Biomedical Admissions Test (BMAT)

Section 2: Mathematics
Questions by Topic

M1: Units

M1: Units - Questions by Topic
Mark scheme and explanations at the end

1   Evaluate:

$$0.75mm - 8.8\mu m$$

Give your answer in standard form and in metres.

A 6.62×10^{-4}
B 7.412×10^{-3}
C 7.412×10^{-4}
D 0.0007412
E 0.000662

2   A developer is planning to build residential properties on a plot of land. His map is drawn to a scale of 1:160000. The area of the plot of land on the map is 10 cm^2.

Calculate the real area of the plot of land, in square kilometres.

A   256000
B   2560
C   2.56
D   256
E   25.6

3   The time T in seconds it takes to boil water in a water tank is inversely proportional to the square root of the power P in watts (w) supplied to the water tank. When the power is 4 kilowatts, it takes 6 seconds to boil the water. Find the time taken to boil the water when the power is 2500 watts.

A $\frac{6}{25}$
B $30\sqrt{5}$
C $\frac{12}{5}\sqrt{10}$
D $\frac{23}{7}$
E $\frac{13}{7}$

4   Alexander mixes 800 g of cement with 2.8 kg of sand.

Express the ratio of cement to sand in its simplest form.

A   20:7
B   2000:7
C   1:3.5
D   7:2
E   2:7

5   A man travels a distance of 196 km by train and returns the same distance in a car which travels at an average speed of 21 km/h faster than the train. The total journey takes 11 hours. Find the average speeds of the train and the car respectively.

A   Speed of train is 13.36 km/h, speed of car is 34.36 km/h
B   Speed of train is 21 km/h, speed of car is 28 km/h
C   Speed of train is 26.36 km/h, speed of car is 68.36 km/h
D   Speed of train is 42 km/h, speed of car is 56 km/h
E   Speed of train is 28 km/h, speed of car is 49 km/h

6   Priya travels from the office to the train station at an average speed of 72 km/h. For Nikki to do a roundtrip between the office and the train station, it takes her three times the time it takes for Priya to do a single trip to the train station. The distance between the office and the train station is 18 km.
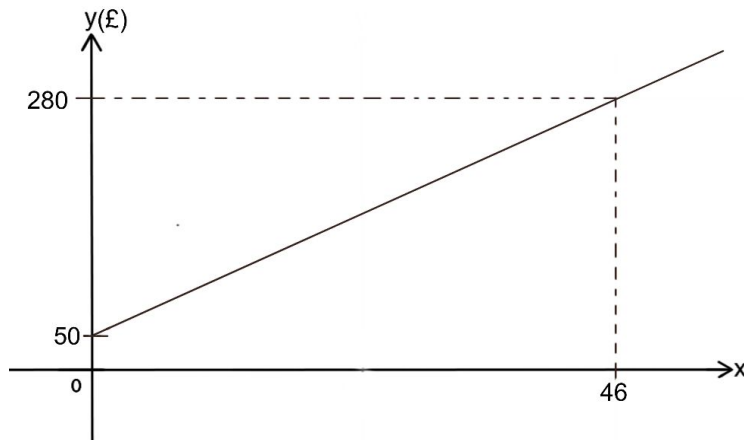
Find Nikki's average speed in m/s.

A $\frac{20}{3}$
B   48
C $\frac{40}{3}$
D   800
E   24

7 Angelica, the president of a school's student council, wishes to order some T-shirts with the council's logo and design on them for the members. She goes to Mr Murni's shop to find out the cost of making the T-shirts. Mr Murni shows her a graph displaying the cost (£C) of making N number of T-shirts.

The photography club has 88 members including Angelica and she wishes to order a T-Shirt for each member.

Calculate the cost of making 88 T-shirts.

A   £536
B   £490
C   £416
D   £572
E   £438

8 Silver has a density of 10.5 g/cm³. A silver ball has a radius of 5 mm. The volume of a sphere is given by the formula $\frac{4}{3}\pi r^3$ where r is the radius of the sphere.

What is the mass of the silver ball?

A $\frac{7}{4}\pi \ grams$
B $1750\pi \ grams$
C $\frac{7}{2}\pi \ grams$
D $\frac{7}{32}\pi \ grams$
E $\frac{875}{4}\pi \ grams$

9   A crate of weight 14 N is resting on a table. The pressure on the table is 35 N/m^2.

Calculate the area of the crate that is in contact with the table, in cm^2.

