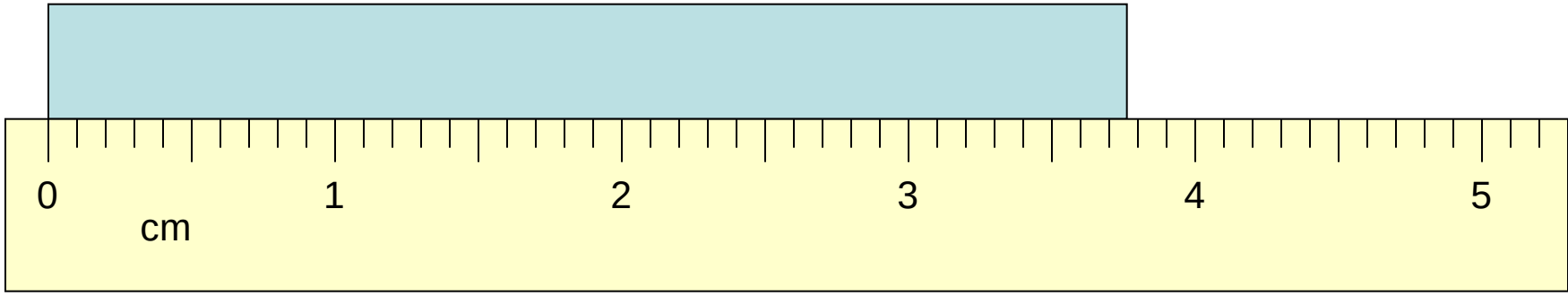
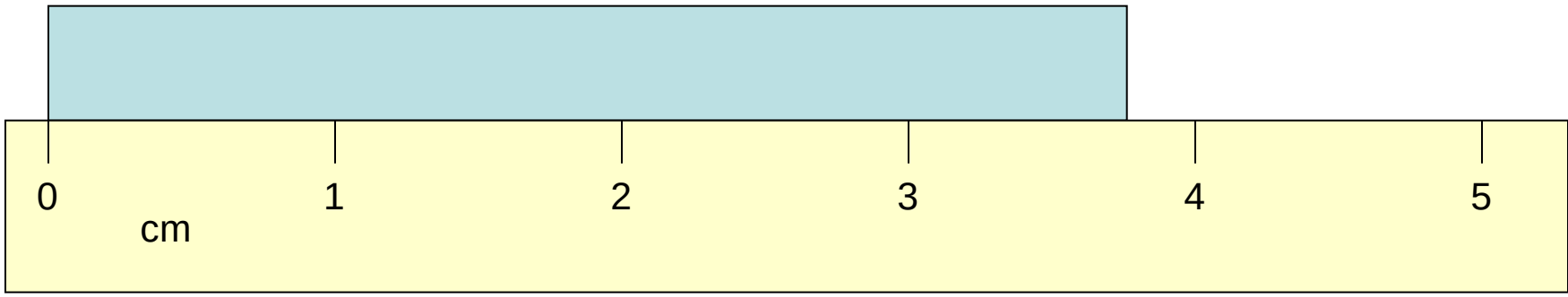
Significant Figures

As you learned in a previous tutorial, an appropriate measurement for the length of the rectangle below is **3.76 cm**. Because the “3” and the “7” are certain, and the “6” is our guess, all three digits are intentional or “significant.” Thus **3.76 cm** contains **three significant figures.**



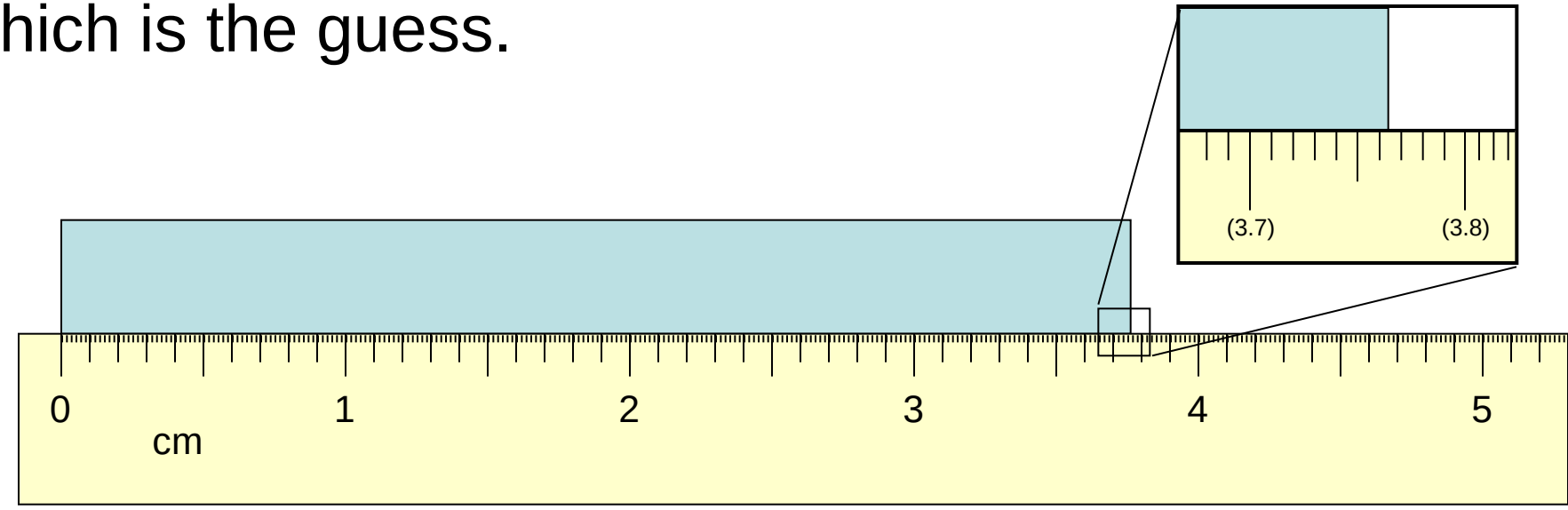
Significant Figures

The scale below is less precise, and so the rectangle's length should be reported as just **3.8 cm**. This measurement has just two significant figures: the "3" and the "8" and it is considered to be a weaker, less valuable measurement than 3.76 cm.



Significant Figures

The scale below, however, is more precise, and a magnified view (shown at right) is helpful in making a good reading: **3.764 cm.** This measurement has **4 significant figures**: the “3.76…” which are certain, and the “4” which is the guess.



