BOUND CALCULATIONS

1) A rectangle has a length of 7 m and a width of 4 m, each rounded to the nearest metre.
   a. What is the minimum possible perimeter of the rectangle?
   Minimum perimeter
   = 2 × (6.5 + 3.5)
   = 2 × 10
   = **20 m**
   b. What is the maximum possible area of the rectangle?
   Maximum area
   = 7.5 × 4.5
   = **33.75 m²**

2) Jupiter's diameter is 142,000 km to the nearest thousand. Saturn's diameter is 120,500 km to the nearest 500 km. Work out the minimum difference in their diameters.
   Minimum difference
   = 141,500 − 120,750
   = **20,750 km**

3) A cyclist travelled 48 km to the nearest kilometre at a speed of 16 km/h, correct to the nearest km/h. Work out the maximum time travelled. Give your answer in hours and minutes, to the nearest minute.
   Maximum time
   = maximum distance ÷ minimum speed
   = 48.5 ÷ 15.5
   = 3.12903… h
   = **3 h 8 min**

4) The radius of a circle is 6 cm to the nearest cm.
   a. Work out the maximum circumference of the circle. Give your answer in terms of π.
   Maximum circumference
   = 2 × π × 6.5
   = **13π cm**
   b. Work out the minimum area. Give your answer to 2 decimal places.
   Minimum area
   = π × 5.5^2
   = 30.25π cm^2
   = **95.03 cm^2 (2 dp)**

5) The height of plants measure: 7.2 cm, 5.8 cm, 6.5 cm, 6.9 cm, 7.0 cm, each to the nearest tenth.
   a. Work out the greatest possible mean.
   Max heights: 7.25, 5.85, 6.55, 6.95, 7.05
   Mean
   $= \frac{7.25 + 5.85 + 6.55 + 6.95 + 7.05}{5}$
   = 33.65 ÷ 5 = **6.73 cm**
   b. Work out the smallest possible median.
   Min heights: 5.75, 6.45, 6.85, 6.95, 7.15
   6.85

6) A frame has a length of 3.2 m and a width of 1.5 m, both to 1 decimal place. Work out the maximum possible area of the frame.
   Maximum area
   = 3.25 × 1.55
   = **5.0375 m²**

7) The length of a square field is measured as 40 m to the nearest metre. Find the minimum possible area of the field.
   Minimum area
   = 39.5^2
   = **1560.25 m²**

8) A circular pond has a radius of 8 m, correct to the nearest metre. Work out the maximum circumference. Give your answer in terms of π.
   Maximum circumference
   = 2 × π × 8.5
   = **17π m**

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9) A parcel has a mass of 2.4 kg, correct to the nearest 0.1 kg. Work out the maximum mass of the parcel.

Maximum mass = **2.45 kg**

10) A string is measured as 12.5 m, correct to the nearest 0.1 m. Find the minimum possible length.

Minimum length = **12.45 m**

11) A cube has side length 6 cm, correct to the nearest cm. Work out the maximum possible volume.

Maximum volume = 6.5^3

= **274.625 cm³**

12) $a = b - c$

$b = 3.54$ correct to 2 decimal places

$c = 2.168$ correct to 3 decimal places

Work out the upper bound of a.

$a_{upper} = b_{upper} - c_{lower}$

$= 3.545 - 2.1675$

$= \mathbf{1.3775}$

13) $x = \frac{y}{z}$

$y = 10.2$ correct to 3 significant figures

$z = 0.5$ correct to 1 decimal place

Work out the lower bound of x.

$x_{lower} = \frac{y_{lower}}{z_{upper}}$

$= \frac{10.15}{0.55}$

$= 18.454545 \ldots$

$= \mathbf{18.5\ (3\ sf)}$

14) $m = np$

$n = 5.46$ correct to 2 decimal places

$p = 10$ correct to 2 significant figures

Work out the lower bound of m.

$m_{lower} = n_{lower} \times p_{lower}$

$= 5.455 \times 9.5$

$= \mathbf{51.8225}$

15) A rectangular swimming pool is measured 10 m × 4 m, both to the nearest metre. Work out the maximum possible perimeter.

Maximum perimeter

= 2 × (10.5 + 4.5)

= **30 m**

16) A cylinder has radius 4.0 cm to 1 decimal place and a height of 12 cm to the nearest centimetre. Given that the cylinder weights 200 g to the nearest gram, work out the minimum possible density to 2 decimal places.

$$D = \frac{m}{v}$$

Maximum volume

= π × 4.05^2 × 12.5

= $205\frac{1}{32}\pi$

Minimum density

= $\frac{199.5}{205\frac{1}{32}\pi}$

= 0.3097 …

= **0.31 g/cm³ (2 dp)**

17) A car travels 150 km, correct to the nearest km, in 2 hours, correct to the nearest tenth. Work out the minimum possible average speed. Give your answer to 1 decimal place.

