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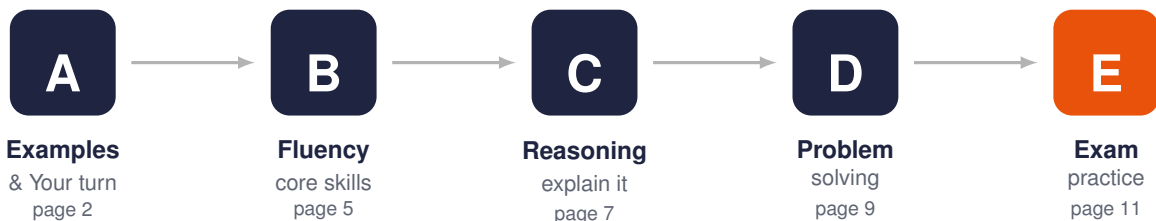
GCSE MATHEMATICS • NUMBER

Error Intervals & Bounds

Worksheet

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • Calculator only where shown

Free Error Intervals and Bounds worksheet for GCSE and iGCSE Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: write the error interval for a rounded number using inequalities • write the error interval for a truncated number • find lower and upper bounds of measurements • *Higher:* find bounds of calculations, decide which bounds to combine, and justify a suitable degree of accuracy.

Which questions are for me?

FOUNDATION Everyone starts here. These skills appear on both tiers.

HIGHER Upper and lower bounds in calculations. This is Higher-only content: choosing the right bounds for sums, differences, products and quotients, and giving an answer to a suitable degree of accuracy.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Foundation marks	20	12	14	8
Higher marks	11	12	18	13
My score				

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A

Worked examples & Your turn

Read each example carefully. Cover it up, then answer the question beside it using the same method.

FOUNDATION

Everyone starts here

Worked example A1: rounded to the nearest whole

The length, l cm, of a pencil is 8 cm correct to the nearest centimetre.

Write down the error interval for l .

Go half a unit below and half a unit above.



7.5 rounds to 8, so it **is** included ($\leq$). 8.5 rounds to 9, so it is **not** ($<$).

$$7.5 \leq l < 8.5$$

Your turn A1

The mass, m kg, of a dog is 23 kg correct to the nearest kilogram.

Write down the error interval for m .

Worked example A2: decimal places and significant figures

Write down the error interval for

(a) $x = 4.3$ correct to 1 decimal place

(b) $y = 600$ correct to 1 significant figure

Find the size of one step, then go half a step each way.

(a) step 0.1, half 0.05 (b) step 100, half 50

$$(a) 4.25 \leq x < 4.35 \quad (b) 550 \leq y < 650$$

Your turn A2

Write down the error interval for

(a) $x = 7.62$ correct to 2 decimal places

(b) $y = 3000$ correct to 1 significant figure

Worked example A3: truncated numbers

A number t is truncated to 1 decimal place. The result is 6.4

Write down the error interval for t .

Truncating cuts the extra digits off and never rounds up. Anything from 6.4 up to, but not including, 6.5 is cut down to 6.4

$$6.4 \leq t < 6.5$$

Your turn A3

A number n is truncated to 2 decimal places. The result is 12.37

Write down the error interval for n .



HIGHER*Higher only: bounds in calculations***Worked example A4: adding and multiplying**

A rectangle measures 12.4 cm by 7.6 cm, each correct to 1 decimal place.

Work out the upper bound of **(a)** the perimeter
(b) the area.

*For the biggest sum or product, use the **upper** bound of every measurement.*

Upper bounds: 12.45 and 7.65

(a) $2 \times (12.45 + 7.65) = 40.2$

(b) $12.45 \times 7.65 = 95.2425$

(a) 40.2 cm	(b) 95.2425 cm ²
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Your turn A4

(calculator) A rectangle measures 9.3 cm by 5.8 cm, each correct to 1 decimal place.

Work out the lower bound of **(a)** the perimeter
(b) the area.

Worked example A5: subtracting

$a = 15.2$ and $b = 6.8$, each correct to 1 decimal place.

Work out the upper bound and the lower bound of $a - b$.

*To make a difference as **big** as possible: biggest take away smallest.*

Upper bound = $15.25 - 6.75 = 8.5$

*To make it as **small** as possible: smallest take away biggest.*

Lower bound = $15.15 - 6.85 = 8.3$

upper 8.5	lower 8.3
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Your turn A5

$p = 40$ correct to the nearest 10, and $q = 17$ correct to the nearest whole number.

Work out the upper bound and the lower bound of $p - q$.



Worked example A6: dividing

(calculator) A runner covers 240 m, correct to the nearest 10 m, in 38 s, correct to the nearest second.

Work out the upper bound of the runner's speed.

