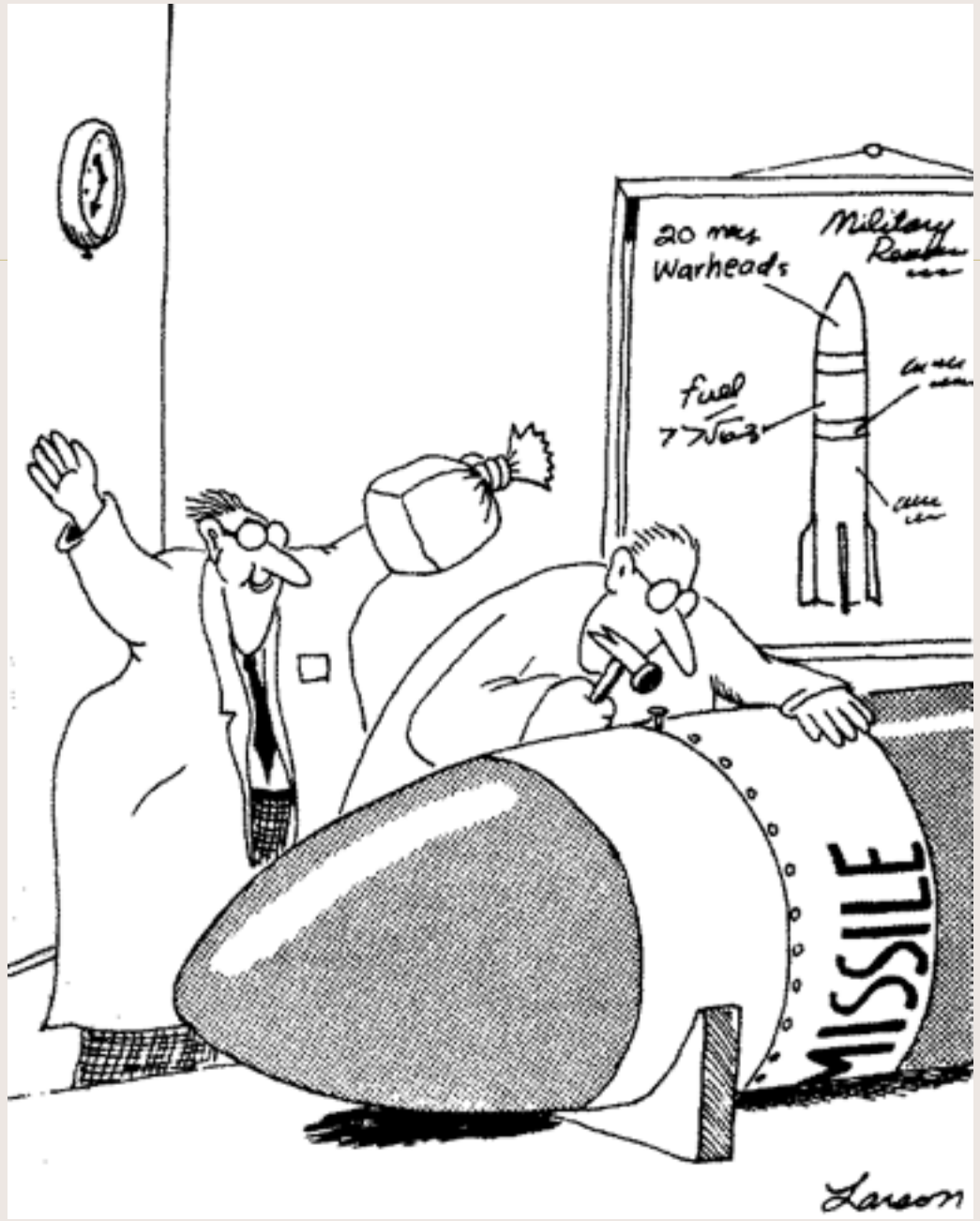
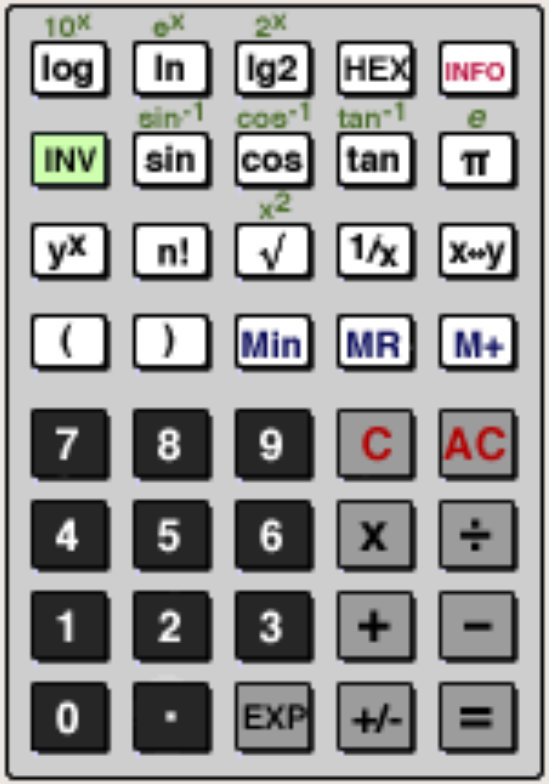
Scientific Notation
Significant Figures