Significant Figures

3.7 cm has two significant figures,

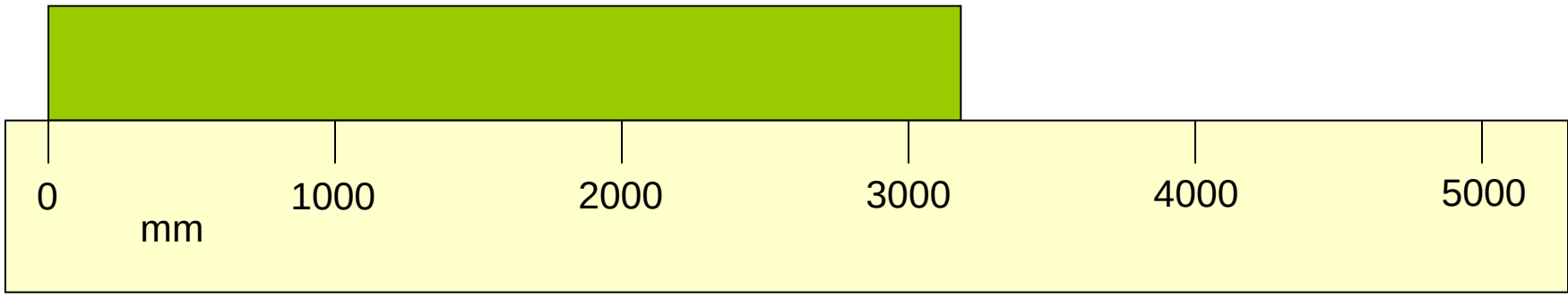
3.76 cm has three significant figures,

3.764 cm has four significant figures.

You might start to think that the number of significant figures is simply equal to the number of digits there are in a measurement, but that is not always the case…

Significant Figures

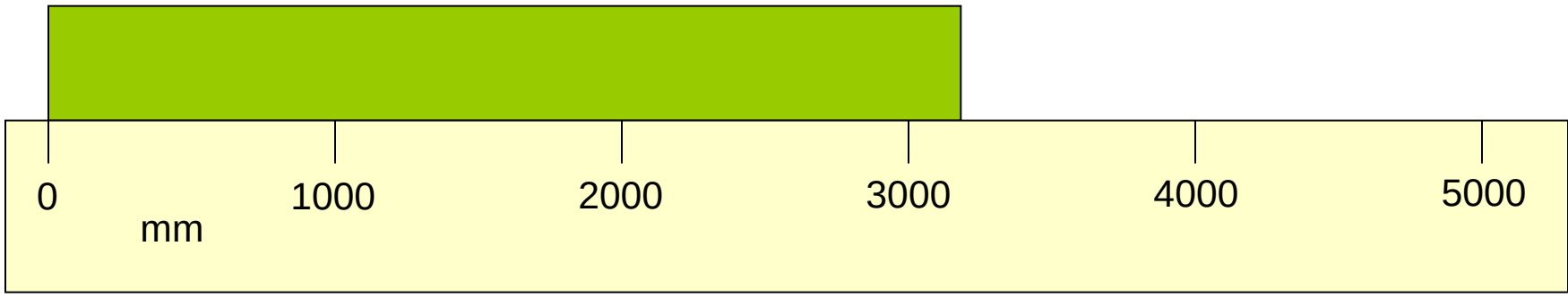
Consider the length of the rectangle below: **3200 mm**. The “3” is definite. The “2” is the guess. So what about the two zeroes at the end? Are they significant?



Significant Figures

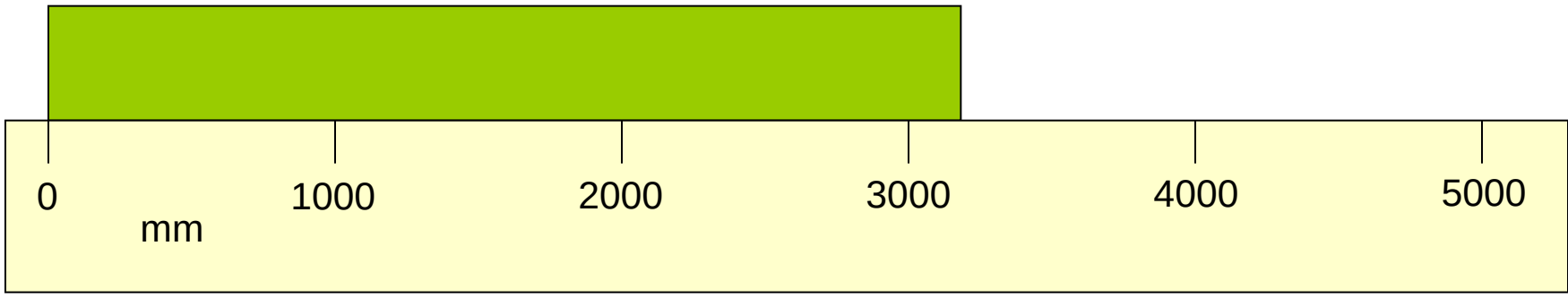
Consider the length of the rectangle below: **3200 mm**. The “3” is definite. The “2” is the guess. So what about the two zeroes at the end? Are they significant?

NO! They are not considered significant.



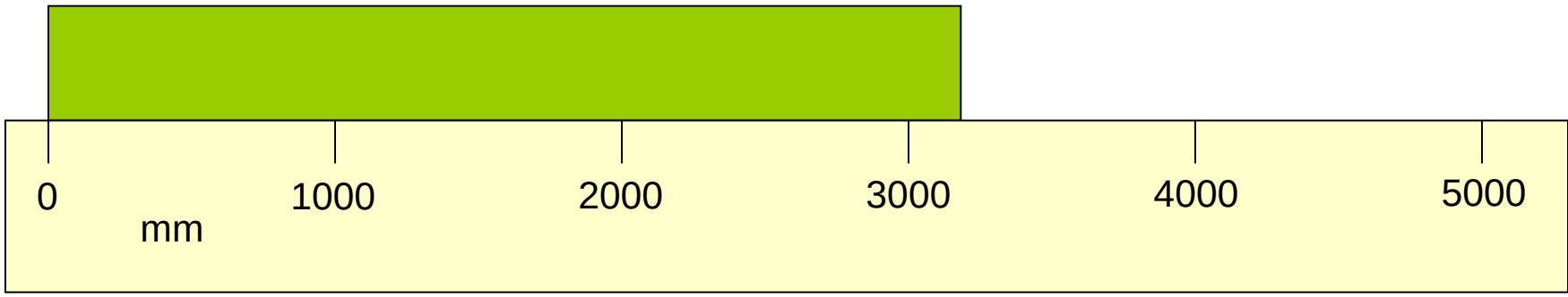
Significant Figures

In **3200 mm**, the zeroes are serving a very different purpose than the “3” and the “2.” These two zeroes are acting as **place-keepers**. They show the size of the measurement -- **3200 mm**, not just **32 mm** – but they do not make the measurement any more precise.



