.8 m^3 are removed from the pond.
So divide 1.4 by 0.8 to find out how many hours are left until the pond is emptied completely.

$$1.4 \div 0.8 = \frac{7}{4} = 1\frac{3}{4}$$

[1]

$1\frac{3}{4}$ hours [1]

1.75 hours or 1 hour 45 minutes will also get the mark here.

Q3

First find out how long it takes her to go from Fulbeck to Ganby.
Use the formula Time = Distance ÷ Speed.
It's easiest to convert to minutes at this point. (Remember there are 60 minutes in an hour!)

$$\frac{10}{40} = \frac{1}{4} \text{ hour} = 15 \text{ minutes}$$

[1]

10.00 to 10.35 is 35 minutes, so subtract 15 from 35 to find how many minutes she has to get from Ganby to Horton.
Then divide 18 by that to see how many miles per minute she needs to go.
And multiply that by 60 to convert miles per minute to miles per hour.

$$35 - 15 = 20 \text{ minutes}$$

$$\frac{18}{20} = 0.9 \text{ miles per minute}$$

$$0.9 \times 60 = 54$$

[1]

54 mph [1]

Q4

First find the mass of liquid C.

$$140 + 128 = 268 \text{ g}$$

[1]

Now use Volume = Mass ÷ Density to find the volumes of Liquids A and B.
Then add those together to find the volume of Liquid C.

$$\text{Liquid A: } \frac{140}{0.7} = 200 \text{ cm}^3$$

$$\text{Liquid B: } \frac{128}{1.6} = 80 \text{ cm}^3$$

$$200 + 80 = 280 \text{ cm}^3$$

[1]

Use Density = Mass ÷ Volume to find the density of Liquid C.

$$\frac{268}{280} = 0.957142...$$

[1]

0.957 g/cm^3 (3 s.f.) [1]

Answers between 0.957 and 0.96 will get the mark here

Q5

Use Volume = Mass ÷ Density to find the volumes of lead and tin.

$$\text{lead: } \frac{74}{11.34} = 6.5255... \text{ cm}^3$$

$$\text{tin: } \frac{126}{7.31} = 17.2366... \text{ cm}$$

[1]

Mark is for using Volume = Mass ÷ Density to try to find either volume

Now add the volumes together to find the total volume of the alloy.
Then use Density = Mass ÷ Volume to find the density of the alloy.

$$6.5255... + 17.2366... = 23.7622... \text{ cm}^3$$

$$\frac{200}{23.7622...} = 8.4167...$$

[1]

Round to 1 d.p., as asked for in the question.

8.4 g/cm^3 (1 d.p.) [1]

Answers between 8.4 and 8.44 will get the mark here

Q6

We need to find the total distance travelled, and the total time it took.
Start by finding the time from Liverpool to Manchester.
Use the formula Time = Distance ÷ Speed.

$$56 \div 70 = 0.8 \text{ hours}$$

[1]

Now find the total distance and the total time.
For time, first convert 75 minutes into decimal hours.
(Remember there are 60 minutes in an hour!)

$$\text{total distance} = 56 + 61 = 117 \text{ km}$$

$$75 \text{ minutes} = \frac{75}{60} = 1.25 \text{ hours}$$

$$\text{total time} = 0.8 + 1.25 = 2.05 \text{ hours}$$

[1]

*This mark is for a correct process to find total distance **or** total time.*

Use Speed = Distance ÷ Time to find the average speed.

$$117 \div 2.05 = 57.07317...$$

[1]

57.1 mph (3 s.f.) [1]

Answers between 57 and 57.1 will get the mark here.

6b

In general, the total average speed can only be equal to the mean of the speeds of the two parts of the journey if the times were the same for each part.

The times from Barnsley to Leeds and from Leeds to York must have been the same. [1]

You can also get the mark here for saying that the distance from Leeds to York must be 3/4 of the distance from Barnsley to Leeds. (With the given speeds, that relation of distances would mean that the two times were the same.)

Q7

Use Mass = Density × Volume to find the masses of the three liquids.

$$\text{apple juice: } 1.05 \times 25 = 26.25 \text{ g}$$

$$\text{fruit syrup: } 1.4 \times 15 = 21 \text{ g}$$

$$\text{carbonated water: } 0.99 \times 280 = 277.2 \text{ g}$$

[1]

*The mark here is for using Mass = Density × Volume to find any **one** of the three masses.*

Now add those together to find the total mass.

$$26.25 + 21 + 277.2 = 324.45 \text{ g}$$

[1]

Use Density = Mass ÷ Volume to find the density of the drink.
You are told that the total volume is 320 cm^3, so you don't need to figure that out!

$$324.45 \div 320 = 1.013906...$$

[1]

Round to 2 d.p., as asked for in the question.