20 mgs
Warheads
Military
fuel
MISSILE
Larson

Scientific Notation

- A shorthand method of displaying very large (distance to the sun) or very small numbers (lengths of atoms).
- Consists of a coefficient, a base 10, and an exponent
- e.g. 3.95×10^3
- The coefficient must be between 1 and 10 or it is not in scientific notation.
- If the exponent is positive (such as above), the number will be large (greater than 1).
- If the exponent is negative, the number will be small (less than 1).

How to do Sci Not. On the Calc.



Express in Scientific Notation

- E.g. $3756 = ?$
- $3756 = 3.756 \times 10^{3}$
- $0.000493 = ?$
- $0.000493 = 4.93 \times 10^{-4}$

Express in Standard Notation

- E.g. $5.21 \times 10^4 =$

The exponent is positive, so make the coefficient a large number (move the decimal to the right)

$5.21 \times 10^4 = 52100$

- 2.694×10^{-5}

The exponent is negative, so make the coefficient a small number (move decimal to the left).

$2.694 \times 10^{-5} = 0.00002694$

Practice

- Put in scientific notation
- 1. 8720000 =
- 2. 0.0000513 =
- 3. 5302 =
- 4. 0.00117 =
- Put in standard notation
- 5. $7.03 \times 10^{-2} =$
- 6. $1.38 \times 10^{4} =$
- 7. $3.99 \times 10^{-5} =$
- 8. $2.781 \times 10^{7} =$