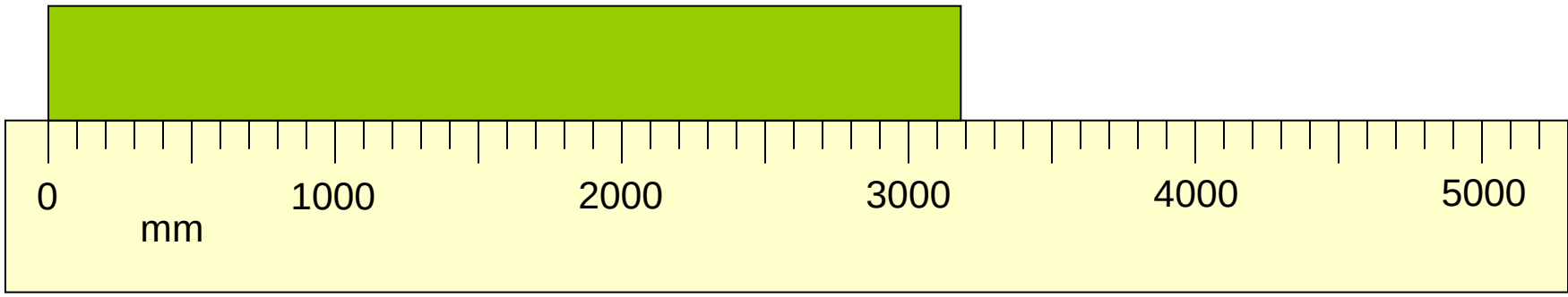
Significant Figures

Thus **3200 mm** has just two significant figures, not four.



Significant Figures

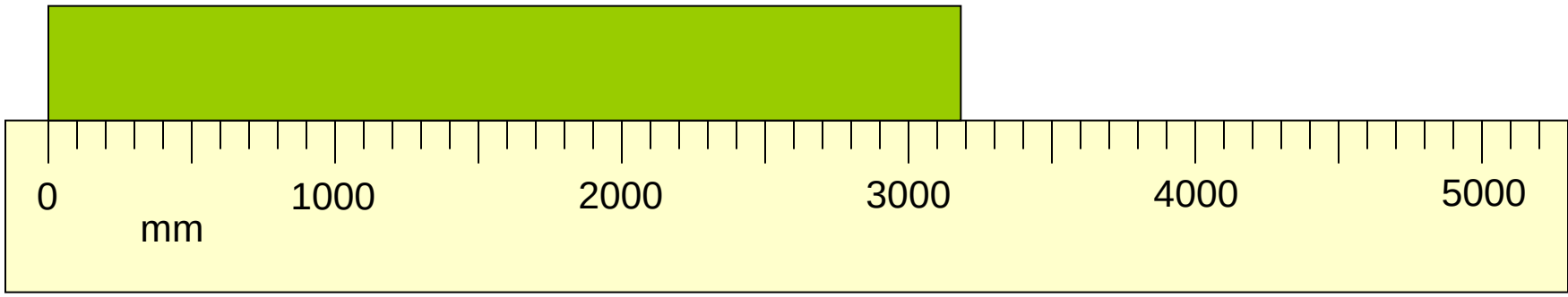
Now consider the measurement below: **3190 mm.** How many significant figures does it have? (Make a guess before continuing.)



Significant Figures

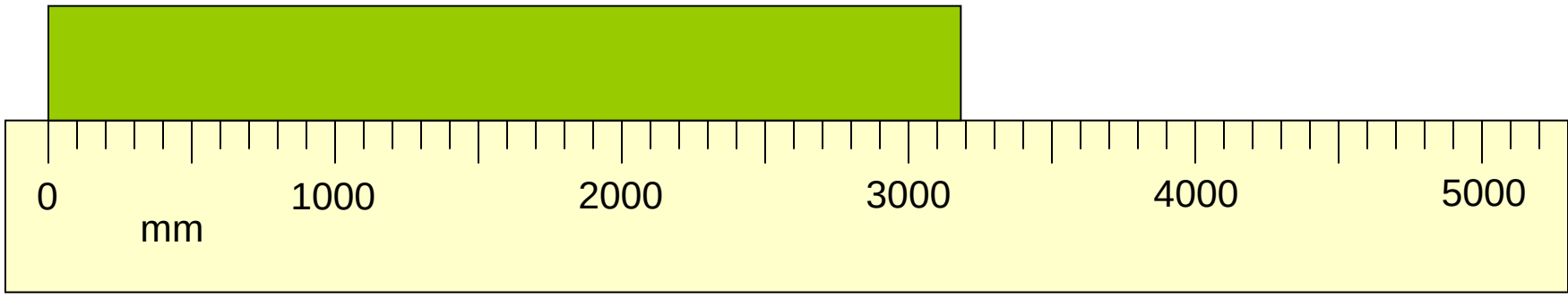
Now consider the measurement below: **3190 mm.** How many significant figures does it have? (Make a guess before continuing.)

If you said three, you are correct!



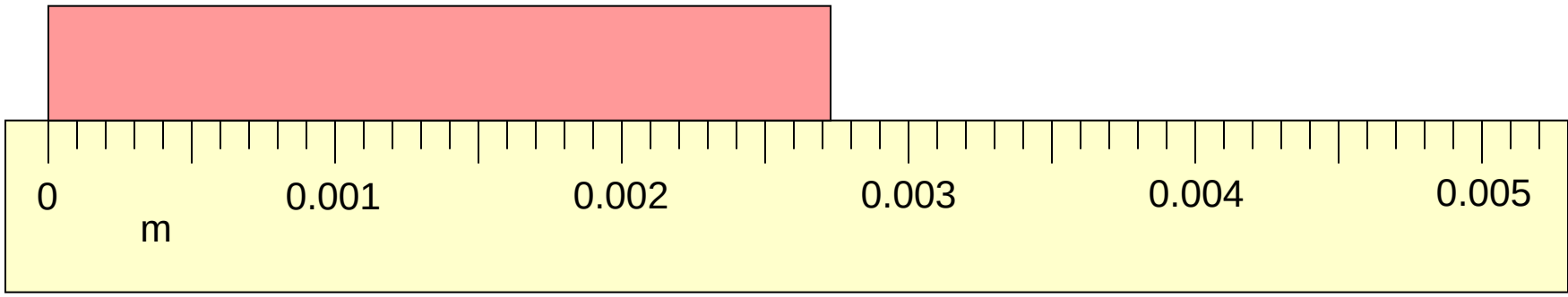
Significant Figures

In **3190 mm**, the “3” and “1” are definite and the “9” is the guess, so those are the three significant figures. The zero at the end is a place-keeping zero, and so it is not considered to be significant.



Significant Figures

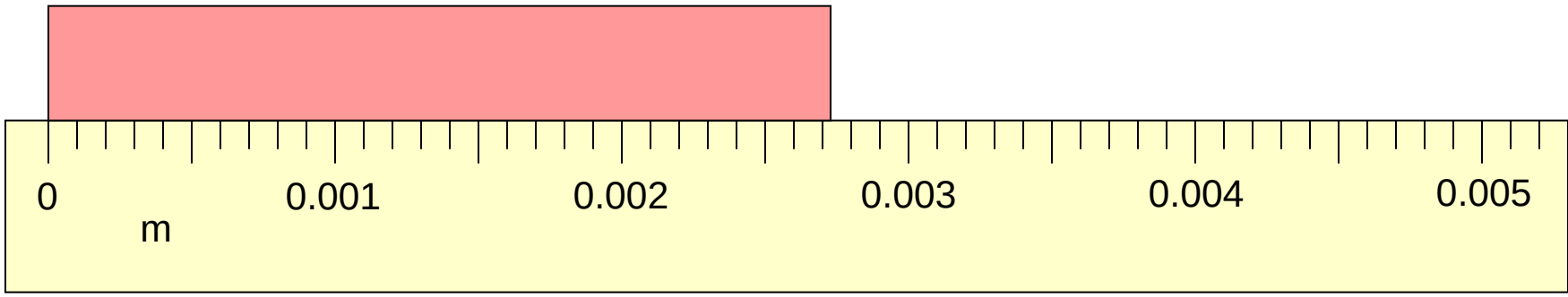
Now what about the measurement below: **0.00273 m**? How many significant figures do you think it has? (Make a guess before continuing.)



