Theme 1
Introductory Material

Module T1M2:
The Predictable Universe

T1M2 – Learning Objectives

- Recognize that the presentation of a numerical quantity, using ***significant figures*** and ***scientific notation***, reflects the accuracy of a measurement.
- Carry the appropriate significant figures through simple arithmetic calculations.
- Appreciate the importance of ***estimating unknown quantities*** as a means of understanding a system and predicting outcomes.
- Develop the skill of making an estimate and performing '***order of magnitude' approximations***.

Module Clicker Quiz!

Now that you have had a chance to review module, T1M2, here is your

module quiz!

Module Clicker Quiz!

Significant Figures (120 seconds)

- Using the correct number of significant figures, what is the result of calculation

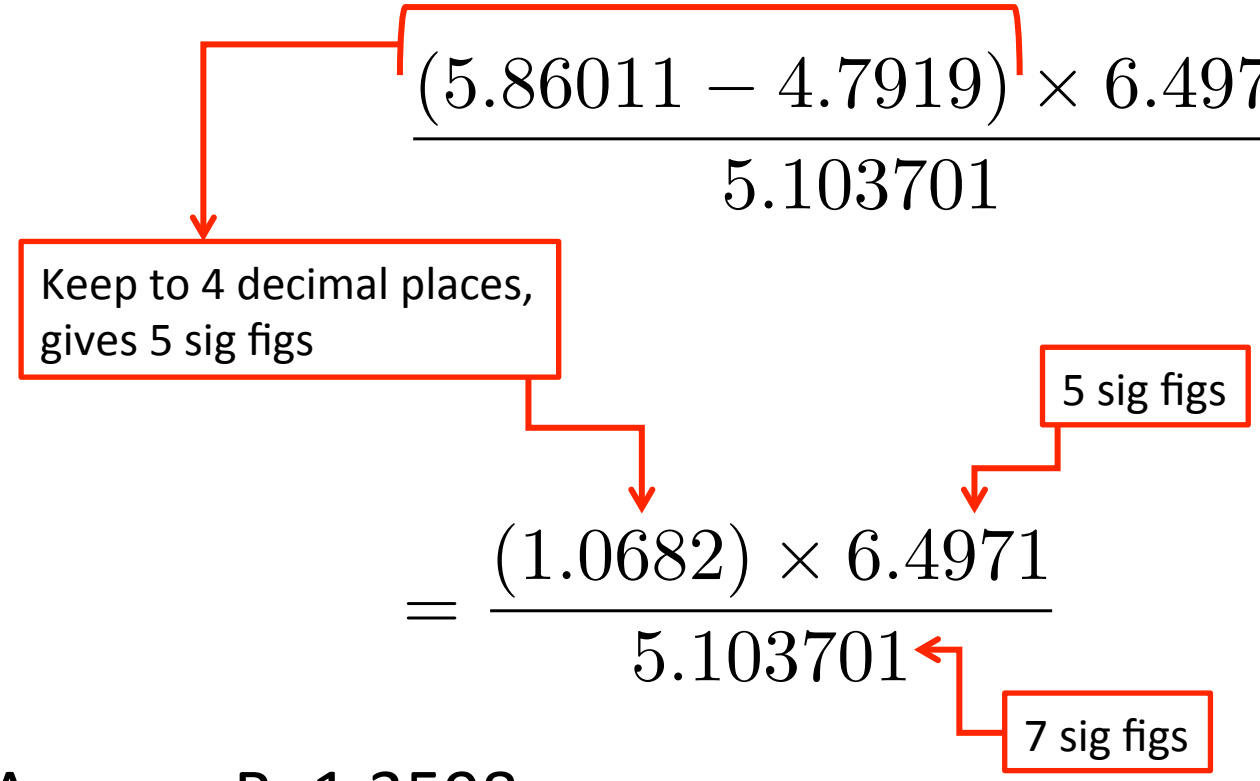
$$\frac{(5.86011 - 4.7919) \times 6.4971}{5.103701}$$

A. 1.360
B. 1.3598
C. 1.35985
D. 1.359650
E. I don't know

Module Clicker Quiz!

Significant Figures (120 seconds)

- Using the correct number of significant figures, what is the result of calculation



Answer B: 1.3598

Estimation – When 'Close' is good enough!

- We don't always need exact values to appreciate a quantity!
- Consider the statement:

  "Within your body there are 2.75×10^{14} ***bacterial cells***"

- It's not "2.75", but 10^{14} that wows us (i.e. order of magnitude)
- Especially when we put it into context:

  "Our bodies only contain 10^{13} of our own cells"

- ***Our* Goals for Estimation**: To develop a logical thought process for estimating values
  - Look at a few techniques and tricks
  - There is no 'one correct way' to estimate!

Mmm... Donuts

How many donuts would it take to cover a soccer pitch?

What kinds of questions do we need to be asking ourselves?

- How big is a soccer pitch?
- How big is a donut?

Mmm... Donuts

How many donuts would it take to cover a soccer pitch?

