DENSITY

DATE OF SOLUTIONS: 15/05/2018
MAXIMUM MARK: 89

SOLUTIONS

GCSE (+ IGCSE) EXAM QUESTION PRACTICE

1. [New Question, by Maths4Everyone.com] Density **[2 Marks]**

The mass of 4 m^3 of copper is 35 800 kg.
Calculate the density of the copper.

DENSITY = MASS / VOLUME

DENSITY = $\frac{35800}{4}$ (M1)

8950 (A1) ..... kg/m^3

(2)

2. [New Question, by Maths4Everyone.com] Density **[2 Marks]**

The density of steel is 8050 kg/m^3.
Work out the mass of 5 m^3 of steel.

DENSITY = MASS / VOLUME

MASS = VOLUME x DENSITY

= 5 x 8050 (M1)

40 250 (A1) ..... kg

3. [New Question, by Maths4Everyone.com] Density **[2 Marks]**

A gold chain has a volume of 4 cm^3.
The density of gold is 19.3 grams per cm^3.
Calculate the mass of the gold chain.

DENSITY = MASS / VOLUME

MASS = VOLUME x DENSITY

= 4 x 19.3 (M1)

77.2 (A1) ..... g

4. [New Question, by Maths4Everyone.com] Density **[2 Marks]**

The mass of a standard gold bar is 1000 grams.
The density of gold is 19.3 grams per cm^3.
Work out the volume of a standard gold bar.

DENSITY = MASS / VOLUME

VOLUME = MASS / DENSITY

$= \frac{1000}{19.3}$ (M1)

$= 51.813...$

(A1)

51.8 ..... cm^3

5. [New Question, by Maths4Everyone.com] Density **[3 Marks]**

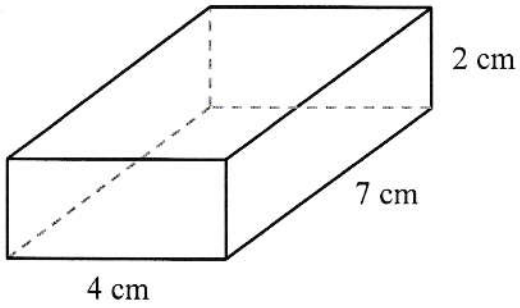


Diagram **NOT** accurately drawn

DENSITY = MASS / VOLUME

The diagram shows a solid wooden block in the shape of a cuboid.
The block is made from wood with density 0.58 g/cm^3
Work out the mass of the block.

MASS = VOLUME x DENSITY.

= (4 x 2 x 7) x 0.58 (m1) [FOR VOLUME x DENSITY]

(m1) [FOR EITHER] = 56 x 0.58

= 32.48 (m1)

32.5 ..... g

6. [New Question, by Maths4Everyone.com] Density **[2 Marks]**

The density of concrete is 2.4 g/cm^3.
Work out the mass of a concrete slab which has a volume of 12 m^3.
Give your answer in kilograms.

DENSITY = MASS / VOLUME

MASS = VOLUME × DENSITY

= 12 × 2400 (m1)

I HAVE CHANGED g/cm^3 INTO kg/m^3

28 800 (A1) ..... kg

(2)

7. [New Question, by Maths4Everyone.com] Density **[3 Marks]**

The diagram shows a solid triangular prism.

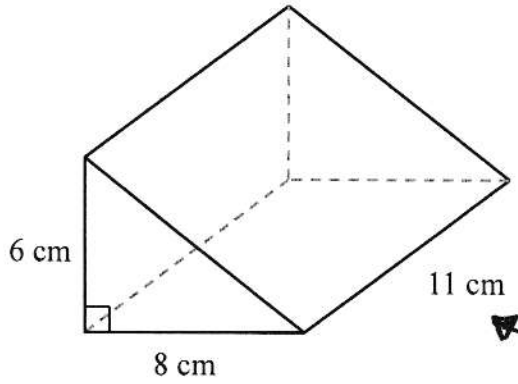


Diagram **NOT** accurately drawn

1ST

$V = \left[\frac{1}{2} \times 6 \times 8\right] \times 11 = 264\ cm^3$ M1

The prism is made from steel.

The density of the steel is 7.9 grams per cm^3.