Significant Figures

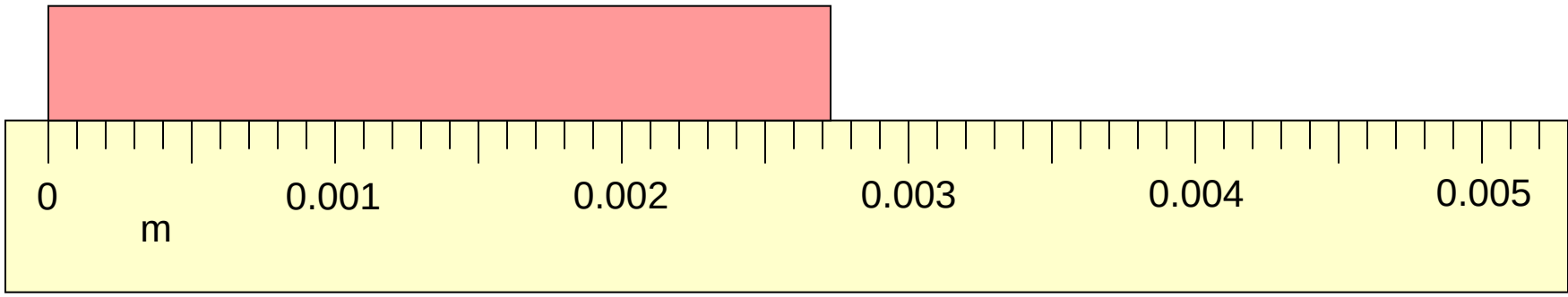
Now what about the measurement below: **0.00273 m**? How many significant figures do you think it has? (Make a guess before continuing.)

If you said three, good job.



Significant Figures

In **0.00273 m**, the “2” and “7” are definite and the “3” is the guess. Here the zeroes in the beginning of the number are place keepers. They make **0.00**273 a small number, just as the zeroes in 32**00** make it a big number.



Significant Figures

If you are good at converting numbers into scientific notation then this will help:

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170,000,000,000 converts into 1.7×10^{11}.

Significant Figures

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170,000,000,000 converts into 1.7×10^{11}.

And 0.00000563 converts into 5.63×10^{-6}.

Significant Figures

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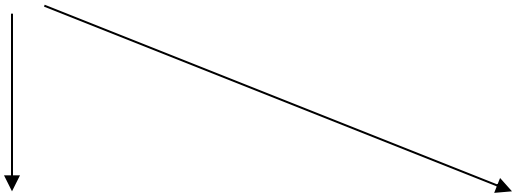
170,000,000,000 converts into 1.7×10^{11}.

And 0.00000563 converts into 5.63×10^{-6}.

Notice how scientific notation separates out all the significant figures and puts them in the beginning…



1.7×10^{11} 5.63×10^{-6}

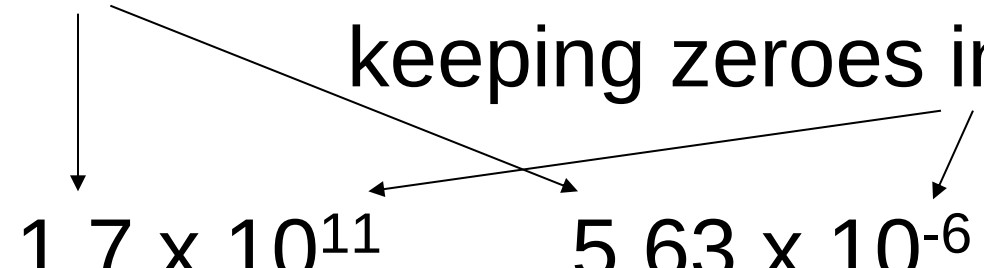
Significant Figures

If you are good at converting numbers into scientific notation then this will help:

170,000,000,000 converts into 1.7×10^{11}.

And 0.00000563 converts into 5.63×10^{-6}.

Notice how scientific notation separates out all the significant figures and puts them in the beginning…and it changes all the place-keeping zeroes into a power of ten



Significant Figures

3200 has two significant figures,

0.00273 has three significant figures.

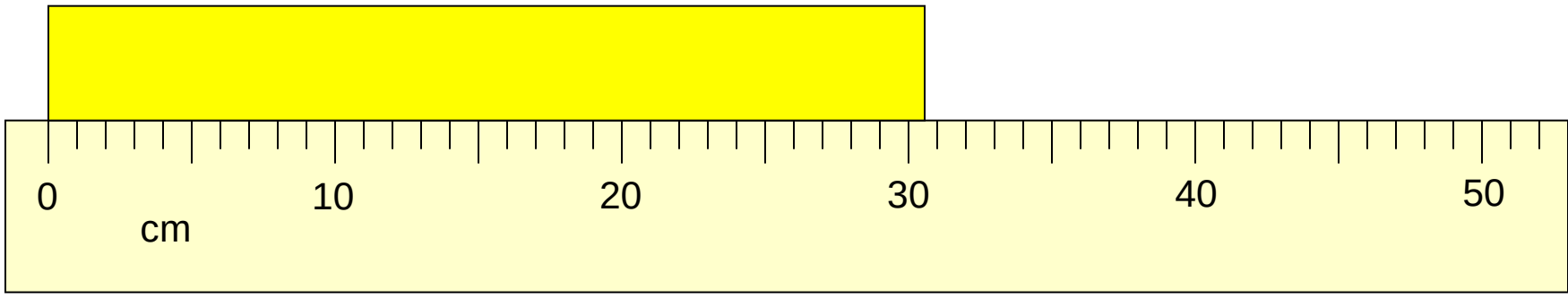
6000000 has just one significant figure.

