1) **Upper and Lower bounds of a Measurement**

The simple rule is this:

The real value can be as much as **HALF THE ROUNDED UNIT** above and below the rounded-off value.

1) A room is given as being '9 m long to the nearest **METRE**' — its actual length could be anything from **8.5 m** up to **9.5 m** — i.e. **HALF A METRE** either side of 9 m. So 8.5m and 9.5m are the lower and upper bounds.

2) If it was given as ‘9.4 m, to the nearest **0.2 m**’, then it could be anything from **9.3 m** up to **9.5 m** (9.4 ± 0.1 m) — i.e. **0.1 m either side** of 9.4 m. So 9.3 m and 9.5 m are the lower and upper bounds.

3) If a length is given as **2.4 m to the nearest **0.1 m**, the rounded unit is 0.1 m so the real value could be anything up to **2.4 m ± 0.05 m** giving answers of 2.45 m and 2.35 m for the upper and lower bounds.

4) 'A school has 460 pupils to 2 Sig Fig' (i.e. to the nearest 10) — the actual figure could be anything from **455 up to 464**. — (Why isn’t it 465?) So 455 and 464 are the upper and lower bounds.

2) **Maximum and Minimum Values for Calculations**

When a calculation is done using rounded-off values there will be a **DISCREPANCY** between the **CALCULATED VALUE** and the **ACTUAL VALUE**:

**EXAMPLE:** A floor is measured as being **5.3 m × 4.2 m** to the nearest 10 cm.

Calculate the minimum and maximum values for the area and perimeter.

Multiplying 5.3 m by 4.2 m gives an area of **22.26 m²**, but this is not the actual floor area because the real length and width values could be anything from **5.25 m to 5.35 m** and **4.15 m to 4.25 m**.

:. Maximum possible floor area = **5.35 × 4.25 = 22.7375 m²**,

:. Minimum possible floor area = **5.25 × 4.15 = 21.7875 m²**.

Also, using these values:

Maximum possible perimeter = (**5.35 + 4.25**) × 2 = **19.2 m**,

Minimum possible floor area = (**5.25 + 4.15**) × 2 = **18.8 m**.

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**Exercises**

1) A yacht is described as **17 metres long to the nearest 0.1 m**. What is the longest and shortest it could be?

2) **x and y** are measured as **2.32 m** and **0.45 m** to the nearest **0.01 m**.

   a) Find the upper and lower bounds of x and y.

   b) If **z = x + 1/y**, find the max and min possible values of z.

   Careful here — the biggest input values don’t always give the biggest result.