A   2.5
B   2500
C   0.4
D   400
E   4000

10   Paul is a sales assistant and is paid £7.00 per hour for a 37 hour week.

He is paid time and a half for overtime on weekdays, and double time for overtime on weekends.

Calculate his total weekly pay if he works 4 hours overtime on thursday, and 5 hours overtime on Saturday.

A   £353.50
B   £385.00
C   £371.00
D   £322.00
E   £367.50

11   Zainab runs a 500 metre race in 125 seconds. Mai runs the same distance with an average speed which is 1 m/s faster than Zainab's speed.

How long does it take Mai to run the 500 metre race?

A $125 \ seconds$
B $100 \ seconds$
C $124 \ seconds$
D $101 \ seconds$
E $\frac{500}{3} \ seconds$

12   A soap solution is made by adding soap powder to water.

How many kilograms of soap powder should be added to 5 litres of water if the concentration should be 15 grams per centilitre?

A   7500 kg
B   75 kg
C   7.5 kg
D   0.75 kg
E   750 kg

13   The distance from Bristol to Sheffield is 195 miles.

Marc drives from Bristol to Sheffield. His average speed is 54 miles per hour for the first half of the journey and 76 miles per hour for the second half of the journey.

What time should Marc leave in order to arrive in Sheffield at 10:45?

A   08:45
B   07:15
C   13:45
D   08:15
E   07:45

14   Tobias mixes together 300 g of material A and 75 g of material B.

Material A has a density of 20 g/cm³

Material Y has a density of 15 g/cm³

What is the density of the compound material?

A   19 g/cm^3
B   18 g/cm^3
C   18.5 g/cm^3
D   19.5 g/cm^3
E   17 g/cm^3

15 Jamie works for a company. His normal rate of pay is £15 per hour. When Jamie works more than 7 hours a day, he is paid overtime for each hour he works. Jamie's rate of overtime pay per hour is 1.4 times his normal rate of pay per hour.

On Tuesday Jamie worked for 9.5 hours.

How much money did Jamie make on Tuesday?

A   £147.00
B   £142.50
C   £189.00
D   £157.50
E   £199.50

16 Cameron and Katie work in a cupcake business. Cameron makes 25 cupcakes per hour and is paid 28p for each cupcake he makes. Katie works 36 hours and is paid £261.

Calculate the difference in Cameron and Katie's hourly rate of pay.

A   0.75 p
B   25 p
C   0.25 p
D   75 p
E   50 p

17 Tom is about to drive to Sheffield from London.
The distance from London to Sheffield is 170 miles.
Tom's car can drive 60 miles using 1 gallon of petrol.

Petrol costs £1.20 per litre
4.5 litres = 1 gallon

How much will it cost for Tom to make a round-trip to sheffield?

A   £16.80
B   £30.60
C   £25.50
D   £15.30
E   £36.20

18 Isabella collected money for four different charities. The total amount collected was divided amongst the four charities, A, B,C and D, in the ratio

$$1 : \tfrac{1}{3} : \tfrac{3}{5} : \tfrac{1}{4} .$$

Charity C received £36.

How much money did Isabella collect in total?

A   £144.00
B   £131.00
C   £147.00
D   £114.40
E   £134.00

19 One side of a rectangle is $(16 - \sqrt{7})\ cm$. The rectangle has an area of $996\ cm^2$.

What is the perimeter, in cm, of the rectangle?

A $160 + 6\sqrt{7}$
B $64 + 4\sqrt{7}$
C $80 + 3\sqrt{7}$
D $305 - 32\sqrt{7}$
E $96 + 2\sqrt{7}$

20 The length of a field measures 35 m. The diagonal of the field measures 65 m. 25 % of the field space will be used to grow corn.

What area of the field will be used to grow corn?

