**Q1.** Gerry has an ingot of steel that he is going to turn into ball bearings.

The ingot is in the shape of a cuboid and it cost him £50.

The dimensions of the cuboid are 30 cm by 15 cm by 8 cm to the nearest mm.
The ball bearings are spheres of diameter 5 mm to the nearest tenth of a millimetre.

Gerry melts the ingot and recasts the metal without losing any of the steel.
He sells all the ball bearings he makes at 10 ball bearings for 1 pence.

Work out the least profit Gerry could make if he sells all of the ball bearings.

£ .....

**(Total 6 marks)**

**Q2.** Katy drove for 238 miles, correct to the nearest mile.
She used 27.3 litres of petrol, to the nearest tenth of a litre.

$$\text{Petrol consumption} = \frac{\text{Number of miles travelled}}{\text{Number of litres of petrol used}}$$

Work out the upper bound for the petrol consumption for Katy's journey.
Give your answer correct to 2 decimal places.

..... miles per litre

**(Total 3 marks)**

**Q3.** A ball is thrown vertically upwards with a speed $V$ metres per second.

The height, $H$ metres, to which it rises is given by

$$H = \frac{V^2}{2g}$$

where $g$ m/s2 is the acceleration due to gravity.

$V$ = 24.4 correct to 3 significant figures.
$g$ = 9.8 correct to 2 significant figures.

(i) Write down the lower bound of $g$.

.....

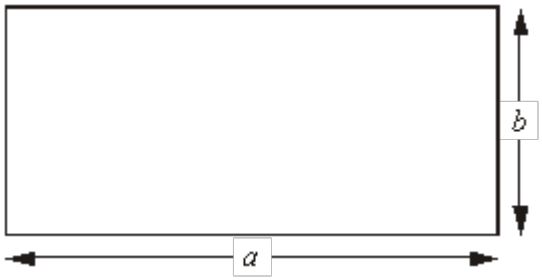
(ii) Calculate the upper bound of $H$.
Give your answer correct to 3 significant figures.

.....

**(Total 3 marks)**

**Q4.** Here is a rectangle.

Diagram **NOT** accurately drawn



$a$ = 8.3 cm correct to 1 decimal place.
$b$ = 3.6 cm correct to 1 decimal place.

(a) Calculate the upper bound of the area of this rectangle.
Write down all the figures on your calculator.

..... $cm^2$

**(2)**

(b) Find the area of this rectangle correct to an appropriate number of significant figures.

..... $cm^2$

**(2)**
**(Total 4 marks)**

**M1.**

| | Working | Answer | Mark | Additional Guidance |
|---|---|---|---|---|
| **FE** | $\frac{(29.95 \times 14.95 \times 7.95)^3}{\frac{4}{3}\pi(0.255)^3}$<br><br>$= \frac{3559.632375}{0.0694559011 \quad 8}$ | £462.25 | 6 | **B1** for using the least value of 1 dimension of the cuboid<br><br>**M1** for 29.95 × 14.95 × 7.95 oe<br><br>**B1** for using greatest radius of sphere as 0.25cm + 0.005 cm<br><br>**M1** for dividing least volume of lead "3559.632375" by greatest volume<br><br>of sphere "0.0694559"<br><br>**A1** for 51250 or Selling price = £51.25<br><br>**A1** for Profit = £1.25 cao |
| | | | | **Total for Question: 6 marks** |

**M2.**

| Working | Answer | Mark | Additional Guidance |
|---|---|---|---|
| 238 has an UB 238.5,<br>a LB of 237.5<br>27.3 has an UB of 27.35,<br>a LB of 27.25<br><br>Upper: $\frac{238.5}{27.25}$ = 8.75229 | 8.75 | 3 | **B1** for one of 238.5, 237.5, 27.35, 27.25, $238.4\dot{9}, 27.34\dot{9}$ seen<br><br>**M1** for 'UB no of miles'÷'LB no of litres'<br>Where 238 < 'UB no of miles'≤238.5 and<br>27.25 ≤ 'LB no of litres' < 27.3<br>**A1** 8.75 or 8.752 or 8.7522 or 8.7523 or better<br><br>SC 238.4 ÷ 27.25 which leads to 8.748…**B1**<br>**M1** A0 |
| | | | **Total for Question: 3 marks** |

**M3.**

| | Working | Answer | Mark | Additional Guidance |
|---|---|---|---|---|
| (i) | | 9.75 | 3 | **B1** cao<br><br>**M1** for $\frac{V_{UB}^{\ 2}}{2 \times g_{LB}}$ where $24.4 < V_{UB} \leq 24.45$ and $9.75 \leq g < 9.8$ **or** $\frac{V_{UB}^{\ 2}}{2\times'9.75'}$ (= 30.6565…)<br><br>**A1** for 30.7 or 30.66 or 30.657 or 30.6565 or 30.65654 or better coming from 30.6565384… |
| (ii) | $\frac{24.45^2}{2 \times 9.75}$<br>$= \frac{597.8025}{19.5}$<br>= 30.6565 … | 30.7 | | |
| | | | | **Total for Question: 3 marks** |

**M4.**

| | Working | Answer | Mark | Additional Guidance |
|---|---|---|---|---|
| (a) | UB 8.35 × 3.65 = 30.4775 | 30.4775 | 2 | **M1** sight of 8.35 or 3.65<br><br>**A1** 30.7445 |

| | | | | |
|---|---|---|---|---|
| (b) | LB 8.25 × 3.55 = 29.2875 | 30 | 2 | **M1** 8.25 × 3.55<br>**A1** 30 (dep on 8.25 × 3.55) |
| | | | | **Total for Question: 4 marks** |

**E2.** As with Question 20, another important technique with applications in science. Many candidates could identify at least one upper or lower bound correctly, but then used commonly $\frac{238.5}{27.35}$. Many candidates simply used $\frac{238}{27.3}$ and then rounded off or $\frac{238.4}{27.25}$. Most candidates sensibly avoided recurring decimals saving themselves a problem when using their calculator.

**E3.** Approximately 20% candidates obtained the correct answer in part i) but part (ii) was very poorly done. 9.7 or 9.8 were the most frequent incorrect answers for part (i). Most candidates failed to use the correct values in part (ii). Most frequently, 24.4 and 9.8, i.e. the given values, were used suggesting that they had little understanding of the use of bounds. A very few candidates used the correct values but failed to include the 2 in the denominator.