## Approximation

When a question asks you to approximate a number, generally all it really asks you to do is to **round** that number.

There are three main ways to round a number:

1) Rounding to the **nearest unit, ten, hundred, thousand**, etc.
2) Rounding to a certain number of **decimal places.**
3) Rounding to a certain number of **significant figures.**

General rounding rules:

- If the number you are rounding is followed by 0, 1, 2, 3, or 4: round the number down.
- If the number you are rounding is followed by 5, 6, 7, 8, or 9: round the number up.

**Example:** Round 24,693 to the nearest 10

*When rounding 24,693 to the nearest 10, we look at the **tens digit**, which in this case is 9:*
24,693

*3 is the number on the right of it, which is smaller than 5, so we keep the digit 9 there. This is called **rounding down**. Now we change all the numbers to the right of 9 to 0s.*

*Final answer:* **24,690**

**Example:** Round 24,693 to the nearest 100

*When rounding 24,693 to the nearest 100, we look at the **hundreds digit**, which in this case is 6:*
24,693

*9 is the number on the right of it, which is bigger than 5, so we increase the hundreds digit by one (so from 6 to 7). This is called **rounding up**. Now we change all the numbers to the right of 7 to 0s.*

*Final answer:* **24,700**

**Example:** Round 2,981 to 2 significant figures

*When rounding 2,981 to 2 significant figures, we look at the **second digit from the left**, which in this case is 9:*
2,981

*8 is the number on the right of it, which is bigger than 5, so we **increase the second digit by one**. However, the second digit is 9, so we change it to 0 and increase the digit to the left by one (2 to 3). Now we change all the numbers to the right of the second digit to 0s.*

*Final answer:* **3,000**

## Decimal Places

A question may specify the **number of decimal places** (d.p.) that are required in the answer. This means that we will need to **round the digit** that is to the **right** of the number of decimal places required.

For example, we may want to round the decimal 3.6783 to two decimal places:

- We count two digits from the decimal point and look at the **next digit to the right**.
  - If this number is less than 5, then we leave the other digits as they are. However, if the next digit is 5 or more, then we will need to **add 1** to the **second digit** from the decimal point.

  This is the case here: the third digit is 8, which is more than 5. So, we then add 1 to the second digit, which is 7. This gives us **3.68**.

**Example:** What is 135.72572 to 3 decimal places?

*As we are looking to round to 3 decimal places, we **count 3 digits** from the decimal point:* **135.725**72

*We then look at the fourth digit, which is 7. This is **more than 5**, so we can add 1 to the digit before, making it 6.*

*This gives us **135.726**.*

## Significant Figures

S.f.

We can also round to a certain number of **significant figures**. Significant figures can be used for all numbers, not just decimals. To use significant figures, we need to ignore any leading zeros. This means that the first significant figure of 0.003 is 3 and not 0.

For example, say we want to round the number 5821 to 2 significant figures.

1. We start at the **first digit** and check if it is 0 or not. If it is not 0, as with the number 5821, then this digit is the **first significant figure**.
2. We can then look to the next digit, 8, which is the second significant figure.
3. To round to 2 significant figures, we need to check the digit **next to the 2nd significant figure** to see if the 2nd significant figure should be **rounded**. For 5821, the third digit is 2, which means that we round the second significant figure, 8, down. To finish writing the number, we put **zeros** in the places after the significant figures. Therefore, 5821 rounded to 2 significant figures is **5800**.

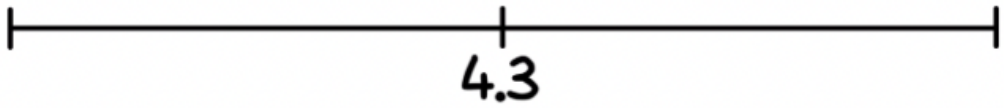
We don't always ignore the zeros when using significant figures.

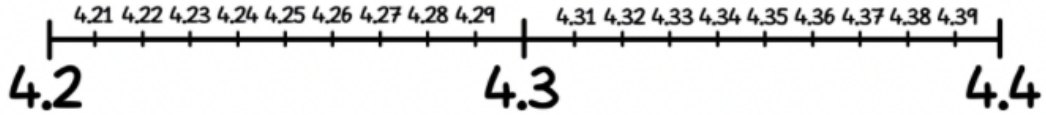
As an example, let's round the number 70064 to 3 significant figures.

1. We start by looking for the first **non-zero digit**, which is 7 here. Now that we have the first non-zero digit, any zeros after this **are counted as significant figures**. Therefore, the two zeros after 7 are the second and third significant figures.
2. Before writing the answer, we need to check whether we round the last significant figure up or down. Rounding 70064 to 3 significant figures means we **round the third significant figure up** to 1 and write zeros in the remaining places. This leaves us with **70100**.

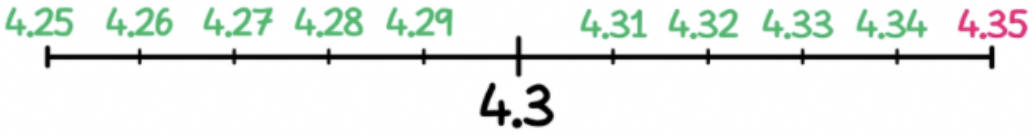
# Error Interval & Upper and Lower Bound

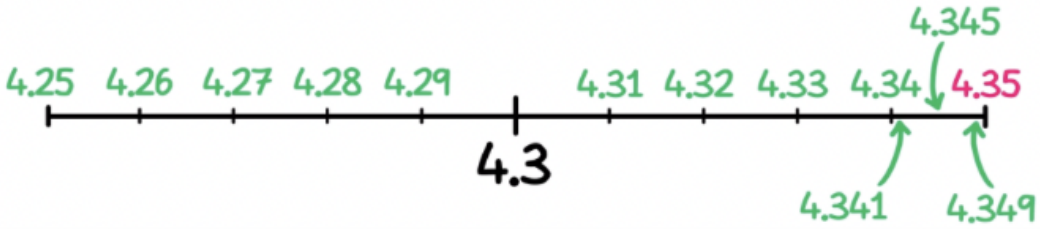
A number, 4.3, is rounded to the nearest 0.1 dp. But didn't tell you what the original number was. So what might it have been?

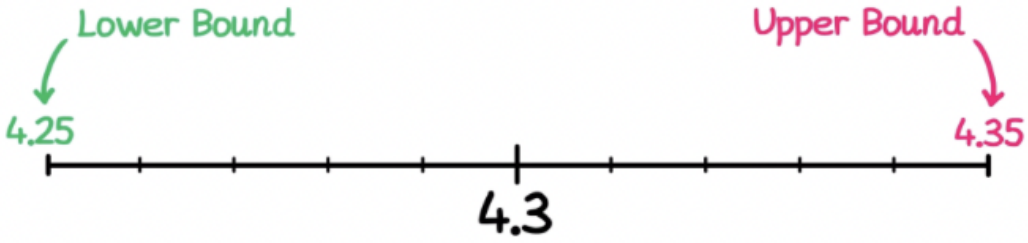







$$\underbrace{4.25 \leq n < 4.35}_{\text{Error Interval}}$$

## Error Intervals

A number, $n$, is rounded to 1 decimal place.

The result is 6.7

Write the error interval for $n$.


$6.65 \leq n < 6.75$

## Error Intervals

A number, $y$, is rounded to 2 decimal places.

The result is 8.42

Write the error interval for $y$.


$8.415 \leq y < 8.425$