- How big is a soccer pitch?

$$\sim 100\ \mathrm{m} \times 100\ \mathrm{m}$$
$$= 10^2\ \mathrm{m} \times 10^2\ \mathrm{m} = 10^4\ \mathrm{m}^2$$

- How big is a donut?

$$\sim 10\ \mathrm{cm\ by\ 10\ cm?}$$
$$= (0.1\ \mathrm{m})^2 = (10^{-1}\ \mathrm{m})^2 = 10^{-2}\ \mathrm{m}^2$$

$$\Rightarrow \frac{10^4\ \mathrm{m}^2}{10^{-2}\ \mathrm{m}^2} = 10^6 !!!$$

$$(\mathrm{FIFA\ pitch\ is\ 70\ m\ by\ 100\ m})$$

Clicker Quiz

What is the approximate volume of this room?

A. 10^0 m^3
B. 10^1 m^3
C. 10^2 m^3
D. 10^3 m^3
E. 10^4 m^3

Clicker Quiz

What is the approximate volume of this room?

A. 10^0 m^3
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$$V = W \times L \times H$$

$$\sim (20 \times 30 \times 5)\ \mathrm{m}^3$$

$$\sim 3000\ \mathrm{m}^3 = 3 \times 10^3\ \mathrm{m}^3$$

$$\sim 10^3\ \mathrm{m}^3$$

Put your brain to work!

Estimate the mass of your brain, and the number of cells it contains

What kinds of questions do we need to be asking ourselves?

- What is the volume of your brain?
- How do we go from *volume* to *mass*?
- What is the size of a brain cell?

Put your brain to work!

- What is the volume of your brain?
  - One bag of milk, three cans of coke, two pints of beer?
    - 1 liter = 10 cm x 10 cm x 10 cm
- How do we go from *volume* to *mass*?
  - We are mostly water, density 1 g/cm^3
  - 1 liter → 1 kg
- What is the mass of your brain?
  - 1 bag, about 1 kg, 2 pints of beer about 1 kg, two blocks of butter (1 kg)

Put your brain to work!

- How many cells?
- How big is a cell?
  - Eukaryotic cells vary between 5-100 micrometers (prokaryotic cells are more like 1 micrometer)
  - 1 micrometer = 1 µm = 10^{-6} m
- Cell is 10 µm x 10 µm x 10 µm
  - We *could* calculate the mass assuming the density

$$\text{Number of cells in brain} = \frac{\text{volume of brain}}{\text{volume of cell}}$$

$$\sim \frac{10\ \text{cm} \times 10\ \text{cm} \times 10\ \text{cm}}{10\mu\text{m} \times 10\mu\text{m} \times 10\mu\text{m}} = \frac{(10\ \text{cm})^3}{(10\mu\text{m})^3}$$

$$\sim \frac{(10 \times 10^{-2}\ \text{m})^3}{(10 \times 10^{-6}\ \text{m})^3} = \frac{(10^{-1}\ \text{m})^3}{(10^{-5}\ \text{m})^3} = \left(\frac{10^{-1}}{10^{-5}}\right)^3 = (10^4)^3$$

$$10^{12} \text{ cells in your brain!!!!!!!!}$$

Tim Hortons

How many Tim Hortons coffees do we go through in a year?

What kinds of questions do we need to be asking ourselves?

- How many people are there in Canada?
- How much coffee does the average Canadian drink in a day?
- How much of that coffee is Tim's?

Suppose we stacked all of our cups – how tall of a stack would that be?

Tim Hortons

What is the population of Canada? $\sim 35 \times 10^6$

What fraction of people drink a cup per day? $\sim 1/4$

365 days a year

$$35 \times 10^6 \times \tfrac{1}{4} \times 365 \sim 3000 \times 10^6$$

THREE BILLION CUPS OF COFFEE!!!!

From Tim Horton's Website:

- 2 Billion cups per year (world wide), but 80% of stores in Canada.
- So in Canada about 80% of 2 billion cups sold!

lets stack them: about 1 cm per cup (0.01 m)?

$$\sim 30 \times 10^6 \text{ m} \sim 30,000 \text{ km}$$

Clicker Quiz

Approximately how many cars are there in Canada?

A. 10^5
B. 10^6
C. 10^7
D. 10^8

Clicker Quiz

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Social Media

How many people in the world are on Facebook, right now?

What kinds of questions do we need to be asking ourselves?

- What fraction of your day do you spend on Facebook?
- How many people are there in the world?

If we spend 1/3rd of our day sleeping, and there are 7 billion people in the world, then $7x10^9/3$ sleeping now

See the trick? Relate the fraction of a day that an activity is done to the fraction of people in the world doing it right now.

Clicker Quiz

On average, how many hours a day do you spend on facebook?

A. 0 h
B. 1 h
C. 2 h
D. 4 h
E. 5 h or more

Closing Remarks

Next class:

- Begin T2M1! We will begin to discuss kinematic quantities
  - Distance, displacement, velocity and speed
  - Simple calculations, reading/plotting position time graphs

- Next week labs start!!!!
  - Only L10-L18, but double check calendar on Avenue
- CAPA: next week homework in class! Look at news item on Avenue
- Use your mcmaster email xxxxxx@mcmaster.ca, not Avenue email