To make a fraction as **big** as possible: biggest top, smallest bottom.

Upper bound of distance = 245 Lower bound of time = 37.5

speed = distance $\div$ time

$245 \div 37.5 = 6.5333 \dots$

6.53 m/s (3 s.f.)

Your turn A6

(calculator) A metal block has mass 540 g, correct to the nearest 10 g, and volume 72 cm^3 , correct to the nearest cm^3 .

Work out the lower bound of its density. Give your answer correct to 3 significant figures.

Worked example A7: a suitable degree of accuracy

(calculator) $v = \frac{a}{b}$ $a = 8.43$ and $b = 2.35$, each correct to 2 decimal places.

By considering bounds, work out v to a suitable degree of accuracy.

Find both bounds of v .

Upper: $8.435 \div 2.345 = 3.5970 \dots$

Lower: $8.425 \div 2.355 = 3.5774 \dots$

Round both until they agree. To 2 d.p.: 3.60 and 3.58 (different). To 1 d.p.: 3.6 and 3.6 (same).

$v = 3.6$, because both bounds round to 3.6

Your turn A7

(calculator) $w = \frac{p}{q}$ $p = 56.2$ correct to 1 decimal place and $q = 4.37$ correct to 2 decimal places.

By considering bounds, work out w to a suitable degree of accuracy. Give a reason.



B**Fluency**

Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer?

FOUNDATION*Everyone starts here*

B1 Write down the error interval for x when

(a) $x = 40$ to the nearest 10

(b) $x = 400$ to the nearest 100

(c) $x = 400$ to the nearest 10

(d) $x = 400$ to the nearest whole number

[4 marks]

B2 Write down the error interval for x when

(a) $x = 3.7$ to 1 decimal place

(b) $x = 3.70$ to 2 decimal places

(c) $x = 0.08$ to 2 decimal places

(d) $x = 12.0$ to 1 decimal place

[4 marks]

B3 Write down the error interval for x when

(a) $x = 5000$ to 1 significant figure

(b) $x = 5000$ to 2 significant figures

(c) $x = 0.6$ to 1 significant figure

(d) $x = 0.060$ to 2 significant figures

[4 marks]

B4 Each value of x has been **truncated**. Write down the error interval for x .

(a) $x = 7$ truncated to a whole number

(b) $x = 2.5$ truncated to 1 decimal place

(c) $x = 0.34$ truncated to 2 decimal places

(d) $x = 180$ truncated to 2 significant figures

[4 marks]

B5 Write down the lower bound and the upper bound of each measurement.

(a) 64 kg to the nearest kg

(b) 8.2 s to the nearest tenth of a second

(c) 1500 m to the nearest 100 m

(d) 250 ml to the nearest 10 ml

[4 marks]



HIGHER*Higher only: bounds in calculations*

B6 $x = 6.4$ and $y = 2.7$, each correct to 1 decimal place. Work out

(a) the upper bound of $x + y$

(b) the lower bound of $x + y$

(c) the upper bound of $x - y$

(d) the lower bound of $x - y$

[4 marks]

B7 (*calculator*) $a = 8$ correct to the nearest whole number and $b = 2.5$ correct to 1 decimal place. Work out

(a) the upper bound of ab

(b) the lower bound of ab

(c) the upper bound of $\frac{a}{b}$, to 3 significant figures

(d) the lower bound of $\frac{a}{b}$, to 3 significant figures

[4 marks]

B8 Write down the error interval for

(a) $l = 145$ to the nearest 5

(b) $s = 60$ to the nearest 5

(c) $t = 3.5$ to the nearest 0.5

[3 marks]



C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

FOUNDATION

Everyone starts here

- C1** A number x is 9 correct to the nearest whole number. Tom writes the error interval as $8.5 \leq x \leq 9.5$
Explain what is wrong with Tom's answer. [2 marks]
- C2** Mia says, "The biggest number that rounds to 8, to the nearest whole number, is 8.4"
Write down a number that shows Mia is wrong. [2 marks]
- C3** A mass is recorded as 14 kg.
(a) Write down the error interval if 14 was **rounded** to 2 significant figures.
(b) Write down the error interval if 14 was **truncated** to 2 significant figures. [3 marks]
- C4** Pencil A is 12 cm long, to the nearest centimetre. Pencil B is 12.0 cm long, to the nearest millimetre.
Write down the error interval for each pencil, and say which has been measured more accurately. [3 marks]
- C5** x is 50 correct to the nearest 10
Which of these could be the value of x ?
45 55 44.9 54.99 [2 marks]



HIGHER*Higher tier only*

- C6** A lift can safely carry 450 kg. Six people get in. Each person has a mass of 74 kg, correct to the nearest kilogram.
Is it certain that the lift is safe? You must show your working. [3 marks]
- C7** Explain why the upper bound of $a - b$ uses the **lower** bound of b . [2 marks]
- C8** $x = 5.0$ correct to 1 decimal place.
Is it certain that x^2 is less than 25.6? You must show your working. [3 marks]
- C9** (*calculator*) $p = 3.2$ and $q = 0.4$, each correct to 1 decimal place.
- (a) Work out the upper bound and the lower bound of $\frac{p}{q}$
- (b) Both numbers were rounded to the same accuracy. Explain why the answer can vary so much. [4 marks]



D**Problem solving**

You decide the method. Read the whole question first, and show every step.