You might start to think that zeroes are never significant, but that is not always the case…

Significant Figures

Consider the measurement shown below:

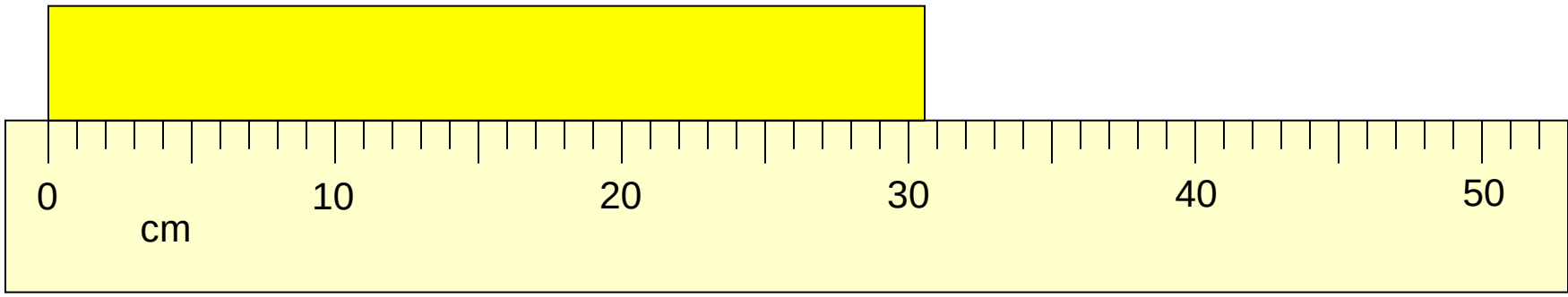
30.6 cm.



Significant Figures

Consider the measurement shown below:

30.6 cm. Here the zero is one of the significant figures: the “3” and the “0” are definite, and the “6” is the guess.

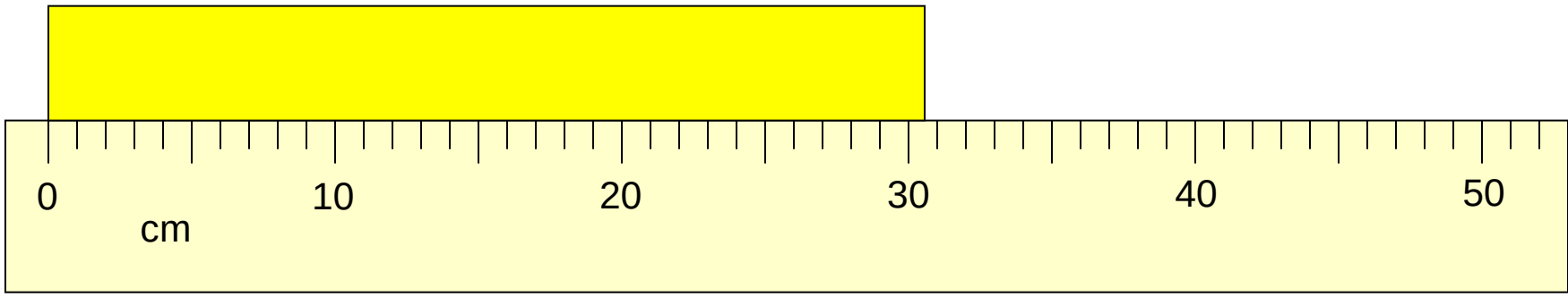


Significant Figures

Consider the measurement shown below:

30.6 cm. Here the zero is one of the significant figures: the “3” and the “0” are definite, and the “6” is the guess.

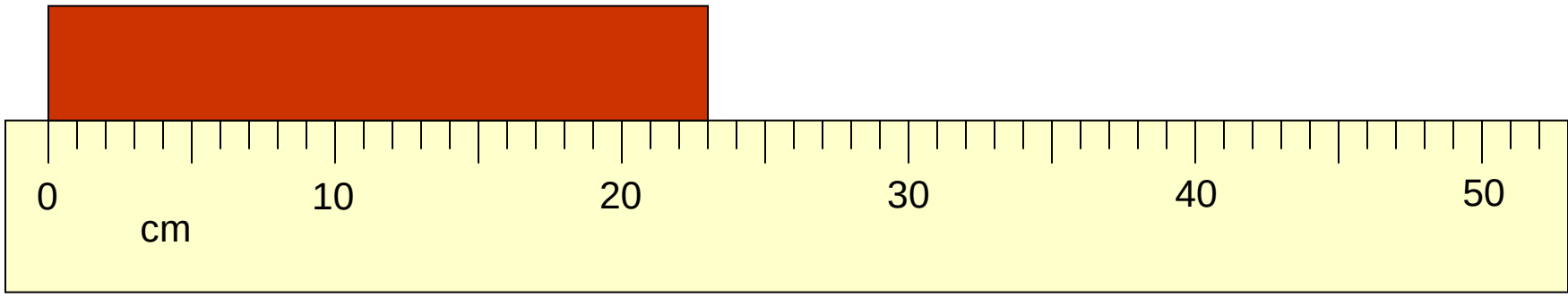
30.6 cm has **three** significant figures.



Significant Figures

And consider the measurement shown below:

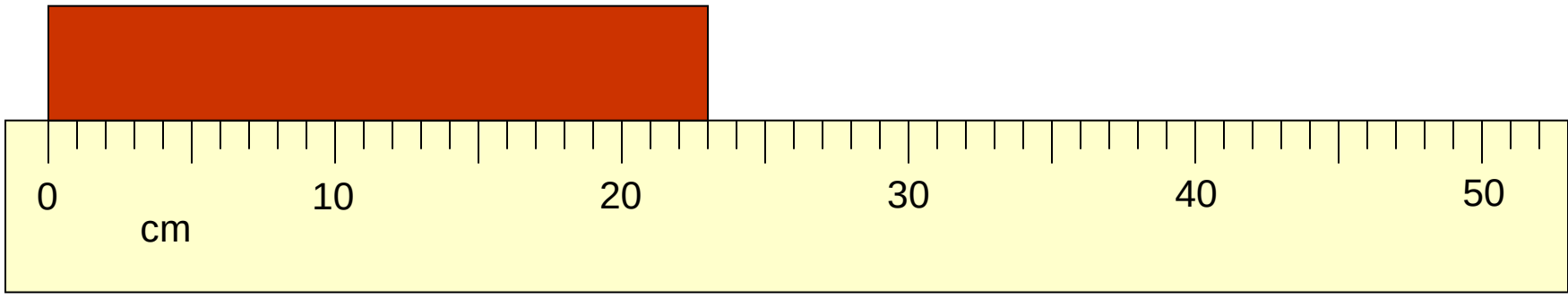
23.0 cm.



Significant Figures

And consider the measurement shown below:

23.0 cm. Here the zero is also one of the significant figures: the “2” and the “3” are definite, and this time the “0” is the guess.