Calculate the mass of the prism.

Give your answer in kilograms, correct to 3 significant figures.

2ND

$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$

$\Rightarrow \text{MASS} = \text{VOLUME} \times \text{DENSITY}$

$= 264 \times 7.9$ M1

$= 2085.6$ GRAMS

$\rightarrow$ 2.09 kg A1

8. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

The diagram shows a solid rubber ball in the shape of a sphere.

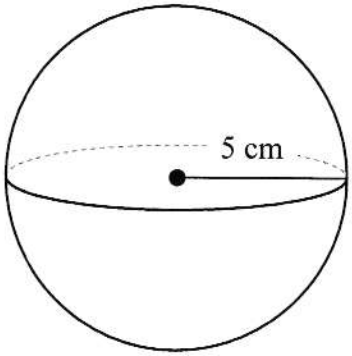


Diagram **NOT** accurately drawn

1ST

$V = \frac{4}{3}\pi \times 5^3 = 523.598...$ (M1)

The radius of the ball is 5 cm.
The mass of the ball is 550 grams.
An object will only float in water if its density is less than 1.0 g/cm^3.
Will this rubber ball float in water?
You must show clear calculations to justify your answer.

2ND

$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$

$= \frac{550}{523.598...}$ (M1)

$= 1.0504 \text{ g/cm}^3$ (A1)

THIS IS GREATER THAN 1.0 g/cm^3

SO IT WILL NOT FLOAT! (A1)

[MUST HAVE FULL CALCULATIONS!]

9. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

The diagram shows a steel girder in the shape of a prism.

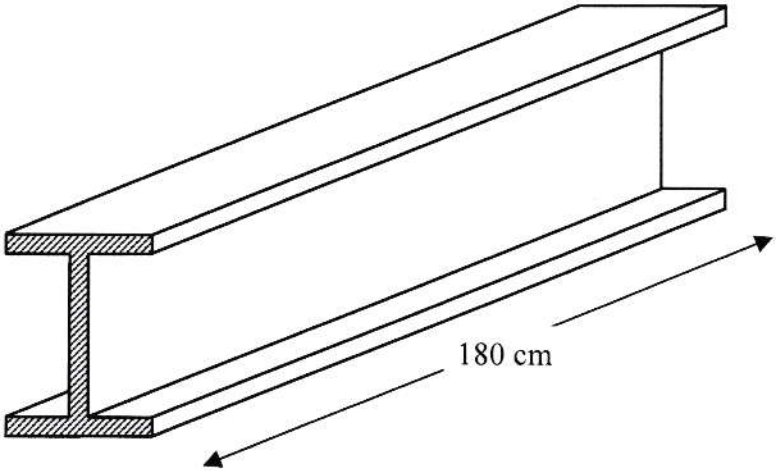


Diagram **NOT** accurately drawn

The length of the girder is 180 cm.
The cross sectional area of the girder is 18 cm^2.
The steel has a density 7.8 g/cm^3.
Justin has a pickup truck.
The maximum load that Justin's truck can carry is 500 kg.
Find the maximum number of these steel girders that Justin can carry in his truck, without exceeding the maximum load.

1ST $V = 180 \times 18$

$= 3240\ cm^3$ M1

2ND

$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$

$\Rightarrow \text{MASS} = \text{VOLUME} \times \text{DENSITY}$

OF ONE GIRDER

$= 3240 \times 7.8$ M1

$= 25272\ g$

$= 25.272\ kg$ A1

3RD

$\text{MAXIMUM GIRDERS} = \frac{500}{25.272}$ M1

$= 19.78... \Rightarrow 19$ A1

10. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

200g of aluminium and 200g of copper are mixed to make 400g of an alloy.
Aluminium has a density of 2.7 g/cm^3.
Copper has a density of 8.9 g/cm^3.
Work out the density of the alloy.