A $\frac{175}{2}\sqrt{30}$
B $350\sqrt{30}$
C $\frac{2275}{4}$
D $\frac{5\sqrt{218}}{4}$
E $70\sqrt{30}$

1   **C is the answer**

You need to know the following **conversions** to answer this question successfully:

To convert mm to m you need to divide by 1000
To convert μm to m you need to divide by 1000,000 (divide by 1000 twice)

Therefore,

$$0.75 \ mm \ - 8.8 \mu m$$
$$= 0.75 \times 10^{-3} - 8.8 \times 10^{-6} m$$
$$= 0.75 \times 10^{3} \times 10^{6} - 8.8 \times 10^{-6} m$$
$$= 750 \times 10^{-6} - 8.8 \times 10^{-6} m$$
$$= 741.2 \times 10^{-6} m$$
$$= 7.412 \times 10^{2} \times 10^{-6} m$$
$$= 7412 \times 10^{-4} m$$

A is incorrect because this answer would be obtained by converting micrometres into 10^{-5} m instead.
B is incorrect because the answer is incorrect by one power of 10.
D is incorrect because it is not in standard form.
E is incorrect because it is not in standard form.

2   **E is the answer**

The given scale is 1:160000. This means that 1 unit on the map is 160000 units in real-life size.

Therefore: 1 cm : 160000 cm $\Rightarrow$ 1 cm : 1600 m $\Rightarrow$ 1 cm : 1.6 km
                    (Remember that 1 m = 100 cm and 1 km = 1000 m)

The question is looking at an **area** which requires the **ratio to be squared**.