FOUNDATION

Everyone starts here

- D1** The number of people at a football match is 24 000, correct to the nearest thousand.
Write down the smallest possible number and the largest possible number of people at the match.

[3 marks]

- D2** You must be at least 1.4 m tall to go on a ride. Ben's height is 1.4 m, correct to 1 decimal place.
Can you be certain that Ben is tall enough? Give a reason.

[2 marks]

- D3** The diagram shows an error interval for a number x .



Write down the rounded value of x and the accuracy it was rounded to.

[2 marks]

- D4** A calculator truncates its answers to 3 decimal places. The display shows 2.718

(a) Write down the error interval for the exact answer, x . (b) Could the exact answer be 2.7189? Give a reason.

[3 marks]

- D5** A shelf is 80 cm long, correct to the nearest centimetre. Each book is 4 cm wide, correct to the nearest centimetre.

(a) Show that 20 books might **not** fit on the shelf.

(b) Work out the greatest number of books that will **definitely** fit.

[4 marks]



HIGHER*Higher tier only*

- D6** (*calculator*) A triangle has base 9.4 cm and height 6.2 cm, each correct to 1 decimal place.
Work out the lower bound of the area of the triangle. [3 marks]
- D7** (*calculator*) A sprinter runs 100 m, correct to the nearest metre, in 9.8 s, correct to 1 decimal place.
By considering bounds, work out the sprinter's average speed to a suitable degree of accuracy. You must give a reason. [5 marks]
- D8** A field is a rectangle. Its width is 36 m, correct to the nearest metre. Its length is 120 m, correct to the nearest 5 metres.
Work out the upper bound of the perimeter of the field. [3 marks]
- D9** (*calculator*) A statue has mass 2460 g, correct to the nearest 10 g, and volume 310 cm^3 , correct to the nearest 10 cm^3 .
Work out the upper bound of the density. Give your answer correct to 3 significant figures. [3 marks]
- D10** (*calculator*) $R = \frac{a}{b-c}$ $a = 12$ correct to the nearest whole number. $b = 7.5$ and $c = 3.2$, each correct to 1 decimal place.
Work out the upper bound of R . Give your answer correct to 3 significant figures. [4 marks]



E**Exam practice**

Exam-style questions. Write your answers in the spaces. Aim for about one minute per mark.

FOUNDATION

Foundation and Higher crossover

- E1** A number, n , is rounded to 1 decimal place. The result is 6.3
Using inequalities, write down the error interval for n .

.....

(Total for Question E1 is 2 marks)

- E2** The length, L cm, of a line is 25 cm correct to the nearest centimetre.
Complete the statement to show the range of possible values of L .

..... $\leq L <$

(Total for Question E2 is 2 marks)

- E3** Jo truncates a number, m , to 1 decimal place. The result is 4.8
Write down the error interval for m .

.....

(Total for Question E3 is 2 marks)

- E4** The height, h metres, of a pole is 3.20 m correct to the nearest centimetre.
Write down the error interval for h .

.....

(Total for Question E4 is 2 marks)



HIGHER*Higher tier only*

E5 (*calculator*) A rectangle has length 15.3 cm and width 8.6 cm, each correct to 1 decimal place.

Work out the upper bound of the area of the rectangle.

..... cm²

(Total for Question E5 is 3 marks)

E6 $x = 9.7$ and $y = 3.4$, each correct to 1 decimal place.

Work out the lower bound of $x - y$.

.....

(Total for Question E6 is 2 marks)

E7 (*calculator*) A car travels 380 km, correct to the nearest 10 km. The journey takes 4.5 hours, correct to the nearest 0.1 hour.

Work out the lower bound of the average speed. Give your answer correct to 3 significant figures.

..... km/h

(Total for Question E7 is 3 marks)



E8 (calculator) $y = \sqrt{\frac{p}{q}}$

$p = 7.26$ correct to 2 decimal places. $q = 2.40$ correct to 2 decimal places.

By considering bounds, work out the value of y to a suitable degree of accuracy.

You must show all your working and give a reason for your final answer.

.....
(Total for Question E8 is 5 marks)

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