1.01 g/cm^3 (2 d.p.) [1]

Answers between 1.01 and 1.014 will get the mark here

Q8

Start by finding James' speed.
Use the formula Speed = Distance ÷ Time.

$$\text{James: } 50 \div 2.5 = 20\,\text{km/hour}$$

[1]

Now use the formula Time = Distance ÷ Speed to find how long it took James to cycle 15 km.
It's easiest also to convert to minutes at this point.
(Remember 1 hour = 60 minutes, so 1/4 hour = 15 minutes!)

$$15 \div 20 = \frac{15}{20} = \frac{3}{4}\,\text{hours} = 45\,\text{minutes}$$

[1]

Peter started 5 minutes after James.
So subtract 5 from 45 to find how many minutes it took Peter to cycle the same distance.

$$45 - 5 = 40\,\text{minutes}$$

[1]

Divide 15 by 40 to find Peter's speed in km/minute.
Then multiply that by 60 to find his speed in km/hour.

$$15 \div 40 = \frac{15}{40} = \frac{3}{8}\,\text{km/minute}$$

$$\frac{3}{8} \times 60 = \frac{45}{2}$$

Divide 15 by 40 to find Peter's speed in km/minute.
Then multiply that by 60 to find his speed in km/hour.

$$15 \div 40 = \frac{15}{40} = \frac{3}{8}\,\text{km/minute}$$

$$\frac{3}{8} \times 60 = \frac{45}{2}$$

[1]

$\frac{45}{2}$ km/h [1]

22.5 km/h (decimal form) will also get the mark here

Q9

Use Distance = Speed × Time to find how far Sean travelled in the first 3 hours.

$$50 \times 3 = 150 \text{ miles}$$

[1]

Now use Time = Distance ÷ Speed to find how long it took James to drive the last 150 miles.

$$150 \div 30 = 5 \text{ hours}$$

[1]

Now find the total time and total distance.
Then use Average Speed = Total Distance ÷ Total Time to find Sean's average speed.

$$\text{total distance} = 150 + 150 = 300 \text{ miles}$$

$$\text{total time} = 3 + 5 = 8 \text{ hours}$$

$$300 \div 8 = 37.5$$

[1]

Interpret your result in the context of the question.

Sean is not right, because his average speed was actually 37.5 mph. [1]

Q10

Use Volume = Mass ÷ Density to find the volumes of the two metals.

$$\text{metal A: } 150 \div 19.3 = 7.7720... \text{ cm}^3$$

$$\text{metal B: } 150 \div 8.9 = 16.8539... \text{ cm}^3$$

[1]

*The mark here is for using Volume = Mass ÷ Density to find any **one** of the two volumes.*

Now add those together to find the total volume.

$$7.7720... + 16.8539... = 24.6259... \text{ cm}^3$$

[1]

Use Density = Mass ÷ Volume to find the density of the alloy.
You are told that the total mass is 300 g, so you don't need to work that out!

$$300 \div 24.6259... = 12.1822...$$

[1]

12.2 g/cm^3 (3 s.f.) [1]

Answers between 12.1 and 12.2 will get the mark here.

Q11

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?

CHECK UNITS ARE CONSISTANT

SPEED = 3×10^5 km/s DISTANCE = 3.9×10^7 km

$T = \frac{D}{S}$ $T = \frac{3.9 \times 10^7}{3 \times 10^5} = 130$

130 SECONDS

11b

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)?

DIVIDING BY SMALLER NUMBER WILL GIVE BIGGER ANSWER

Q12

The density of ethanol is 1.09 g/cm³
The density of propylene is 0.97 g/cm³

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.

FIND MASS OF EACH CHEMICAL $M = D \times V$

ETHANOL = $1.09 \times 60 = 65.4$

PROPLYLENE = $0.97 \times 128 = 124.16$

TOTAL MASS = $65.4 + 124.16 = 189.56$

FIND DENSITY OF ANTIFREEZE $D = \frac{M}{V}$

$189.56 \div 188 = 1.008297872$

1.01 (2dp)

Q13

All measurements need to use the same units.
Convert all lengths to metres using 1 m = 100 cm.

$$1.8 \text{ cm} = 0.018 \text{ m}$$

Convert all masses to kilograms using 1 tonne = 1000 kg.

$$15 \text{ tonnes} = 15\,000 \text{ kg}$$

[1]

Calculate the volume of a wood panel by multiplying the three lengths.

$$\text{Volume} = 2.4 \times 1.2 \times 0.018 = 0.05184 \text{ m}^3$$

[1]

$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$. Rearrange the formula to find the mass: $\text{Mass} = \text{Density} \times \text{Volume}$.

$$\text{Mass} = 750 \times 0.0518 = 38.88 \text{ kg}$$

[1]

Divide 15 000 kg by the mass of one wood panel to determine how many wood panels the truck can hold.

$$\frac{15\,000}{38.88} = 385.802...$$

Dividing 15 tonnes by mass of one wood panel [1]
Correct answer [1]

Round down to the next largest integer.

385 wood panels [1]