1ST TOTAL VOLUME = $V_{AL} + V_{Cu}$

$= \frac{m_{AL}}{D_{AL}} + \frac{m_{Cu}}{D_{Cu}}$

$= \frac{200}{2.7} + \frac{200}{8.9} = 96.5459...$ (A1)

2ND NEW DENSITY = $\frac{\text{MASS}}{\text{VOLUME}}$ (m1)

$= \frac{400}{96.54...}$ (m1)

4.14 (A1) ..... g/cm^3

11. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

Liquid A has a density of 0.7 g/cm^3.
Liquid B has a density of 1.6 g/cm^3.
140 g of liquid A and 128 g of liquid B are mixed to make liquid C.
Work out the density of liquid C.

1ST $V_C = V_A + V_B$ $\left[V = \frac{M}{D}\right]$

$= \frac{140}{0.7} + \frac{128}{1.6} = 280 \text{ cm}^3$ A1

M1

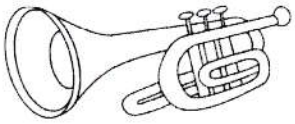
2ND $D_C = \frac{M_C}{V_C}$

$= \frac{140+128}{280}$ M1

0.957 A1 ..... g/cm^3

12. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

Brass is an alloy which is made by mixing copper and zinc.



Copper has a density of 8.9 g/cm^3.

Zinc has a density of 7.1 g/cm^3.

1 kilogram of brass is made by mixing 630 g of copper with 370 g of zinc.

Work out the density of the brass.

Give your answer correct to 1 decimal place.

1ST

$$V_{BRASS} = V_{Cu} + V_{ZN} = \frac{M_{Cu}}{D_{Cu}} + \frac{M_{ZN}}{D_{ZN}}$$

$$= \frac{630}{8.9} + \frac{370}{7.1} = 122.899\ldots$$

(M1) (A1)

2ND

$$D_{BRASS} = \frac{M}{V}$$

$$= \frac{630+370}{122.899\ldots}$$ (M1)

8.14 (A1) g/cm^3

13. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

One sheet of A4 paper has dimensions 21.0 cm by 29.7 cm.
The paper has a mass of 80 g per m^2.
Work out the total mass of 500 sheets of A4 paper.
Give your answer in kilograms, correct to 3 significant figures.

DENSITY OF PAPER IS ACTUALLY MEASURED IN g/m^2 RATHER THAN g/m^3!

CHANGE TO m

FOR ONE SHEET,

MASS = $(0.21 \times 0.297) \times 80$ (M1)

$= 4.9896$ g (A1)

∴ FOR 500 SHEETS,

MASS = 5000×4.9896 (M1)

$= 2494.8$g

$= 2.49$ kg (A1)

(4)

14. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

Mia makes an orange drink by mixing orange concentrate with water.
She mixes 15 ml of orange concentrate with 200 ml of water.
The density of the orange concentrate is 1.24 g/cm^3.
The density of water is 1.00 g/cm^3.
Work out the density of Mia's drink.
Give your answer correct to 2 decimal places.

1ST

TOTAL VOLUME = 215 cm^3

ml ≡ cm^3

TOTAL MASS = MASS$_C$ + MASS$_W$

= 1·24 × 15 + 1 × 200 (M1)

= 218·6 g (A1)

FINAL DENSITY = $\frac{\text{MASS}}{\text{VOLUME}}$

= $\frac{218·6}{215}$ (M1)

1·02 (A1) ..... g/cm^3

15. [New Question, by Maths4Everyone.com] Density **[4 Marks]**

The density of apple juice is 1.05 grams per cm^3.

The density of fruit syrup is 1.4 grams per cm^3.

The density of carbonated water is 0.99 grams per cm^3.

25 cm^3 of apple juice are mixed with 15 cm^3 of fruit syrup and 280 cm^3 of carbonated water to make a drink with a volume of 320 cm^3.

Work out the density of the drink.

Give your answer correct to 2 decimal places.

TOTAL MASS = $1.05 \times 25 + 1.4 \times 15 + 0.99 \times 280$ (M1)

= 324.45 g (A1)

DENSITY = $\frac{324.45}{320}$ (M1)

= $1.0139...$

(A1)

..... 1.01 ..... g/cm^3

16. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

The densities of two different liquids *A* and *B* are in the ratio 11:9
The mass of 1 ml of liquid *B* is 1.2 g.
10 ml of liquid *A* is mixed with 20 ml of liquid *B* to make 30 ml of liquid *C*.
Work out the density of liquid *C*.

