📘 Limits of Accuracy – IGCSE Mathematics

Limits of accuracy help us understand the **possible range of values** a number could take if it has been **rounded** to a certain degree of accuracy (e.g. nearest 10, nearest whole number, 2 decimal places, etc.).

✅ 1. Give upper and lower bounds for data rounded to a specified accuracy

When a value is **rounded**, the **true value** lies **within a range** called the **upper and lower bounds**.

⭐ Rule:

- If a value is **rounded to the nearest unit (e.g. nearest whole number, tenth, etc.)**,
  - **Lower Bound = Rounded Value – ½ of the unit**
  - **Upper Bound = Rounded Value + ½ of the unit**

🔷 Examples:

Example 1:

A length is recorded as **62 cm**, rounded to the **nearest cm**.
Find the upper and lower bounds.

- Nearest cm → unit = 1 cm
- Half the unit = 0.5 cm
  Lower bound = 62 – 0.5 = 61.5 cm
  Upper bound = 62 + 0.5 = 62.5 cm

✅ **Answer: [61.5 cm, 62.5 cm)**

(Note: Upper bound is not included if the value is rounded to nearest unit)

Example 2:

A number is given as **5.3**, correct to **1 decimal place.**

- Unit = 0.1
- Half of 0.1 = 0.05
  Lower bound = 5.3 – 0.05 = 5.25
  Upper bound = 5.3 + 0.05 = 5.35

✅ **Answer: [5.25, 5.35)**

Example 3:

Mass = 2000g, correct to the **nearest 100g**

- Unit = 100

- Half of 100 = 50
  Lower bound = 2000 – 50 = 1950 g
  Upper bound = 2000 + 50 = 2050 g

✅ **Answer: [1950 g, 2050 g)**

✅ 2. Find upper and lower bounds of the results of calculations using rounded data

When a **calculation uses rounded numbers**, the **result also has limits**.

To find the **maximum and minimum possible result**, use:

- **Upper Bound** of result: use the **most extreme values** (largest for numerator, smallest for denominator)

- **Lower Bound** of result: use the **least extreme values** (smallest for numerator, largest for denominator)

◆ Example 1 – Area of a Rectangle:

A rectangle has:

- Length = 15.2 cm (correct to 1 decimal place)
- Width = 8.1 cm (correct to 1 decimal place)

◆ Step 1: Find bounds of each:

- Length bounds: [15.15, 15.25]
- Width bounds: [8.05, 8.15]

◆ Step 2: Calculate bounds for area:

- Minimum area = Lower bound of length × Lower bound of width
  = 15.15 × 8.05 = **121.9575 cm²**
- Maximum area = Upper bound of length × Upper bound of width
  = 15.25 × 8.15 = **124.0375 cm²**

✅ **Answer: Area is between 121.9575 cm² and 124.0375 cm²**

◆ Example 2 – Speed Calculation:

A car travels **150 km** (correct to nearest 10 km) in **2 hours** (correct to nearest 5 minutes).

◆ Step 1: Convert time to hours:

- 5 minutes = 5/60 = 1/12 hour
- Time bounds: [2 − 1/12, 2 + 1/12] = [1.9167, 2.0833] hours
- Distance bounds: [145, 155] km

◆ Step 2: Speed = Distance ÷ Time

- Minimum speed = 145 ÷ 2.0833 ≈ **69.6 km/h**
- Maximum speed = 155 ÷ 1.9167 ≈ **80.9 km/h**

✅ **Answer: Speed is between approximately 69.6 km/h and 80.9 km/h**

📌 Tips:

- Always identify what accuracy the number was rounded to.
- Use **lower bound** and **upper bound** carefully depending on the **type of operation** (add/subtract/multiply/divide).
- Use a calculator to handle decimals precisely.