OCR 04 Approximation and Estimation (Higher)

1. Round 33 179 614 to the nearest thousand.

2. Round 63.87 419 to 2 decimal places.

3. Round 0.24 581 to 3 significant figures.

4. Round 28 537.5159 to 2 significant figures.

5. Round 4.69723×10^{12} to 3 significant figures.

6. The side length of a square is 124 cm correct to the nearest centimetre.
   Write down the error interval for its perimeter (p).

7. The radius of a circle is 8.39 cm truncated to two decimal places.
   Write down the error interval for its area (a).

8. Estimate the answer to $\dfrac{821.5 \times 67.9}{4.5^2 \times 0.36}$.

9. Estimate what percentage of £36 277 is £7682.

10. Carl counted the number of steps he took to walk from his house to the station to be 3678. He estimates that his stride is approximately 58 cm. Estimate the distance from Carl's house to the station.

11. Fredo walked the 1536 miles from Bug End to Mount Doum in 198 days. Estimate how many miles he walked per day on average, and evaluate the reliability of this estimate.

12. The attendance at a football match (n) was given as 17 800 to the nearest hundred people. Rakesh says that the error interval can be written as $17750 \leq n < 17850$, where n is the number of people. Paula says that the error interval is $17750 \leq n \leq 17849$.
    State if each of them is correct, and explain your answer.

13. A roll of edging tape is stated to be 150 m long correct to the nearest 10 metres. A cushion maker uses 2.4 m of edging tape, correct to the nearest 10 cm, for each cushion he makes. Show that the number of cushions he can make is in the range 59 to 65.

14. A rectangular field is 110 m wide and 170 m long, each distance correct to the nearest 10 m. A path crosses the field diagonally. Show that the difference between the longest and shortest possible length of the path is greater than 10 m.

15. Lev wants to estimate the height of a tree in his garden. He stands on horizontal ground 20m (to the nearest 10cm) from the base of the tree. The height of his eyes above the ground is 168cm to the nearest cm. The angle of elevation from his eyes to the top of the tree is 38° to the nearest degree By considering bounds, show that the tree is between 17 and 18 metres tall.

16. In the UK, large eggs must be of a certain weight, $63 \leq$ large < 73 g. Henrietta has 1 kg of large eggs. What is the range of the number of large eggs she has?

17. The distance from London to New York is 5552 km to the nearest kilometre. A plane flies from London to New York in 6 hours 45 minutes correct to the nearest minute. Calculate the lower bound for the speed of the plane. Give your answer correct to 3 significant figures.

18. An elephant has a weight of 2860 N to 3 significant figures. Assume that the area of each foot in contact with the ground is a circle of radius 16 cm to the nearest centimetre. Calculate the upper bound for the pressure that the elephant would exert on the ground when standing on all four feet. Use the formula $\text{pressure} = \frac{\text{force}}{\text{area}}$ and give your answer in N/m^2.

19. Arthur and Mary want to put a fence around their rectangular paddock. Fence panels are sold in 5 m lengths. Arthur measures the length and width of the paddock to be 46 m and 90 m both correct to the nearest metre. Mary measures the length and width of the paddock to be 46.00 m and 90.00 m both correct to the nearest 10 centimetres. Would Arthur's measurements and Mary's measurements result in different numbers of fence panels needed?

20. The density of steel (d) varies within the range $7.75 \leq d < 8.05$ g/cm^3. A company manufactures cylindrical steel rods that have a radius of 160 mm and a length of 8470 mm, both given to the nearest millimetre. For quality assurance, the company proposes to accept a rod if its weight (w) is in the range 5250-5500 kg correct to the nearest 10 kg. Calculate the bounds for the weight of the rods, and comment on the proposal.

Answers

1. 33 180 000

2. 63.87

3. 0.246

4. 29 000

5. 4.70×10^{12}

6. $494 \leq p < 498$

7. $221.14 \leq a < 221.67$

8. $\dfrac{821.5 \times 67.9}{4.5^2 \times 0.36} \approx \dfrac{800 \times 70}{5^2 \times 0.4} = \dfrac{56\,000}{10} = 5600$

9. $\dfrac{7682}{36\,277} \times 100 \approx \dfrac{8000}{40\,000} \times 100 = 20\%$

10. $3678 \approx 4000$. $58\text{ cm} \approx 60\text{ cm}$. $4000 \times 60 = 240\,000\text{ cm} = 2400\text{ m} = 2.4\text{ km}$.