1 cm : 1.6 km $\Rightarrow$ 1 cm^2 : 2.56 km^2

```
            1.    6
     ×      1.    6
            9     6
      1     6
     2.     5     6
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The question is looking for the   real area of a plot of land given that the area of the plot of land drawn on the map is 10 cm^2.

$$1 \text{ cm}^2 : 2.56 \text{ km}^2 \implies 10 \text{ cm}^2 : 25.6 \text{ km}^2$$

A is incorrect because the units were converted incorrectly: 1 km = 1000 cm was used instead of 1 km = 100000 cm:

$$1 \text{ cm} : 160000 \text{ cm} \implies 1 \text{ cm} : 160 \text{ km (wrong conversion)}$$
$$1 \text{ cm} : 160 \text{ km} \implies 1 \text{cm}^2 : 25600 \text{ km}^2 \implies 10 \text{ cm}^2 : 256000 \text{ km}^2$$

C is incorrect.

$$1 : 160000 \implies 1 \text{ cm} : 1.6 \text{ km} \implies 1 \text{ cm}^2 : 2.56 \text{ km}^2$$

The answer option of 2.56 will be obtained if working is stopped here and the ratio is not scaled up to 10 cm².

D is incorrect because the operations were performed in the wrong order. The units were multiplied by 10 before incorrectly squaring only the kilometre value:

$$1 \text{ cm} : 160000 \text{ cm} \implies 1 \text{ cm} : 1.6 \text{ km}$$
$$1 \text{ cm} : 1.6 \text{ km} \implies 10 \text{ cm} : 16 \text{ km}$$

Final incorrect conversion as the same operation has not been applied to both sides:

$$\implies 10 \text{ cm}^2 : 256 \text{ km}^2$$

3   **C is the answer**

This is an **inverse proportion** question.

Convert the information given in the question into a proportionality: $T \; \alpha \; \dfrac{1}{\sqrt{P}}$

Replace α with '$= k$' to form an equation. 'k' **represents an unknown constant.**
Because this question refers to **inverse direct proportion the generic equation is:**

$$y = \frac{k}{x}$$

If this question was about **direct proportion the generic equation would be** $y = kx$.

$$T = \frac{k}{\sqrt{P}}$$

Use the given values of T and P (6 *seconds and* 4 *kilowatts*) to find k. You must identify that the power P is measured in **watts** in the equation, yet the value is provided to you in kilowatts. Before substituting the values for T and P into the equation, convert 4 kilowatts into watts.

$$4kw = 4000w$$

$$6 = \frac{k}{\sqrt{4000}} \quad \Rightarrow 6 = \frac{k}{\sqrt{400} \, x\sqrt{10}} \quad \Rightarrow 6 = \frac{k}{20\sqrt{10}} \quad \Rightarrow k = 120\sqrt{10}$$

You are not expected to know the square root of 4000. However you should be able to manipulate surds to simplify the surd down to $20\sqrt{10}$. Simplifying $\sqrt{4000}$ to $20\sqrt{10}$ will make the rest of the calculation easier for you.

Put the value of k back into the equation: $\quad T = \frac{120\sqrt{10}}{\sqrt{P}}$

Use the equation to find the value of T when $P = 2500 \; watts$

$$T = \frac{120\sqrt{10}}{\sqrt{2500}} \quad \Rightarrow \quad T = \frac{120\sqrt{10}}{\sqrt{25}x\sqrt{100}} \quad \Rightarrow \quad T = \frac{120\sqrt{10}}{5x10} \quad \Rightarrow \quad T = \frac{120\sqrt{10}}{50}$$

Simplifying this gives: $\quad T = \frac{12}{5}\sqrt{10}$

A is incorrect because the power of 4 kilowatts has not been converted into watts. The $\sqrt{4}$ has been used to work out the value of k instead of $\sqrt{4000}$ as required.

B is incorrect because the equation has been set up for direct proportion i.e $y = kx$ when this question is about inverse proportion.

4   **E is the answer**

Write down the ratio of cement to sand with their respective units:

Cement : Sand
800 g : 2.8 kg

Convert the ratio into one with **common units.** You can choose to make the common unit g or kg:

800 g : 2800 g

Simplify the ratio:

800 g : 2800 g

$\Rightarrow 8 : 28$

$\Rightarrow \mathbf{2 : 7}$

A is incorrect because the units were converted wrongly. 2.8 kg was converted to 280 g instead. Remember that 1 kg = 1000 g!

B is incorrect because the units were not converted into common units. This results in the incorrect initial ratio to begin with.
C is incorrect because the ratio is not in its simplest form. The simplest form of a ratio must not involve fractions or decimals.
D is incorrect because it is the ratio of sand to cement instead.

5   **E is the answer**

First you need to form two **simultaneous equations** from the information given in question. The first equation can be formed from the information that the car is 21 km/h faster than the train, and the second equation can be formed from the knowledge that the total travelling time is 11 hours.