Practice - Answers

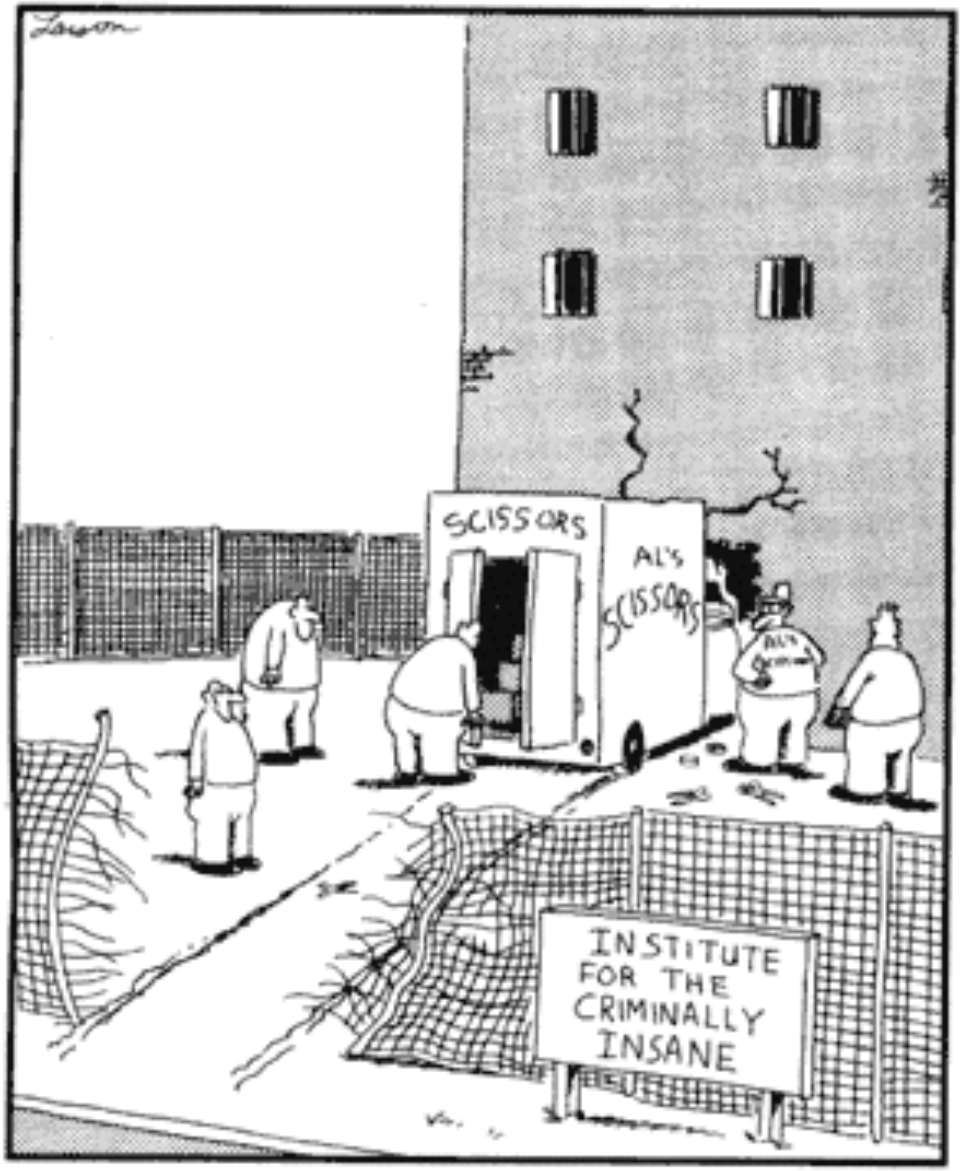
- 1. $8720000 = 8.72 \times 10^{6}$
- 2. $0.0000513 = 5.13 \times 10^{-5}$
- 3. $5302 = 5.302 \times 10^{3}$
- 4. $0.00117 = 1.17 \times 10^{-3}$
- 5. $7.03 \times 10^{-2} = 0.0703$
- 6. $1.38 \times 10^{4} = 13800$
- 7. $3.99 \times 10^{-5} = 0.0000399$
- 8. $2.781 \times 10^{7} = 27810000$

Write as Correct Scientific Notation

- 1. $34.79 \times 10^{3} =$
- 2. $0.497 \times 10^{6} =$
- 3. $19.5 \times 10^{-2} =$
- 4. $0.837 \times 10^{-4} =$

Write as Correct Scientific Notation - Answers

- 1. $34.79 \times 10^{3} = 3.479 \times 10^{4}$
- 2. $0.497 \times 10^{6} = 4.97 \times 10^{5}$
- 3. $19.5 \times 10^{-2} = 1.95 \times 10^{-1}$
- 4. $0.837 \times 10^{-4} = 8.37 \times 10^{-5}$