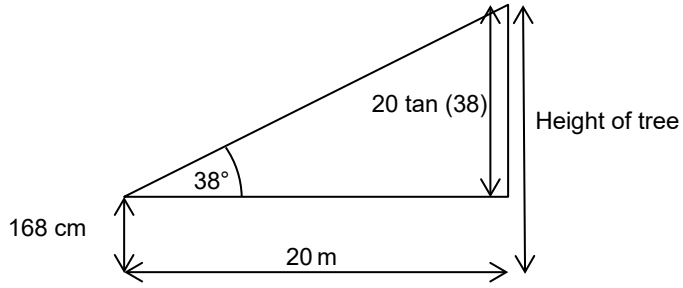
11. $1536 \div 198 \approx 2000 \div 200 = 10$. This estimation is not likely to be reliable as the distance is rounded up by almost a third of its original value, whereas the time is rounded up by only a small amount. The number of miles per day is therefore an overestimate.

12. Both Rakesh and Paula are correct. The error interval can be given as either $17\,750 \leq n < 17\,850$ or $17\,750 \leq n \leq 17\,849$ because the number of people can only be a whole number.

13. $145 \leq$ length of roll $< 155\text{ m}$
    $2.35 \leq$ length of roll per cushion $< 2.45\text{ m}$
    Minimum number of cushions $= \dfrac{145}{2.45} = 59.18$ so 59
    Maximum number of cushions $= \dfrac{155}{2.35} = 65.96$ so 65
    Range = 59-65

14. Difference in length $= \sqrt{115^2 + 175^2} - \sqrt{105^2 + 165^2}$
    $= \sqrt{43\,850} - \sqrt{38\,250}$
    $= 209.404 - 195.576$
    $= 13.828$ which is greater than 10 m

15.



Lower bound for height of tree $= \tan 37.5^\circ \times 19.95 + 1.675 = 17.0$ m

Upper bound for height of tree $= \tan 38.5^\circ \times 20.05 + 1.685 = 17.6$ m

so the tree is between 17 and 18 metres tall.

16. $(1000 \div 73) = 13.70$

$(1000 \div 63) = 15.87$

Range is 14-16 eggs (or 2 eggs).

17. Need $\dfrac{\text{upper bound for distance}}{\text{upper bound for time}} = \dfrac{5552.5}{6\dfrac{45.5}{60}} = 822$ km/h

18. Pressure $= \dfrac{\text{force}}{\text{area}}$.

Upper bound for pressure $= \dfrac{\text{upper bound for weight}}{\text{lower bound for area}} = \dfrac{2865}{0.155^2 \times \pi \times 4} = 9489 = 9490$ N/m^2 to 3sf.

19. Arthur: Upper bound for perimeter = 2(46.5 + 90.5) = 274 m, so he would calculate 274 ÷ 5 = 54.8 i.e. 55 fence panels.
Mary: Upper bound for perimeter = 2(46.05 + 90.05) = 272.2 m, so she would calculate 272.2 ÷ 5 = 54.44 i.e. 55 fence panels.
Therefore the measurements do not result in different numbers of fence panels needed.

20. Lower bound for weight $= 7.75 \times (\pi \times 15.95^2 \times 846.95) \div 1000 = 5246.03$ kg.

Upper bound for weight $= 8.05 \times (\pi \times 16.05^2 \times 847.05) \div 1000 = 5518.29$ kg.

Allowable range (r) is $5245 \le r \le 5505$ kg. The lowest possible weight is in range but the highest possible weight is outside the allowable range and therefore it is possible that some of the rods could be rejected.

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Assessment Objective	Qu.	Topic	R	A	G
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AO1	5	Round a number given in standard form to 3 significant figures			
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AO1	7	Write an error interval for a truncated value			
AO1	8	Estimate the answer to a calculation involving division by a decimal			
AO1	9	Estimate a percentage			
AO1	10	Estimate the answer to a calculation involving a product			
AO2	11	Estimate in context			
AO2	12	Explain bounds for discrete data			
AO2	13	Calculate with bounds			
AO2	14	Calculate with bounds			
AO2	15	Use bounds in a real-life context			
AO3	16	Calculate with bounds			
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AO3	18	Find an upper bound for pressure			
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AO3	20	Solve a problem using bounds			

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