Remember, $Speed\ (km/h) = \frac{Distance\ (km)}{Time\ (h)}$.

Let speed of train be T and speed of car be C.

$$C = T + 21\ \text{(1)}$$
$$\frac{196}{T} + \frac{196}{C} = 11\ \text{(2)}$$

Substitute equation (1) into equation (2):

$$\frac{196}{T} + \frac{196}{T+21} = 11$$

$$\frac{196(T+21)+196T}{T(T+21)} = 11$$

$$196(T + 21) + 196T = 11T(T + 21)$$

$$196T + 4116 + 196T = 11T^2 + 231T$$

$$11T^2 - 161T - 4116 = 0$$

$$T = \frac{-(-161)\pm\sqrt{(-161)^2-4(11)(-4116)}}{2(11)}$$

$$T = \frac{161+455}{22}\ \text{ or }\ T = \frac{161-455}{22}$$

In this case, speed must be positive so we have:

$$T = 28$$
$$C = 28 + 21 \Rightarrow C = 49$$

Therefore, the **train travels at 28 km/h** and the **car travels at 49 km/h**.

> *Exam Tip* - If the calculations involving simultaneous equations look too tricky, find the correct answer by substitution the possible answers you are given into the required equations. Choose the answer in which both equations are satisfied!

6   **C is the answer**

The key equation required for this question is the equation which relates speed, distance and time. You also must know how to successfully convert between units.

$$Speed = \frac{Distance}{Time}$$

First, we need to calculate the time it takes Priya to travel to the train station:

$$Time = \frac{Distance}{Speed} \quad \Rightarrow \quad Time = \frac{18}{72} = 0.25 \ hours$$

For Nikki to do a round trip, it takes her three times the time it takes Priya to do a single trip. Therefore Nikki takes $3 \times 0.25 = 0.75 \ hours$ to travel to the train station and back again. The distance Nikki travels is **double the distance** to the train station so she travels $18 \times 2 = 36 \ km$.

Now we need to calculate **Nikki's average speed**:

$$Speed = \frac{Distance}{Time} \quad \Rightarrow \quad Speed = \frac{36}{0.75} = 48 \ km/h$$

Finally, we need to **convert** Nikki's speed into **m/s** as this is what the question asks for.

Remember, $1 \ km = 1000 \ m$ and $1 \ hour = 1 \times 60 \times 60 \ seconds$. So,

$$48 \ km/h = \frac{48 \times 1000}{60 \times 60} m/s = \frac{8 \times 10}{6} \ m/s = \frac{40}{3} \ m/s$$

Therefore, Nikki's average speed is $\frac{40}{3} \ m/s$.

A is incorrect because the distance has not been doubled to account for the round trip.
B is incorrect because the speed has not been converted into m/s.
D is incorrect because the speed has not been converted properly. To convert between hours to seconds, the value needs dividing by 60 twice.
E is incorrect because the distance was not doubled and the speed was not converted into m/s.

7   **B is the answer**

First, find the equation of the graph. The **y-intercept** is clearly 50, and you can find the **gradient** by dividing the change in y by the change in x:

$$y = \frac{280-50}{46}x + 50 \Rightarrow y = \frac{230}{46}x + 50 \Rightarrow y = 5x + 50$$

Once you have the equation, to obtain the cost (y), substitute $x = 88$ into the equation:

$$y = 5(88) + 50 = 490$$

Therefore, the total cost will be **£490**.

A is incorrect
C is incorrect
D is incorrect
E is incorrect

8   **A is the answer**

The formula required to answer this question is the formula which links **density** to mass and volume:
$$Density = \frac{Mass}{Volume} \qquad (1)$$

To determine the mass of the silver ball, we first need to find its **volume**. You must make sure the radius of the ball is converted into cm from mm, before using it in the equation for volume - as we want volume in cm³.

Note, $1 \; cm = 10 \; mm.$

$$\text{Radius } 5 \; mm \qquad \Leftrightarrow \qquad Radius \; 0.5 \; cm$$

Therefore,
$$V = \tfrac{4}{3}\pi r^3 \Rightarrow \quad V = \tfrac{4}{3}\pi(0.5)^3 \quad \Rightarrow V = \tfrac{4}{3}\pi(0.125) \Rightarrow V = \tfrac{4}{3}\pi(\tfrac{125}{1000}) = \tfrac{\pi}{6}$$

Then, to find the mass, equation (1) needs rearranging into the following form:

$$Mass = Density \times Volume$$

Therefore,
$$Mass = 10.5 \times \tfrac{\pi}{6} = \tfrac{21}{2} \times \tfrac{\pi}{6} = \tfrac{21}{12}\pi = \tfrac{7}{4}\pi$$

So, the mass of the silver ball is $\tfrac{7}{4}\pi \; grams$.

B is incorrect because the radius has not been converted into cm.
C is incorrect because the volume equation was incorrectly used - the radius was squared rather than being cubed.

