GCSE Maths – Number

Rounding and Limits of Accuracy

Worksheet

WORKED SOLUTIONS

This worksheet will show you how to work out different types of rounding and limits of accuracy questions. Each section contains a worked example, a question with hints and then questions for you to work through on your own.

Section A

Worked Example

What is 4794 rounded to the nearest 10?

Step 1: First, identify the digit in the column of the degree of accuracy we are asked for.

The degree of accuracy here is 10*, so we look for the digit in the tens column. For this number, it is* 9*.*

$$47\mathbf{9}4$$

Step 2: Look at the digit to the right of the identified digit.

The digit to the right of the 9 *is* 4*.*

$$479\mathbf{4}$$

Step 3: Using the number to the right, work out whether the identified digit needs to be rounded up or down.

If the digit to the right is less than 5, then we round down.
If the digit is 5 or more, then we round up.
Here, the digit is 4, so we round down to the nearest 10.
This means that the digit in the tens column (9) stays as it is, and we fill the rest of the number in with zeros.

Final answer: $\mathbf{4790}$

Guided Example

What is 3.57 rounded to the nearest 0.1?

Step 1: First, identify the digit in the column of the degree of accuracy we are asked for.

3.57

Step 2: Look at the digit to the right of the identified digit.

3.57

Step 3: Using the number to the right, work out whether the identified digit needs to be rounded up or down.

7>5 so round up

3.60

3.6

Now it's your turn!

If you get stuck, look back at the worked and guided examples.

1. Round 28812 to the nearest 100

rounding 8

1 < 5, so we round down.

28,800

2. Round 67.89 to the nearest 1

rounding 7

8 > 5, so we round up

68.00

68

3. Round 95 to the nearest 100

rounding 0

9 > 5, so we round up

100

4. Round 0.005923 to the nearest 0.0001

rounding 9

2 < 5, so we round down.

0.005900

0.0059

Section B

Worked Example

Round the number 5.72491 to 2 decimal places

Step 1: Identify the number of decimal places the question asks for. Then, count that number of digits past the decimal point.

The question asks us to round to 2 *decimal places. We count two digits past the decimal point – these digits are* 7 *and* 2.

$$5.\mathbf{72}491$$

Step 2: Look at the next digit, the one to the right of the last one counted.

Looking at the next digit along, it is 4.

$$5.72\mathbf{4}91$$

Step 3: From this digit, work out if the number should be rounded up or down, then write out the final rounded answer.

Since the digit is 4, *we need to round down.*

The final answer is 5.72. *We do not write any zeros after the decimal places.*

Guided Example

Round 9.26 to 1 decimal place

Step 1: Identify the number of decimal places the question asks for. Then, count that number of digits past the decimal point.

9. 26

Step 2: Look at the next digit, the one to the right of the last one counted.

9.26

Step 3: From this digit, work out if the number should be rounded up or down, then write out the final rounded answer.

6 > 5 round up

9.30

9.3

Now it's your turn!

If you get stuck, look back at the worked and guided examples.

5. Round 1.7325 to 3 decimal places

rounding 2

$5 \geq 5$, so we round up

1.7330

1.733

6. Round 3.058 to 2 decimal places

rounding 5

$8 > 5$, so we round up

3.06

7. Round 0.0392164 to 4 decimal places

rounding 2

$1 < 5$, so we round down.

0.0392

8. Round 6.095 to 2 decimal places

rounding 9

$5 \geq 5$, so we round up

6.0100

= 6.1

Section C

Worked Example

Round the number 59067 to 3 significant figures

Step 1: Identify the first non-zero digit. This is the first significant figure.

The first non-zero digit here is 5.

$$\mathbf{5}9067$$

Step 2: Count the next digits until we have the required number of significant figures.

We need to count two more digits past the 5*, as this will give us the 3 significant figures. For this number,* 5*,* 9 *and* 0 *are the significant figures.*

$$\mathbf{590}67$$

We can count 0 *as a significant figure if it comes after a non-zero digit. If there are zeros at the start of the number (such as in a decimal), then we ignore these and do not count them as the first significant figure.*

Step 3: Look at the next digit, the one to the right of the last significant figure. This tells us if we need to round the last significant figure up or down.

$$590\mathbf{67}$$

Looking at the next digit along, we see it is a 6. This is greater than 5, which means we need to round the digit before (the 0*) up to* 1*.*

Step 4: If appropriate, fill in the rest of the number with zeros.

The final number is $\mathbf{59100}$*.*

Guided Example

Round 0.04692 to 2 significant figures

Step 1: Identify the first non-zero digit. This is the first significant figure.

The first non-zero digit is 4

Step 2: Count the next digits until we have the required number of significant figures.

2 sf : 0.04692

Step 3: Look at the next digit, the one to the right of the last significant figure. This tells us if we need to round the last significant figure up or down.

0.04692   9 > 5 round up

Step 4: If appropriate, fill in the rest of the number with zeros.

0.04700   0.047

(extra 0s are not needed)

Now it's your turn!

If you get stuck, look back at the worked and guided examples.

9. Round 76329 to 2 significant figures

rounding 6

3 < 5, so we round down.

76,000

10. Round 0.02976 to 3 significant figures

rounding 7

6 > 5, so we round up

0.0298

11. Round 0.808 to 2 significant figures

rounding 0

8 > 5, so we round up

0.81

12. Round 50023 to 3 significant figures

rounding 0

2 < 5, so we round down.

50,000

Section D

Worked Example

The weights of bags of apples are marked to the nearest 50 g. What is the error interval for a bag marked as weighing 600 g?

Step 1: Work out the degree of accuracy and halve it.

The degree of accuracy is 50 g *here. Halving this gives us* 25 g.