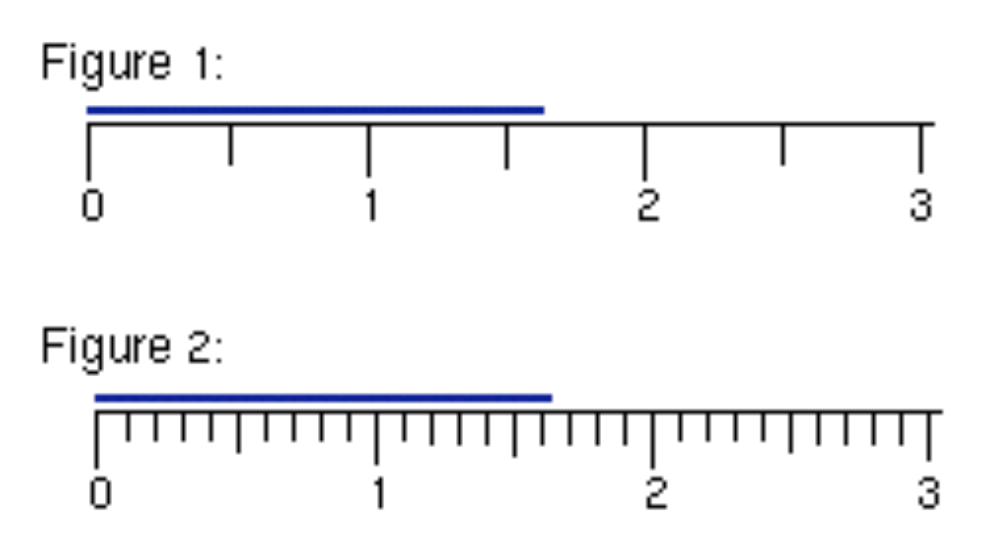


And then Al realized his problems were much bigger than just a smashed truck.

Significant Figures

- When counting objects we can find an exact number
  - eg numbers of students in class
- When measuring quantities there is usually some amount of uncertainty in the number
  - eg length of classroom, mass of person
- We need to have an idea of which digits are meaningful and which are not

How long is each line?



In Figure 1, the line is 1.6cm, therefore 2 s.f.

In Figure 2, the line is 1.63cm (or 1.62 or 1.64), so 3 s.f.

The number of sig figs consists of certain digits + one uncertain (educated guess) digit.

The precision of the measuring device determines the number of sig figs. Fig. 2 has a higher precision

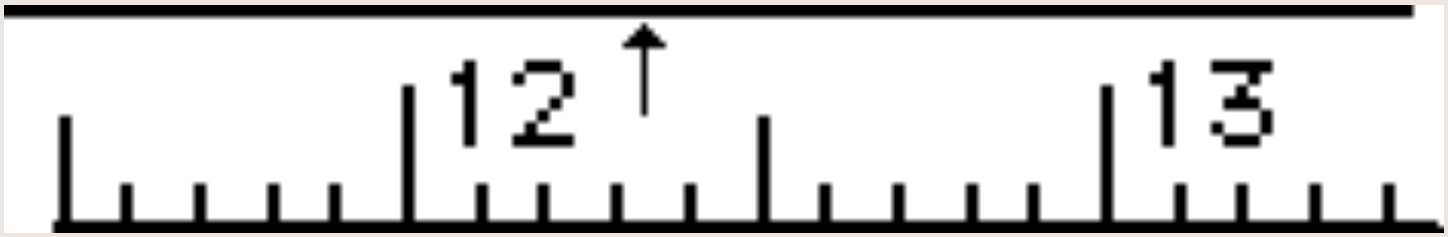
A measurement of 1.635725cm for either ruler would be nonsense.

Significant Figures

- A significant figure (or significant digit) is a measured or meaningful digit.
- Significant figures (or “Sig fig’s”) are the digits known to be exact plus one more that may have some uncertainty but is an educated guess
- The following examples show how many digits can be determined in different cases.

- On the centimetre ruler above we know the length at the arrow is between 2 cm and 3 cm
- If the smaller divisions are 0.1 cm we know the length is between 2.8 cm and 2.9 cm
- We can't read another digit, but we can estimate how many tenths of a division past 2.8 to the arrow
- We can estimate 2 tenths of a division which gives a measurement of 2.82 cm

- We state the measurement as 2.82 cm.
- We are certain about the first 2 digits and have some certainty about the third
- eg - we know the third digit is not 0 or 9, (but it might be 1 or 3)
- This measurement has 3 sig figs
- We cannot give the measurement of 2.8275 because we cannot be that exact with this ruler



- More than 12, less than 13
- More than 12.3, less than 12.4
- Estimated length = 12.33 cm
- (4 significant figures)
- Note it could also be estimated as 12.32 cm or 12.34 cm - be as accurate as you can
- Any of these last 3 would be an acceptable measurement

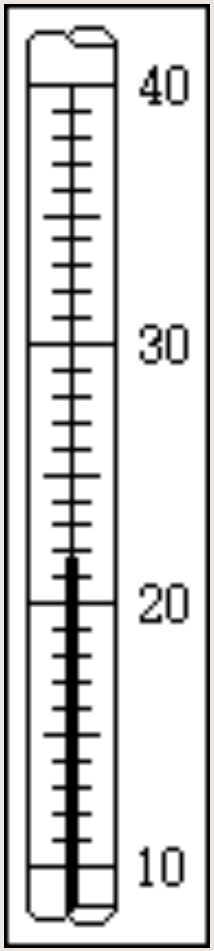
Length is between 4 and 5 cm. Arrow is right at the 0.5cm mark

Our guess digit will be a 0 as the measurement is right on the line.