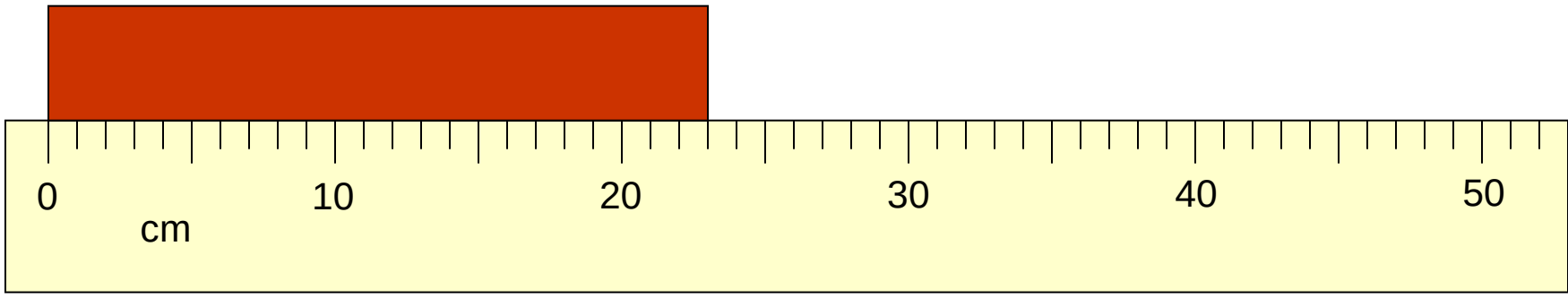


Significant Figures

And consider the measurement shown below:

23.0 cm. Here the zero is also one of the significant figures: the “2” and the “3” are definite, and this time the “0” is the guess.

23.0 cm has **three** significant figures.

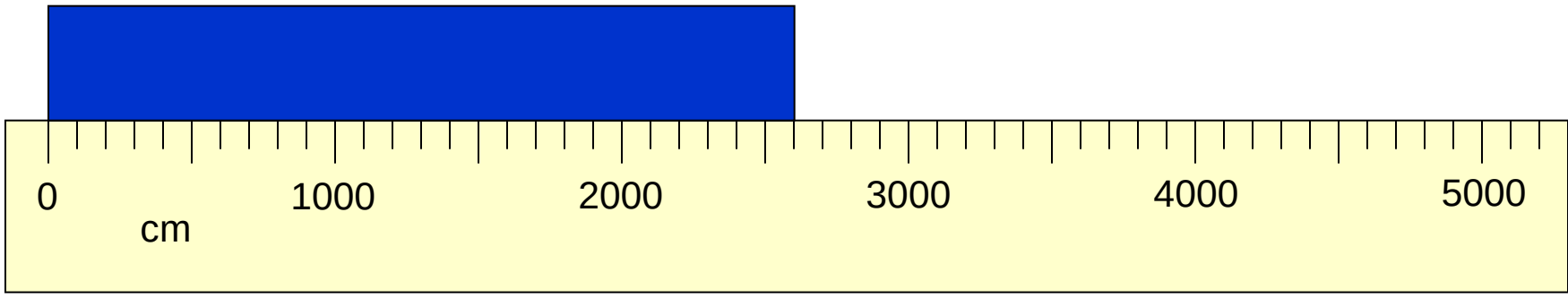


Significant Figures

Sometimes a tricky situation occurs in which a zero looks like its in a place-keeping position, but we intend to have it be a guess.

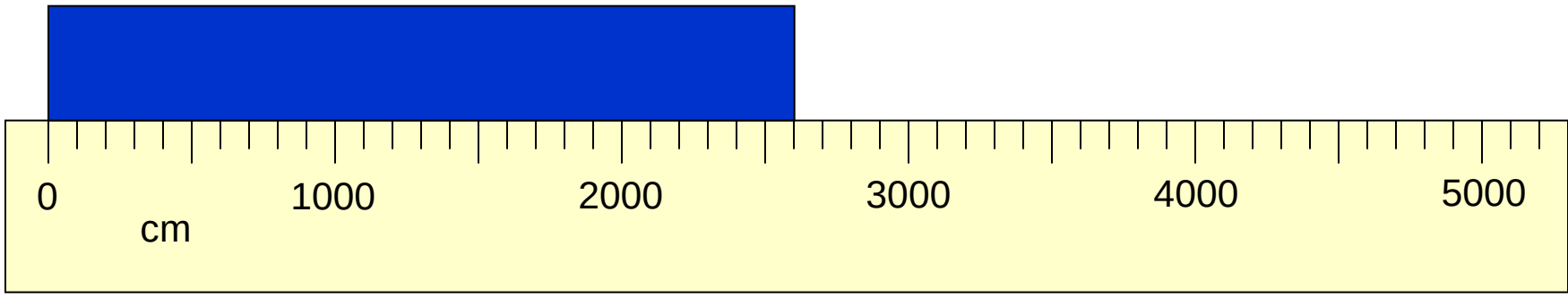
Significant Figures

Sometimes a tricky situation occurs in which a zero looks like its in a place-keeping position, but we intend to have it be a guess. Consider the measurement below: **2600 cm.**



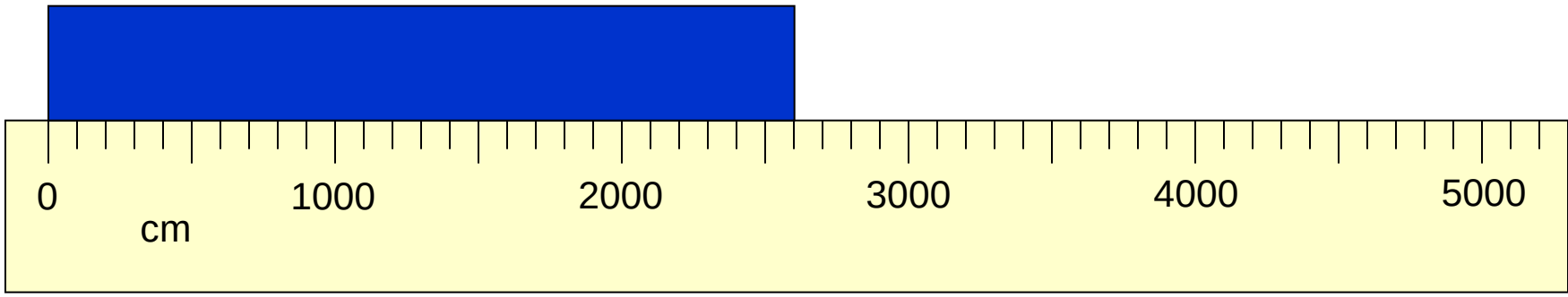
Significant Figures

But if we write it simply as **2600 cm**, it appears to have only two significant figures: the “2” being definite and the “6” being the guess.



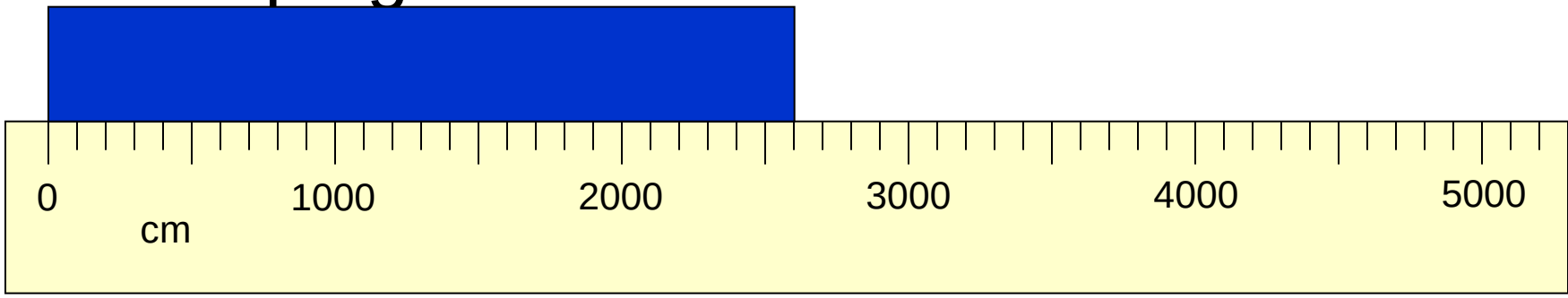
Significant Figures

But if we write it simply as **2600 cm**, it appears to have only two significant figures: the “2” being definite and the “6” being the guess. But the guess is supposed to be first “0” following the “6.”