Step 2: Add the halved value onto the estimated value to get the upper limit and subtract it from the estimated value to get the lower limit.

$$\begin{aligned} Estimated\ value &= 600\text{ g} \\ Lower\ limit\ of\ accuracy &= 600 - 25 = 575\text{ g} \\ Upper\ limit\ of\ accuracy &= 600 + 25 = 625\text{ g} \end{aligned}$$

Step 3: Use inequality notation to show the error interval.

$$Lower\ limit \leq Estimated\ value < Upper\ limit$$

$$575\text{ g} \leq Weight < 625\text{ g}$$

Guided Example

The heights of 20 children are marked to the nearest 1 cm. What is the error interval for a child with a height of 120 cm?

Step 1: Work out the degree of accuracy and halve it.

1cm $1 \div 2 = 0.5$cm

Step 2: Add the halved value onto the estimated value to get the upper limit and subtract it from the estimated value to get the lower limit.

$120 + 0.5 = 120.5$
$120 - 0.5 = 119.5$

Step 3: Use inequality notation to show the error interval.

119.5cm $\leq$ height $<$ 120.5cm

Now it's your turn!

If you get stuck, look back at the worked and guided examples.

13. In a car factory, the cars are weighed and marked to the nearest 10 kg. What is the error interval for a car marked as weighing 1900 kg?

$10kg : 10 \div 2 = 5 kg$

$1900 + 5 = 1905 kg$

$1900 - 5 = 1895 kg$

$1895kg \leq weight < 1905kg$

14. What is the error interval for a tennis ball weighing 56g, marked to the nearest 1g?

$1g : 1 \div 2 = 0.5g$

$56 + 0.5 = 56.5g$

$56 - 0.5 = 55.5g$

$55.5g \leq weight < 56.5g$

15. A sheet of A4 paper is marked as weighing 4.95 g, to the nearest 0.01 g. What is the error interval for one sheet of A4 paper?

$0.01g : 0.01 \div 2 = 0.005g$

$4.95 + 0.005 = 4.955g$

$4.95 - 0.005 = 4.945g$

$4.945g \leq weight < 4.955g$

Section E – Higher Only

Worked Example

A box of cereal is reported to weigh 500 g to the nearest 10 g. What are the upper and lower bounds for the weight of 6 boxes of cereal?

Step 1: Work out the degree of accuracy and halve it.

The degree of accuracy is 10 g *here. Halving this gives us* 5 g.

Step 2: Add the halved value onto the estimated value to get the highest possible value of one unit and subtract it from the estimated value to get the lowest possible value of one unit.

$$\textit{Estimated value} = 500\text{ g}$$
$$\textit{Lowest possible weight of one box} = 500 - 10 = 490\text{ g}$$
$$\textit{Highest possible weight of one box} = 500 + 10 = 510\text{ g}$$

Step 3: Perform the calculation in the question with the highest and lowest values of one unit to obtain the upper and lower bounds.

$$\textit{Lower bound} = 6 \times 490\text{ g} = 2940\text{ g}$$
$$\textit{Upper bound} = 6 \times 510\text{ g} = 3060\text{ g}$$

Guided Example

The weight of a textbook is 1.3 kg to the nearest 100 g. What are the upper and lower bounds for the weight of 7 textbooks?

Step 1: Work out the degree of accuracy and halve it.

100g : 100 ÷ 2 = 50g

Step 2: Add the halved value onto the estimated value to get the highest possible value of one unit and subtract it from the estimated value to get the lowest possible value of one unit.

1.3kg = 1300g
×1000

highest for one: 1300 + 50 = 1350g
lowest for one: 1300 − 50 = 1250g

Step 3: Perform the calculation in the question with the highest and lowest values of one unit to obtain the upper and lower bounds.

1350 × 7 = 9450g
1250 × 7 = 8750g

8750g ≤ 7 books weight < 9450g

Now it's your turn!
If you get stuck, look back at the worked and guided examples.

16. Calculate the upper and lower bounds for the following:

a) The height of 15 bricks, if each brick is 6 cm in height to the nearest 1 cm.

1 cm: $1 \div 2 = 0.5$ cm

Bounds for 1 brick:
$6 + 0.5 = 6.5$ cm
$6 - 0.5 = 5.5$ cm

Bounds for 15 bricks:
$6.5 \times 15 = 97.5$ cm
$5.5 \times 15 = 82.5$ cm

$82.5 \text{ cm} \leq$ heights of 15 bricks < 97.5 cm

b) The area of a pane of glass with length 55 cm and width 15 cm, both measured to the nearest 5 cm.

$5 \div 2 = 2.5$ cm

Area: Upper Bound: UB × UB
Lower Bound: LB × LB

Length: $55 - 2.5 \leq l < 55 + 2.5$
$52.5 \text{ cm} \leq l < 57.5 \text{ cm}$

Width: $15 - 2.5 \leq w < 15 + 2.5$
$12.5 \text{ cm} \leq w < 17.5 \text{ cm}$

Area Limits:

LB = 52.5×12.5
= 656.25 cm^2

UB = 57.5×17.5
= 1006.25 cm^2

$656.25 \text{ cm}^2 \leq$ Area $< 1006.25 \text{ cm}^2$

c) The volume of a cube, with sides of 10 cm to the nearest 2 cm.

$2 \div 2 = 1$ cm

Limits of 1 side:
$10 + 1 = 11$ cm
$10 - 1 = 9$ cm

Volume:
Upper Bound = UB × UB × UB
Lower Bound = LB × LB × LB

UB = $11 \times 11 \times 11 = 1331 \text{ cm}^3$
LB = $9 \times 9 \times 9 = 729 \text{ cm}^3$

$729 \text{ cm}^3 \leq$ volume $< 1331 \text{ cm}^3$