D is incorrect because the radius was halved for use in the formula for volume.
E is incorrect because the radius has not been converted into cm and the volume equation was incorrectly used - the radius was squared rather than being cubed.

9   **D is the answer**

This question relates to use of the relation:

$$Pressure = \frac{Force}{Area} \quad (1)$$

It is important that you recognise that you **don't need to be familiar with the equation** in order to be able to answer the question. The equation can be deduced from the units given in the question. Since the pressure has units **N/m²**, we can see that pressure is calculated by dividing the force, in Newtons, by the area, in m². This allows us to formulate equation (1).

Pressure is given as 35 N/m² and force is given as 14 N. Therefore, by rearranging equation (1),

$$Area = \frac{Force}{Pressure} \qquad \Rightarrow \qquad Area = \frac{14}{35} = \frac{2}{5} \ m^2$$

The question asks for the area in cm². Since 1 m = 100 cm, to convert from m² to cm², you need to multiply by 100 twice. So,

$$Area = \frac{2}{5} \times 100 \times 100 \qquad \Rightarrow \qquad Area = 2 \times 20 \times 100 = 4000 \ cm^2$$

Therefore, the area of the crate in contact with the table, in cm², is **4000 cm²**.

A is incorrect because the wrong formula has been used to calculate area and the answer has not been converted into cm².
B is incorrect because the wrong formula has been used to calculate area.
C is incorrect because the area has not been converted into cm².
E is incorrect because the area has not been converted into cm² correctly. It has only been multiplied by 100 once.

10   **C is the answer**

First, calculate the amount Paul is paid for the normal 37 hour week:

$$37 \times £7 = £259$$

Next, work out how much he will be paid for each overtime shift:

Thursday: 4 hours paid at time and a half
'Paid at time and a half' means the pay for each overtime hour is the same as the normal pay for 1.5 hours. Work out the overtime pay for Thursday by multiplying the normal pay by 1.5 and then by the number of overtime hours:

$$4 \times 1.5 \times £7 = £42$$

Saturday: 5 hours paid at double time
'Paid at double time' means the pay for each overtime hour is the same as the normal pay for 2 hours. Work out the overtime pay for Saturday by multiplying the normal pay by 2 and then by the number of overtime hours:

$$5 \times 2 \times £7 = £70$$

Finally, calculate the total amount Paul earns by adding up each value:

$$Total\ pay\ =\ 259\ + 42 + 70 = £371$$

Therefore, Paul earns **£371** in total.

A is incorrect because this is the amount paid if the overtime hours are all paid at time and a half.
B is incorrect because this is the amount paid if the overtime hours are all paid at double time.
D is incorrect because this is the amount paid if the overtime hours are paid at the normal rate of pay.
E is incorrect because this is the amount obtained if Paul works 5 hours overtime on Thursday and 4 hours overtime on Saturday.

11   **B is the answer**

This question requires use of the following formula: $Speed\ (m/s)\ = \frac{Distance\ (m)}{Time\ (s)}$

First, calculate Zainab's average speed:

$$Zainab's\ speed = \tfrac{500}{125} \Rightarrow Zainab's\ speed = 4\ m/s$$

Since Mai's average speed is 1 m/s faster than Zainab's speed, you obtain:

$$Mai's\ speed = 4 + 1 = 5\ m/s$$

Finally, to calculate how long it takes Mai to run the race, you need to rearrange the formula above to obtain

$$Time\ (s)\ = \frac{Distance\ (m)}{Speed\ (m/s)}$$

$$\Rightarrow \qquad Mai's\ time\ (s)\ = \tfrac{500}{5} = 100\ seconds$$

Therefore, Mai runs the race in **100 seconds**.

A is incorrect because this is the time it takes Zainab to run the race.
C is incorrect as 1 unit has been added to Zainab's time rather than Zainab's speed.
D is incorrect as the time has incorrectly been increased by 1 unit.
E is incorrect as this is the time if Mai was 1 m/s slower than Zainab.

12   **C is the answer**

You are told that the concentration should be in grams per centilitre. This reveals the formula which you should use to answer this question:

$$Concentration\ (g/cl) = \frac{Mass\ (g)}{Volume\ (cl)} \qquad (1)$$

First, convert the volume of water into centilitres (cl):

$$1\ litre = 100\ centilitres \qquad \Rightarrow \qquad 5\ litres = 500\ centilitres$$

The concentration needs to be 15 g/cl. Rearrange formula (1) above:

$$Mass\ (g) = Concentration\ (g/cl) \times Volume\ (cl)$$

$$\Rightarrow Mass\ (g) = 15 \times 500 = 7500\ g$$

Finally, you need to remember to convert the mass into kilograms:

1000 grams = 1 kilogram   ⇒   7500 grams = 7.5 kilograms

Therefore, **7.5 kg of soap powder** must be added to 5 litres of water to obtain a concentration of 15 g/cl.

A is incorrect because the mass has not been converted into kilograms.
B is incorrect because the conversions have been carried out incorrectly.
D is incorrect because the conversions have been carried out incorrectly.
E is incorrect because the conversions have been carried out incorrectly.

13   **E is the answer**

This question makes use of the following relation:

$$Speed\ (m/h) = \frac{Distance\ (m)}{Time\ (h)}\ (1)$$

First, calculate Marc's **average speed**:

$$Average\ speed\ = \frac{54+76}{2} = 65\ miles\ per\ hour$$

Next, calculate the time it takes Marc to travel to Sheffield. This requires rearranging formula (1):

$$Time\ (h) = \frac{Distance\ (m)}{Speed\ (m/h)} \quad \Rightarrow Time\ (h) = \frac{195}{65} = 3 \Rightarrow Marc\ takes\ \textbf{3 hours}\ to\ drive\ to\ Sheffield$$

Finally, calculate the time Marc should leave in order to arrive at sheffield at 10:45:

$$10:45 - 03:00 = 07:45$$

Therefore, Marc should leave at **07:45** in order to arrive at Sheffield on time.

A is incorrect as this suggests the fourney takes 2 hours.
B is incorrect as the driving time has been calculated incorrectly.
C is incorrect as the time has been added to 10:45 rather than subtracted.
D is incorrect as the driving time has been calculated incorrectly.

A is the answer

Let X denote the compound material.

Calculate the total mass of the compound material X:

$$Mass \ of \ material \ X \ = \ 300 \ + \ 75 \ = \ 375 \ g$$

Calculate the density of material X by multiplying each given density by the **proportion** of that material which is within the compound material:

$$Density \ of \ material \ X \ = \ (Proportion \ of \ Material \ A \ in \ X \times 20) \ + \ (Proportion \ of \ Material \ B \ in \ X \times 15)$$

$\Rightarrow$ $\quad\quad\quad Density \ of \ material \ X \ = \ (\frac{300}{375} \times 20) \ + \ (\frac{75}{375} \times 15)$

$\Rightarrow$ $\quad\quad\quad Density \ of \ material \ X \ = \ (\frac{6000}{375}) \ + \ (\frac{1125}{375})$

$\Rightarrow$ $\quad\quad\quad Density \ of \ material \ X \ = \ \frac{7125}{375}$

$\Rightarrow$ $\quad\quad\quad Density \ of \ material \ X \ = \ 19 \ g/cm^3$

Therefore, the compound material X has density **19 g/cm³**.

B is incorrect
C is incorrect
D is incorrect
E is incorrect

15　　**D is the answer**

Jamie works for 9.5 hours. He is paid the normal rate of pay for the first 7 hours and then he is paid overtime for the remaining 2.5 hours.

To calculate the total amount he is paid you need to first calculate what his overtime rate of pay is:

$$Overtime \ rate \ of \ pay \ = \ 1.4 \times £15$$

To perform this calculation without a calculator, it might help to write it in fractional form and then perform cancellations:

$$Overtime \ rate \ of \ pay \ = \ \frac{14}{10} \times 15 = \frac{7}{5} \times 15 = 7 \times 3 = 21$$

$\Rightarrow$ $\quad\quad Overtime \ rate \ of \ pay \ = \ £21$

Total Jamie made working 9.5 hours on Tuesday:

$$Total\ pay\ =\ (7 \times £15) + (2.5 \times 21)$$
$$\Rightarrow\quad Total\ pay\ =\ 105 + \tfrac{5}{2}(21)$$
$$\Rightarrow\quad Total\ pay\ =\ 105 + \tfrac{105}{2}$$

$$\Rightarrow\quad Total\ pay\ =\ £157.50$$

Therefore, Jamie earned **£157.5** for working on Tuesday.

A is incorrect because the overtime rate of pay has been incorrectly calculated.
B is incorrect because this is the pay if he was paid the normal rate of pay for the whole day.
C is incorrect because this is the pay if he is paid overtime for 9 hours.
E is incorrect because this is the pay if he is paid overtime for the whole day.

16   **B is the answer**

Calculating **Cameron's** rate of pay:
Cameron makes 25 cupcakes per hour and is paid 28p for each cupcake he makes.

$$Cameron's\ hourly\ pay\ =\ 25 \times 0.28p$$
$$= 25 \times \tfrac{28}{100} = \tfrac{28}{4} = 7$$

Therefore, Cameron is paid **£7 per hour**.

Calculating **Katie's** rate of pay:
Katie is paid £261 for working 36 hours.

$$Katie's\ hourly\ pay\ =\ \tfrac{£261}{36}$$

$$= \tfrac{261}{36} = \tfrac{87}{12} = \tfrac{29}{4} = 7.25$$

