Theme 1
Introductory Material

Module T1M1:
The Predictable Universe

Lab sections:

- Better when the TA/student ratio is higher:
- We are encouraging students to migrate:
  - *only* **from sections L01-L05, L08, L10**
  - **to sections L09, L13-L18**.

- First come first serve basis.
- Email our Senior Lab Supervisor, Dr. Vorobyov voroby@mcmaster.ca

- Email with: name, student ID number, your current section, and the one you would like to switch to
- Dr. Vorobyov will then respond to you to let you know if the switch was possible.

Module Clicker Quiz!

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

module quiz!

Module Clicker Quiz!

Significant Figures (120 seconds)

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

$$3.66 \times \frac{4.1231}{(2.8019 - 1.291)}$$

A. 10.

B. 9.9

C. 9.99

D. 9.988

E. I don't know

Which one of the following is *not* a vector?

A: velocity
B: displacement
C: position
D: speed
E: acceleration

T1M2 – Learning Objectives

- *Estimating unknown quantities*
- *'order of magnitude' approximations*.

Estimation – When 'Close' is good enough!

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

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

- The "2.75" is not what impresses us here
- It's the 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?

Soccer pitch: 100×70 m^2

$$\text{area} = 7 \times 10^3 \text{ m}^2$$

Donut : approximate by square of
10 cm

$$\text{area} = 0.1 \times 0.1 \text{ m}^2 = 0.01 \text{ m}^2$$

donuts per soccer pitch $\dfrac{7000 \text{ m}^2}{0.01 \text{ m}^2} =$

$$= 700000$$

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

$$V = W \times L \times H$$

$$= 10\,m \times 20\,m \times 5\,m$$

$$= 1000\,m^3 \sim 10^3\,m^3$$

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 size of your brain?

- How do we go from *volume* to *mass*?

- What is the size of a brain cell?

estimate a cube-shaped brain:

$$V_B = 10 \times 10 \times 10 \text{ cm}^3 = 1000 \text{ cm}^3$$

$$= 1000 \times 10^{-6} \text{ m}^3$$

Size of a cell: 5-100 microns   ~10 microns

$$10 \text{ microns} = 10 \times 10^{-6} \text{ m} = 10^{-5} \text{ m} = 10^{-3} \text{ cm}$$

$$\text{volume} = (10^{-3})^3 = 10^{-9}$$

$$\text{number of cells} = \frac{\text{volume brain}}{\text{volume cell}} = \frac{1000 \text{ cm}^3}{10^{-9} \text{ cm}^3} = 10^{12} \text{ cells}$$

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?

35 million people in Canada

$\sim$ 10 million coffee drinkers

1 coffee per day

$\Rightarrow$ 10^7 drinkers $\times$ 1 cup a day = 10^7 cups per day

365 days $\sim 3 \cdot 10^2$ days

$\Rightarrow$ $3 \cdot 10^9$ cups

Tim Horton's web: $2 \cdot 10^9$ cups $\checkmark$

Clicker Quiz

Approximately how many cars are there in Canada?

     A. 10^5

     B. 10^6

     C. 10^7

     D. 10^8

Clicker Quiz

Roughly how much chemical energy is stored in 1 litre of gasoline?

A) This is a "fact" which must be looked up or determined in a lab, there is no way to estimate it.

B)   1000 J

C)   10 kJ

D)   1 MJ

E) 100 MJ

100 PS , 10 l of gas