Minimum speed

= minimum distance ÷ maximum time

= 149.5 ÷ 2.05

= 72.9268…

= **72.8 km/h (1 dp)**

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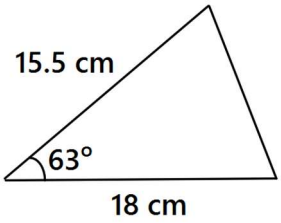
18) A triangle is pictured below. The length 15.5 cm has been rounded to 1 decimal place. The length 18 cm has been rounded to 2 significant figures. The angle 63° has been rounded to the nearest degree. Work out the lower bound of the area of the triangle. Give your answer to 1 decimal place.



$Area = \frac{1}{2}ab\sin C$

$= \frac{1}{2} \times 15.45 \times 17.5 \times \sin(62.5)$

$= 119.9127\ldots$

$= \mathbf{119.9\ cm^2\ (1\ dp)}$

19) $y = \frac{3x}{k}$

$x = 12.4$ correct to 3 significant figures

$k = 7.01$ correct to 3 significant figures

By considering bounds, work out the value of y to a suitable degree of accuracy. Give a reason for your answer.

$y_{lower} = \frac{3x_{lower}}{k_{upper}}$

$= \frac{3 \times 12.35}{7.015}$

$= 5.28153\ldots$

$y_{upper} = \frac{3x_{upper}}{k_{lower}}$

$= \frac{3 \times 12.45}{7.005}$

$= 5.33190\ldots$

$\boldsymbol{y = 5.3\ (1\ dp)}$

Both round to the same value to 1 decimal place (or to 2 significant figures).

20) The area of a circle is given by the formula A = π × r^2. The radius of the circle is measured as 4.00 cm, correct to 2 decimal places. By considering bounds, work out the value of the area of the circle to a suitable degree of accuracy. Give a reason for your answer.

$A_{lower} = \pi \times r^2{}_{lower}$

$= \pi \times 3.995^2$

$= 50.1398\ldots$

$A_{upper} = \pi \times r^2{}_{upper}$

$= \pi \times 4.005^2$

$= 50.3912\ldots$

$\boldsymbol{A = 50\ (2\ sf)}$

Both round to the same value to 2 significant figures (or to the nearest unit).

21) A runner completes a distance of 1500 m in a recorded time of 4.8 minutes, correct to 1 decimal place. By considering bounds, work out the runner's speed in m/s to a suitable degree of accuracy. Give a reason for your answer.

$s_{lower} = d \div t_{upper}$

$= 1500 \div (4.85 \times 60)$

$= 5.15463\ m/s\ldots$

$s_{upper} = d \div t_{lower}$

$= 1500 \div (4.75 \times 60)$

$= 5.26315\ m/s\ \ldots$

$\boldsymbol{s = 5\ m/s\ \ (1\ sf)}$

Both round to the same speed to 1 significant figure (or to the nearest unit).

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22) The kinetic energy of a meteor is given by

$$KE = \frac{1}{2}mv^2$$

The mass of the meteor, m, is 3.62 kg, correct to 3 significant figures. The velocity of the meteor, v, is 1000 m/s, correct to 4 significant figures. By considering bounds, work out the value of KE to a suitable degree of accuracy. Give a reason for your answer.

$$KE_{lower} = \frac{1}{2} \times m_{lower} \times v^2{}_{lower}$$
$$= \frac{1}{2} \times 3.615 \times 999.5^2$$
$$= 1805692.952 \ldots$$

$$KE_{upper} = \frac{1}{2} \times m_{upper} \times v^2{}_{upper}$$
$$= \frac{1}{2} \times 3.625 \times 1000.5^2$$
$$= 1814312.953 \ldots$$

$\boldsymbol{KE = 1,810,000\ (3\ sf)}$

Both round to the same value to 3 significant figures (or to the nearest 10,000)

Challenge

23) In triangle DEF

$$d^2 = e^2 + f^2 - (2ef\cos D)$$

where d is the side opposite angle D.

$e = 7.6\ cm$, correct to 1 decimal place

$f = 5.42\ cm$, correct to 3 significant figures

$D = 38°C$, correct to the nearest degree

By considering bounds, work out the value of d to a suitable degree of accuracy. Give a reason for your answer.

Note that:

$$\cos(38.5) = 0.782608 \ldots$$
$$\cos(37.5) = 0.79335 \ldots$$

$$d_{lower} = \sqrt{7.55^2 + 5.415^2 - (2 \times 7.55 \times 5.415 \times \cos(38.5))}$$
$$= 4.72584 \ldots$$

$$d_{upper} = \sqrt{7.65^2 + 5.425^2 - (2 \times 7.65 \times 5.425 \times \cos(37.5))}$$
$$= 4.70136 \ldots$$

$\boldsymbol{d = 4.7\ (1\ dp)}$

Both round to the same value to 1 decimal place (or 2 significant figures)

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