TOTAL VOLUME!

$D_B = \frac{1.2}{1} = 1.2 \Rightarrow D_A = \frac{1.2}{9} \times 11 = 1.4\dot{6}$ (B1)

TOTAL MASS $= 10 \times 1.4\dot{6} + 20 \times 1.2$ (M1)

$= 38.\dot{6}$ (A1)

$D_C = \frac{\text{MASS}}{\text{VOLUME}} = \frac{38.\dot{6}}{30}$ (M1) $= 1.2\dot{8}$ g/cm^3 (A1)

17. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

. A solid snooker ball is made in the shape of a sphere.
The ball has a mass of 156 g measured to the nearest gram.
Its diameter is 57 mm measured to the nearest millimetre.
Find the lower bound for the density of the ball.
Give your answer correct to 3 significant figures.

DENSITY [LOWER] = MASS [LOWER] / VOLUME [HIGH]

1ST

$V = \frac{4}{3}\pi r^3$

[UPPER BOUND FOR DIAMETER = 57.5 mm
⇒ UPPER BOUND FOR RADIUS = 28.75 mm
= 2.875 cm]

$= \frac{4}{3} \times \pi \times 2.875^3$ M1

B1

$= 99.541 \text{ cm}^3$ A1

DENSITY $= \frac{155.5}{99.541}$ B1

1.56 A1 ..... g/cm^3

18. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A solid metal bar is made in the shape of a cuboid.

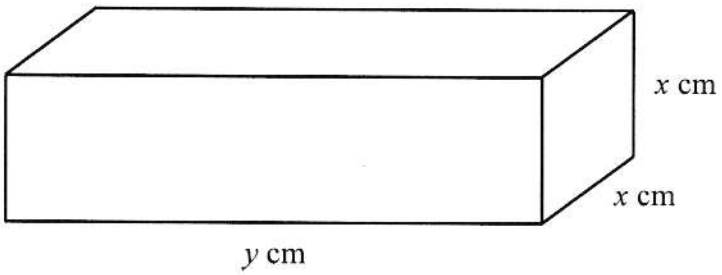


Diagram **NOT** accurately drawn

The cross-section of the bar is a square of side x cm.
The length of the bar is y cm.
The mass of the bar is M kg.
$x = 5.0$ correct to 1 decimal place.
$y = 25$ correct to the nearest whole number.
$M = 4.24$ correct to 2 decimal places.

CHANGE TO GRAMS [4240 g]

Calculate the density of the metal, in g/cm^3, that was used to make the bar.
Give your answer to an appropriate degree of accuracy.

$V_{MAX} = 5.05^2 \times 25.5$
$= 650.313...$ (m1)

$V_{MIN} = 4.95^2 \times 24.5$
$= 600.311...$ (m1)

$DENSITY_{MAX} = \frac{4245}{600.311}$

$= 7.07133...$ (m1)

$DENSITY_{MIN} = \frac{4235}{650.313...}$

$= 6.51224...$ (m1)

ROUNDING IS ONLY THE SAME WHEN DONE TO NEAREST WHOLE NUMBER, SO THIS IS THE APPROPRIATE DEGREE OF ACCURACY!

7 (A1) ..... g/cm^3

19. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A solid cone is made of wood.

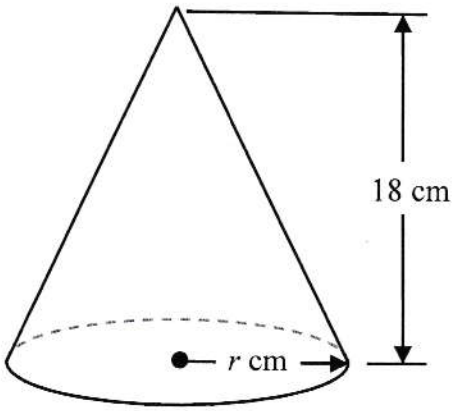


Diagram **NOT** accurately drawn

The height of the cone is 18 cm.
The mass of the cone is 0.98 kg
The wood has a density of 0.43 g/cm^3
Find the radius of the cone.
Give your answer correct to 2 significant figures.

CHANGED TO GRAMS!