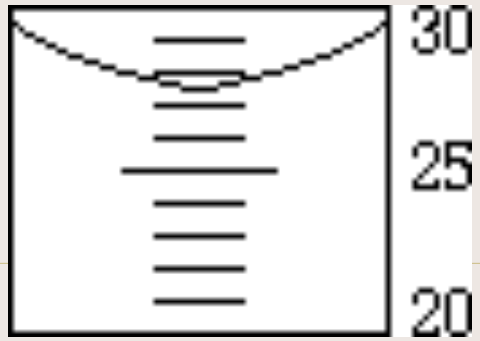
Length can be reported as 4.50 cm. If you can be certain about adding a zero, DO IT!

We know it is not 4.48 cm or 4.53 cm, but it could be 4.51 cm - some uncertainty (but probably not!)

How many degrees Celsius?

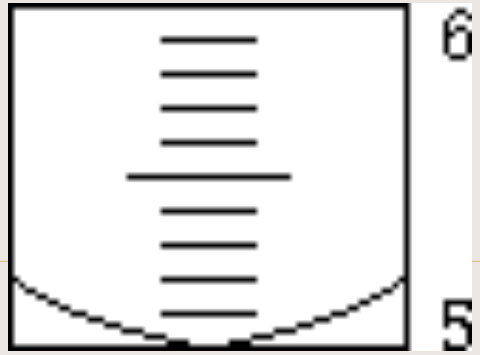


- Decide what each marked division represents
- Estimate between marked divisions
- Estimated temperature
  - Between 21 and 22 degrees C
  - Best estimate 21.8 degrees C
  - 3 sig figs



Graduated Cylinder

- Estimated volume is between 20 and 30 mL (read at bottom of meniscus curve)
- Large division is 5 mL, each small one is 1 mL
- Estimate between 27 and 28 mL
- Volume = 27.5 mL
- 3 sig figs



Graduated Cylinder

- Large division is 0.5 mL, each small one is 0.1 mL
- Volume is 5 ml, but we know it more precisely. We can read 5.0 using marked divisions and estimate one more decimal place
- Volume = 5.00 mL (3 sig figs)

Rules for Significant Figures

- A) all non zero digits are significant
- B) zero's are significant if:
  - They are at at the end of a number if decimal point is shown. i.e. 2.50 (3 sig figs)
  - They are enclosed by non-zero numbers.

    i.e. 2002 (4 sig figs)
- C) zeros that hold place value only are not significant. i.e. 100 (1 sig fig)
- OR zeros leading off a number

Examples

- 34.500
- 5 significant figures
- 0.0087
- 2 significant figures
- 3507
- 4 significant figures
- 1500
- 2 significant figures

Trailing Zeros Exception

- 61000 2 sig figs (zeros are not significant)
- What if you want 100 to have three sig figs?
- Use scientific notation…1.00×10^2
- Sig figs for scientific notation:
- The number of digits in the coefficient IS the number of sig figs!

Same number
Different Sig. Figs.

- 1200
- 1200.0
- 1.2×10^3
- 1.20×10^3
- 1.200×10^3

Same number Different Sig. Figs.

- 1200 2 sig figs (zeros not significant)
- 1200.0 5 sig figs
- (Note 1200. Is not legal usage - if decimal is written a digit must follow it)
- 1.2×10^3 2 sig figs
- 1.20×10^2 3 sig figs