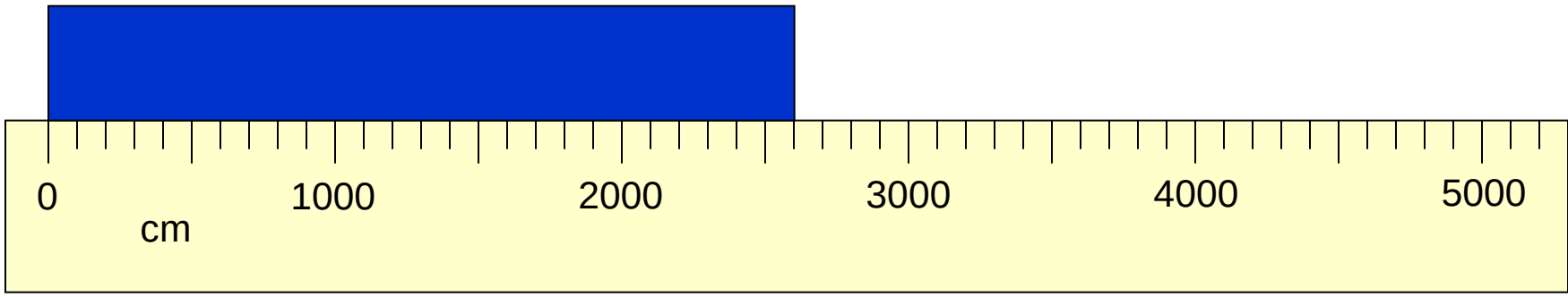
Significant Figures

But if we write it simply as **2600 cm**, it appears to have only two significant figures: the “2” being definite and the “6” being the guess. But the guess is supposed to be first “0” following the “6.” How do we make that zero look significant and not appear to be a place keeping zero?



Significant Figures

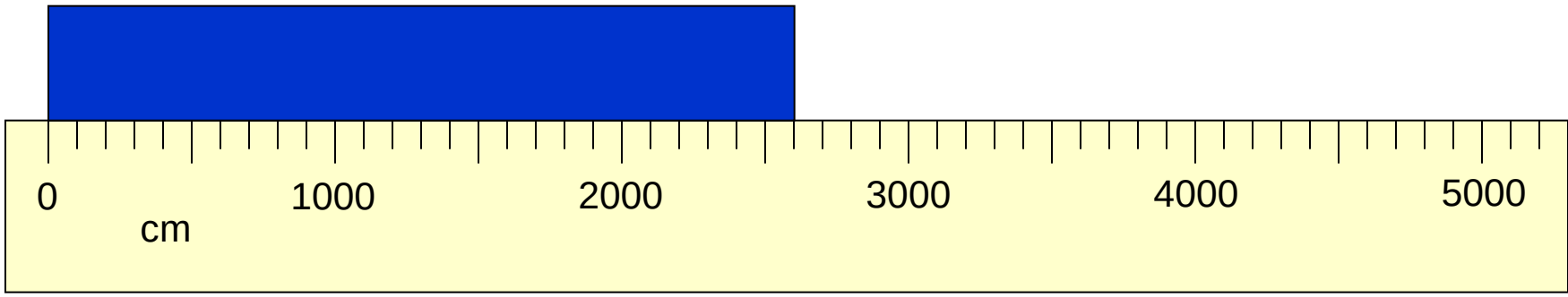
By placing a line over it: **26$\bar{0}$0 cm**.



Significant Figures

By placing a line over it: **$26\bar{0}0$ cm**.

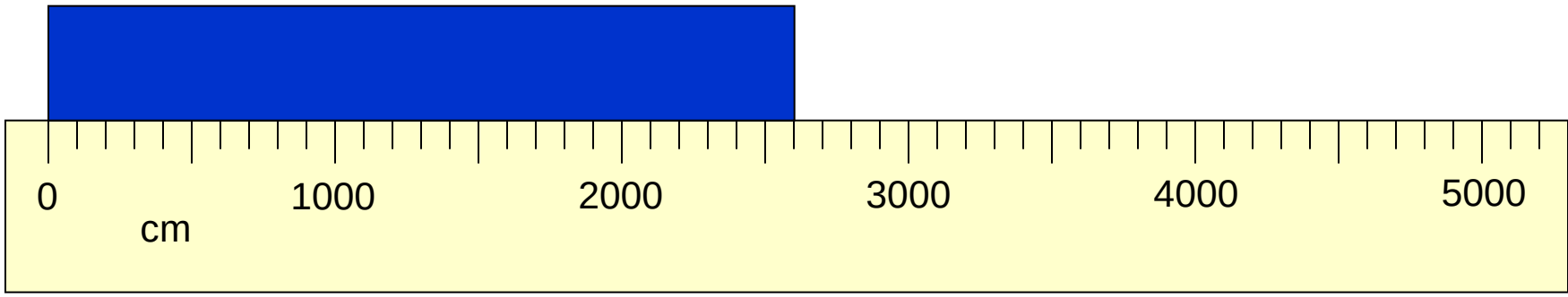
(Sometimes placing a line over a number means that number gets repeated over and over forever: $0.\overline{3} = 0.3333333333\ldots$



Significant Figures

By placing a line over it: **$26\bar{0}0$ cm**.

(Sometimes placing a line over a number means that number gets repeated over and over forever: $0.\overline{3} = 0.3333333333\ldots$ but in $26\overline{0}0$, the line is being used to show that a zero in a place keeping position is actually significant.)



Significant Figures

Now, let's see how much you have learned about significant figures.

What follows are 50 different problems. For each one, simply think of the how many significant figures there are, then go to the next slide to see if you are correct. If you are correct, go on to the next problem. If not, try to figure out why your answer is incorrect.