1ST

VOLUME = $\frac{980}{0.43}$

$= 2279.06...$ (m1)

2ND

$\frac{1}{3}\pi r^2 \times 18 = 2279.06$ (m1) [EQUATION]

$\Rightarrow r^2 = \frac{2279.06 \times 3}{18\pi}$ (m1) ['r' ISOLATED]

$= 120.908...$ (m1)

$\Rightarrow r = 10.995...$

$= \underline{11}$ cm (A1)

20. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A solid sphere is made of glass.

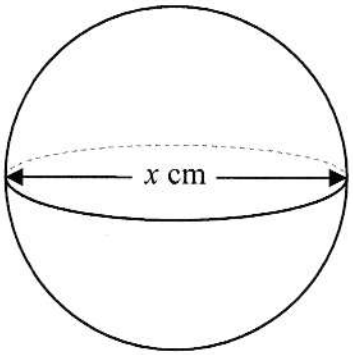


Diagram **NOT** accurately drawn

The mass of the sphere is 58.4 g
The density of the glass is 2.6 g/cm^3
Find the diameter of the sphere.
Give your answer correct to 3 significant figures.

1ST

VOLUME $= \frac{58.4}{2.6}$

$= 22.461\ldots$ (M1)

2ND

$\frac{4}{3}\pi r^3 = 22.461$ (M1) [EQUATION]

$\Rightarrow r^3 = \frac{22.461 \times 3}{4\pi}$ (M1) ['r' ISOLATED]

$= 5.36229\ldots$

$\Rightarrow r = 1.75031\ldots$ (M1)

$\Rightarrow x = 3.5006\ldots$

$= 3.50$ cm (A1)

21. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A solid cube has a mass of 9.8 g.
It has a density of 0.92 g/cm^3.
Find the surface area of the cube.
Give your answer correct to 2 significant figures.

VOLUME $= \frac{9.8}{0.92}$

$= 10.652\ldots$ cm^3 (m1)

EDGE LENGTH $= \sqrt[3]{10.652\ldots}$ (m1)

$= 2.2002\ldots$ (m1)

SURFACE AREA $= 6 \times 2.2002^2\ldots$ (m1)

$= 29.047$

$= \underline{29\ \text{cm}^2}$ (A1)

22. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A squash ball is made of rubber and is the shape of a sphere.

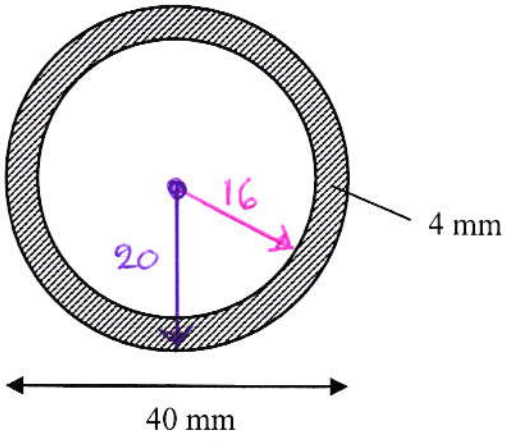


Diagram **NOT** accurately drawn

The mass of the ball is 24 g.

The external diameter of the ball is 40 mm.

The thickness of the rubber is 4 mm.

Assuming that the mass of air inside the ball is negligible, calculate the density of the rubber.

$$\text{VOLUME} = \frac{4}{3}\pi \times 2^3 - \frac{4}{3}\pi \times 1.6^3$$ (M1) [EQUATION]

(B1) [FOR CORRECT INNER RADIUS]

$$= 16.353\ldots \text{ cm}^3$$

(M1) [FOR VOLUME IN cm^3]

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

$$= \frac{24}{16.353\ldots}$$ (M1)