Therefore, Katie is paid **£7.25 per hour.**

$$Difference\ in\ rate\ of\ pay\ = 7.25 - 7.00 = 0.25$$

Equivalently, if Katie's pay is left in fraction form,

$$Difference\ in\ rate\ of\ pay\ = \tfrac{29}{4} - 7 = \tfrac{29-28}{4} = \tfrac{1}{4} = 0.25$$

Therefore, the difference in Cameron's and Katie's rate of pay is **25 p**.
A is incorrect because the rates of pay have been incorrectly calculated.

C is incorrect because the unit has been incorrectly converted into pence.
D is incorrect because the rates of pay have been incorrectly calculated.
E is incorrect because the rates of pay have been incorrectly calculated.

17 **B is the answer**

You should calculate the cost for one journey and then double this value to obtain the cost for the round trip.

First, calculate how many gallons of petrol Tom will require to drive to sheffield:

$$\frac{170}{60} = \frac{17}{6} \ gallons$$

Next, calculate how many litres of petrol he uses to get to sheffield:

$$\frac{17}{6} \times 4.5 = \frac{17}{6} \times \frac{9}{2} = \frac{51}{4} \ litres$$

Calculate the cost for the amount of petrol calculated:

$$\frac{51}{4} \times £1.20 = \frac{51}{4} \times \frac{120}{100} = 51 \times \frac{3}{10} = 15.3$$

The cost for Tom to drive to Sheffield is £15.30.
Finally, calculate the cost of the roundtrip:

$$Total \ cost \ = \ 15.3 \times 2 = 30.6$$

Therefore, it will cost Tom **£30.60** to travel to Sheffield and back.

A is incorrect.
C is incorrect because this is the amount of litres of petrol required for the trip. The cost has not been calculated.
D is incorrect because this is the cost for a one way trip to sheffield.
E is incorrect.

18   **B is the answer**

Charity C received £36. Divide this value by the ratio value for charity C:

$$36 \div \tfrac{3}{5} = 36 \times \tfrac{5}{3} = 60$$

Therefore, as $\tfrac{3}{5}$ units represents £36, we have found that 1 unit represents £60.

Calculate the sum of values in the ratio:

$$1 + \tfrac{1}{3} + \tfrac{3}{5} + \tfrac{1}{4} = \tfrac{60}{60} + \tfrac{20}{60} + \tfrac{36}{60} + \tfrac{15}{60} = \tfrac{131}{60}$$

Thus, there are $\tfrac{131}{60}$ units in the ratio in total. Multiply this value by the value for one unit to calculate the total amount raised for charity:

$$Total\ raised = \tfrac{131}{60} \times 60 = 131$$

Therefore, Isabella raised **£131** for charity.

A is incorrect
C is incorrect
D is incorrect
E is incorrect

19   **A is the answer**

One side of a rectangle is $(16 - \sqrt{7})\ cm$. The rectangle has an area of $996\ cm^{2}$.

First, calculate the length of the other side of the rectangle. Use complementary (conjugate) surds to remove the surd from the denominator:

$$\frac{996}{16-\sqrt{7}} = \frac{996}{16-\sqrt{7}} \times \frac{16+\sqrt{7}}{16+\sqrt{7}} = \frac{996(16+\sqrt{7})}{16^{2}-7} = \frac{996(16+\sqrt{7})}{249} = 4(16 + \sqrt{7})\ cm$$

Calculate the perimeter of the rectangle by adding up each of the sides:

$$Perimeter = (16 - \sqrt{7}) + (16 - \sqrt{7}) + 4(16 + \sqrt{7}) + 4(16 + \sqrt{7}) = 160 + 6\sqrt{7}\ cm$$

Therefore, the **perimeter** of the rectangle is $160 + 6\sqrt{7}\ cm$.

B is incorrect because this is the calculated length of the missing side of the rectangle.
C is incorrect because this is half the required area.

D is incorrect because this is the perimeter of the square with sides $16 - \sqrt{7}$.
E is incorrect because it is the sum of only three of the sides of the rectangle.

20 **A is the answer**

First calculate the total area of the field. Use pythagoras' theorem to calculate the width of the field:

$$Width\ of\ field = \sqrt{(65)^2 - (35)^2} = \sqrt{4225 - 1225} = \sqrt{3000} = 10\sqrt{30}$$

$$Area\ of\ field = 10\sqrt{30} \times 35 = 350\sqrt{30}$$

Since corn is only going to be grown in 25% of the field, calculate 25% of the total area to obtain the final answer:

$$Area\ for\ corn = \frac{350\sqrt{30}}{100} \times 25 = \frac{35\sqrt{30}}{10} \times 25 = \frac{35\sqrt{30}}{2} \times 5 = \frac{175\sqrt{30}}{2}$$

So, the total area of the field is $350\sqrt{30}\ m^2$ and the area used to grow corn is $\frac{175\sqrt{30}}{2}\ m^2$.

B is incorrect because this is the area of the whole field.
C is incorrect because the diagonal of the field was used as the width when calculating area.
D is incorrect because the wrong form of pythagoras's theorem was used.
E is incorrect because the wrong percentage of the total field area was used.