Significant Figures

34.84 cm

Significant Figures

34.84 cm

4 sig figs

Significant Figures

63 g

Significant Figures

63 g

2 sig figs

Significant Figures

109 m

Significant Figures

109 m

3 sig figs

Significant Figures

17.03 cm

Significant Figures

17.03 cm

4 sig figs

Significant Figures

290 mm

Significant Figures

290 mm

2 sig figs

Significant Figures

0.00037 s

Significant Figures

0.00037 s

2 sig figs

Significant Figures

0.00405 kg

Significant Figures

0.00405 kg

3 sig figs

Significant Figures

70400 mL

Significant Figures

70400 mL

3 sig figs

Significant Figures

0.03040 L

Significant Figures

0.03040 L

4 sig figs

Significant Figures

33.0 J

Significant Figures

33.0 J

3 sig figs

Significant Figures

2500.0 cm

Significant Figures

2500.0 cm

5 sig figs

Significant Figures

600 mg

Significant Figures

600 mg

1 sig fig

Significant Figures

$0.0041050\ m^2$

Significant Figures

$0.0041050\ m^2$

5 sig figs

Significant Figures

0.00023 s

Significant Figures

0.00023 s

2 sig figs

Significant Figures

55 mi/hr

Significant Figures

55 mi/hr

2 sig figs

Significant Figures

$1400\ g$

Significant Figures

$14\bar{0}0$ g

3 sig figs

Significant Figures

$1400\bar{0}$ g

Significant Figures

$1400\bar{0}$ g

4 sig figs

Significant Figures

5.62×10^{7} mm

Significant Figures

5.62×10^{7} mm

3 sig figs

Significant Figures

8×10^{-4} g

Significant Figures

8×10^{-4} g

1 sig fig

Significant Figures

3.0×10^{14} atoms

Significant Figures

3.0×10^{14} atoms

2 sig figs

Significant Figures

0.03050 L

Significant Figures

0.03050 L

4 sig figs

Significant Figures

4050 g

Significant Figures

4050 g

3 sig figs

Significant Figures

0.0360 g/mL

Significant Figures

0.0360 g/mL

3 sig figs

Significant Figures

41,000 mm

Significant Figures

41,000 mm

2 sig figs

Significant Figures

41,0$\bar{0}\bar{0}$0 mm

Significant Figures

41,0$\bar{0}$0 mm

4 sig figs

Significant Figures

25.0 ^{o}C

Significant Figures

25.0 ºC

3 sig figs

Significant Figures

3.00×10^4 ms

Significant Figures

3.00×10^4 ms

3 sig figs

Significant Figures

5×10^{-7} K

Significant Figures

5×10^{-7} K

1 sig fig

Significant Figures

0.0000401 L

Significant Figures

0.0000401 L

3 sig figs

Significant Figures

$30200\ cm^3$

Significant Figures

$30200\ cm^3$

3 sig figs

Significant Figures

$30\underline{2}\underline{0}0\ cm^3$

Significant Figures

$30\underline{2}\underline{0}0\ cm^3$

4 sig figs

Significant Figures

210.4 cg

Significant Figures

210.4 cg

4 sig figs

Significant Figures

340 km

Significant Figures

340 km

2 sig figs

Significant Figures

340.0 km

Significant Figures

340.0 km

4 sig figs

Significant Figures

0.500 Hz

Significant Figures

0.500 Hz

3 sig figs

Significant Figures

0.0050400 m

Significant Figures

0.0050400 m

5 sig figs

Significant Figures

50,400 m

Significant Figures

50,400 m

3 sig figs

Significant Figures

23,000 cm

Significant Figures

23,000 cm

2 sig figs

Significant Figures

23.000 cm

Significant Figures

23.000 cm

5 sig figs

Significant Figures

1,000,000 mi

Significant Figures

1,000,000 mi

1 sig fig

Significant Figures

1,000,001 mi

Significant Figures

1,000,001 mi

7 sig figs

Significant Figures

0.30 mL

Significant Figures

0.30 mL

2 sig figs

Significant Figures

4.00×10^3 g

Significant Figures

4.00×10^3 g

3 sig figs

Significant Figures

0.0998 s

Significant Figures

0.0998 s

3 sig figs

Significant Figures

14,3$\bar{0}$0 s

Significant Figures

$14{,}3\bar{0}0$ s

4 sig figs

Significant Figures

530 m

Significant Figures

530 m

2 sig figs

Significant Figures

7 km

Significant Figures

7 km

1 sig fig

Significant Figures

400 kg

Significant Figures

400 kg

1 sig fig

Significant Figures

$0.0032\ m^3$

Significant Figures

$0.0032\ m^3$

2 sig figs

Significant Figures

7060 g/L

Significant Figures

7060 g/L

3 sig figs

Significant Figures

So… How did you do? With more practice, you should be able to zip through those fifty problems with no mistakes!

Significant Figures

Although you have not been given any specific rules about whether or not a digit in a number is significant or not, see if you can figure out those rules for yourself:

(write your list of rules in your notebook.)

Significant Figures

Although you have not been given any specific rules about whether or not a digit in a number is significant or not, see if you can figure out those rules for yourself:

(write your list of rules in your notebook.)

For example, what about nonzero digits (like 2 or 7): when are they significant?

Significant Figures

Although you have not been given any specific rules about whether or not a digit in a number is significant or not, see if you can figure out those rules for yourself:

(write your list of rules in your notebook.)

For example, what about nonzero digits (like 2 or 7): when are they significant? And what about zeroes: when are they significant?

Significant Figures

When you have finished your list, make sure it covers all cases: zeroes in the beginning of numbers, in the middle and at the end… with decimal points and without…. with lines and without…scientific notation…

Significant Figures

When you have finished your list, make sure it covers all cases: zeroes in the beginning of numbers, in the middle and at the end… with decimal points and without…. with lines and without…scientific notation…

Then compare your set of rules to the ones that follow:

Significant Figures

Here is one way to represent the rules for significant figures:

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

If they are at the beginning (0.005), they are **never** significant.

(so 0.005 has one significant figures)

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

If they are at the beginning (0.005), they are **never** significant.

(so 0.005 has one significant figures)

If they are in the middle (1207), they are **always** significant.

(so 1207 has four significant figures)

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

If they are at the beginning (0.005), they are **never** significant.

(so 0.005 has one significant figures)

If they are in the middle (1207), they are **always** significant.

(so 1207 has four significant figures)

And if they are at the end, they are **sometimes** significant.

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

If they are at the beginning (0.005), they are **never** significant.

(so 0.005 has one significant figures)

If they are in the middle (1207), they are **always** significant.

(so 1207 has four significant figures)

And if they are at the end, they are **sometimes** significant.

If there is a decimal point (21.600) they are significant.

(so 21.600 has five significant figures)

Significant Figures

Here is one way to represent the rules for significant figures:

Nonzero digits (26.3) are **always** significant.

(so 26.3 has three significant figures)

Zeroes occur in three different places in a number:

If they are at the beginning (0.005), they are **never** significant.

(so 0.005 has one significant figures)

If they are in the middle (1207), they are **always** significant.

(so 1207 has four significant figures)

And if they are at the end, they are **sometimes** significant.

If there is a decimal point (21.600) they are significant.

(so 21.600 has five significant figures)

If there is no decimal point (21600), they are not significant.

(so 21600 has three significant figures)

Significant Figures

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As for scientific notation (3.40×10^6), it follows these same rules if you just ignore the "times ten to the whatever power." Or, simply put, every digit to the left of the times sign is automatically significant.

So 3.40×10^6 has three significant figures.