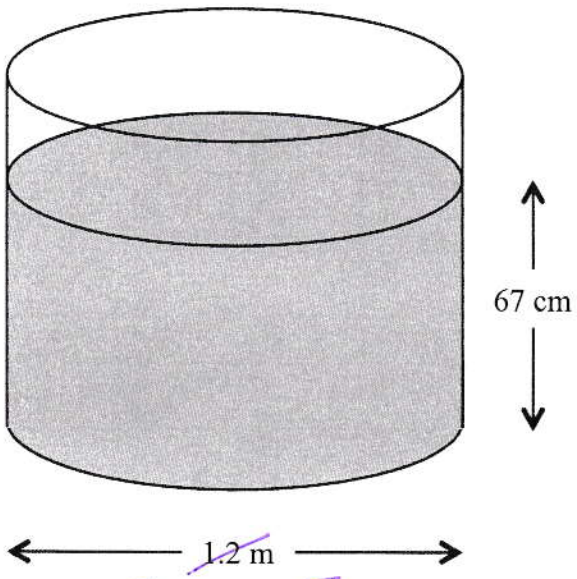
$$= 1.4676\ldots$$ (A1) [ROUNDING IS NOT REQUIRED IN THIS QUESTION]

$$= 1.47 \text{ g/cm}^3$$

23. [New Question, by Maths4Everyone.com] Density **[5 Marks]**

A 200 gallon steam kettle is used to make soup.
The kettle is in the shape of a cylinder.

Diagram **NOT** accurately drawn



The kettle has a diameter of 1.2 m.
The depth of the soup in the kettle is 67 cm.
The density of the soup is 1.15 g/cm^3.
The soup is to be dispensed into tins that hold 400 g of soup each.
How many tins can be filled with the soup from the kettle?
You must show all your working.

VOLUME OF SOUP $= \pi \times 60^2 \times 67$ (M1)

$= \underline{757,752}\ cm^3$ (M1)

MASS OF SOUP $= 1.15 \times 757,752$

$= \underline{871,414.97}\ g$ (M1)

NO. OF TINS $= \dfrac{871,414.97}{400}$ (M1)

$= 2178.53...$

$= \underline{2178}$ (A1)

Disclaimer

While reasonable endeavours have been used to verify the accuracy of these solutions, these solutions are provided on an "as is" basis and no warranties are made of any kind, whether express or implied, in relation to these solutions.

There is no warranty that these solutions will meet Your requirements or provide the results which You want, or that they are complete, or that they are error-free. If You find anything confusing within these solutions then it is Your responsibility to seek clarification from Your teacher, tutor or mentor.

Please report any errors or omissions that You find*. These solutions will be updated to correct errors that are discovered. It is recommended that You always check that You have the most up-to-date version of these solutions.

The methods used in these solutions, where relevant, are methods which have been successfully used with students. The method shown for a particular question is not always the only method and there is no claim that the method that is used is necessarily the most efficient or 'best' method. From time to time, a solution to a question might be updated to show a different method if it is judged that it is a good idea to do so.

Sometimes a method used in these solutions might be unfamiliar to You. If You are able to use a different method to obtain the correct answer then You should consider to keep using your existing method and not change to the method that is used here. However, the choice of method is always up to You and it is often useful if You know more than one method to solve a particular type of problem.

Within these solutions there is an indication of where marks **might** be awarded for each question. B marks, M marks and A marks have been used in a similar, but **not identical**, way that an exam board uses these marks within their mark schemes. This slight difference in the use of these marking symbols has been done for simplicity and convenience. Sometimes B marks, M marks and A marks have been interchanged, when compared to an examiners' mark scheme and sometimes the marks have been awarded for different aspects of a solution when compared to an examiners' mark scheme.

B1 – This is an unconditional accuracy mark (the specific number, word or phrase must be seen. This type of mark cannot be given as a result of 'follow through').

M1 – This is a method mark. Method marks have been shown in places where they might be awarded for the method that is shown. If You use a different method to get a correct answer, then the same number of method marks would be awarded but it is not practical to show all possible methods, and the way in which marks might be awarded for their use, within these particular solutions. When appropriate, You should seek clarity and download the relevant examiner mark scheme from the exam board's web site.

A1 – These are accuracy marks. Accuracy marks are typically awarded after method marks. If the correct answer is obtained, then You should normally (but not always) expect to be awarded all of the method marks (provided that You have shown a method) and all of the accuracy marks.

Note that some questions contain the words 'show that', 'show your working out', or similar. These questions require working out to be shown. Failure to show sufficient working out is likely to result in no marks being awarded, even if the final answer is correct.

* The best way to inform of errors or omissions is a direct Twitter message to @Maths4Everyone