Perfect Numbers

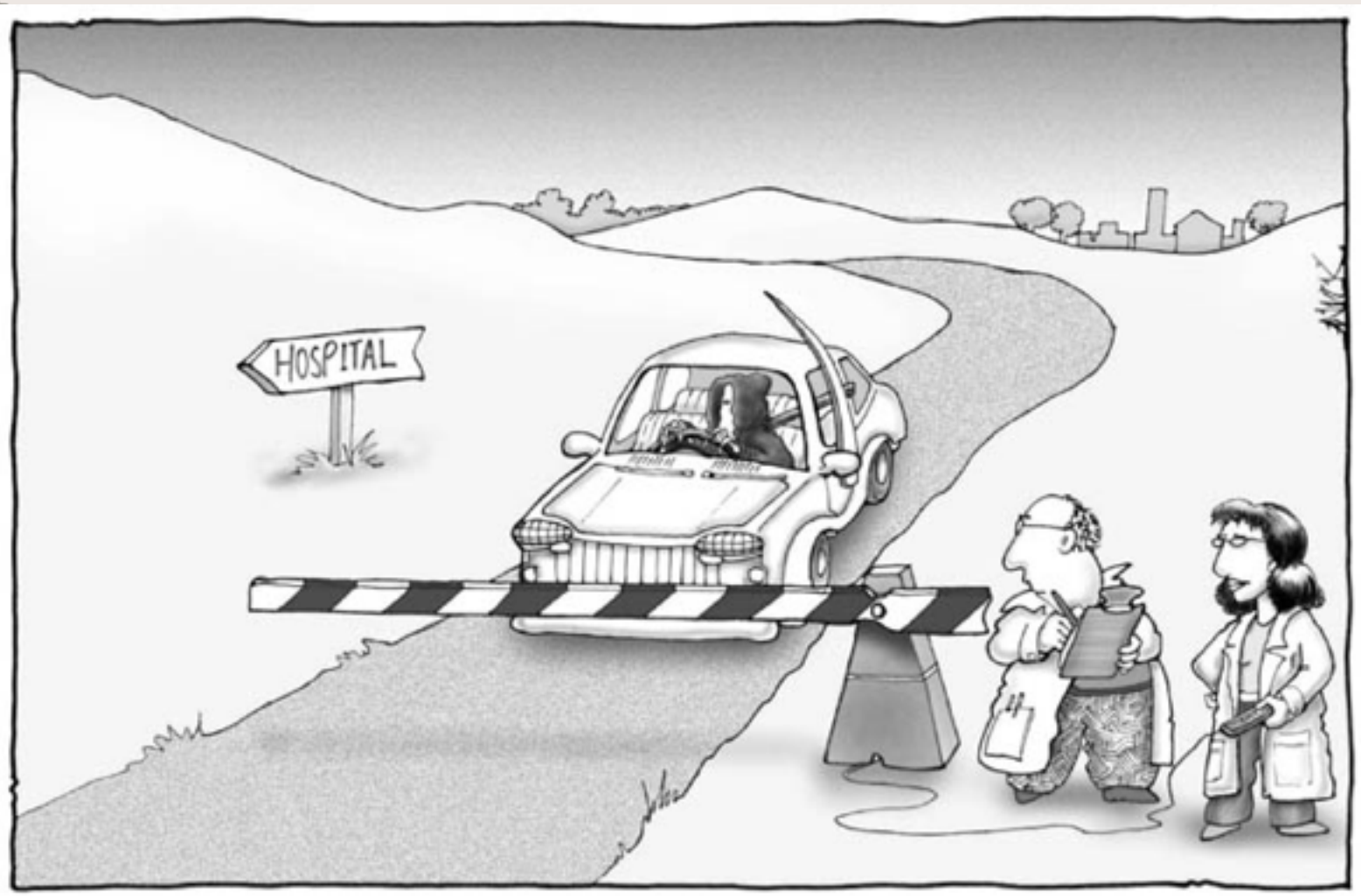
- Counting numbers or defined values are considered to be exact or perfect numbers and are exempt from rules of sig. figs.

Practice - How many Sig Figs

- 13.0 mm
- 48.07 g
- 0.050 cm
- 1001 L
- 5 students
- 15000 g
- 1 L = 1000 mL
- 3.00×10^{-3}

Practice - How many Sig Figs

- 13.0 mm — 3 sig figs
- 48.07 g — 4 sig figs
- 0.050cm — 2 sig figs
- 1001 L — 4 sig figs
- 5 students — perfect number
- 15000 g — 2 sig figs
- 1 L = 1000 mL — perfect number
- 3.00×10^{-3} — 3 sig figs



Scientists devise yet another way of delaying death.