Physics 141 – Fri 9/2

(1) Please pick up Questionnaire and return to me after class or next Wed

(2) Still available are the following handouts:
- a syllabus/ schedule
- Info on "Slawsky clinic" (free tutoring run by volunteers)

(3) Lecture available online **the day before lecture**:
www.ireap.umd.edu/~wlosert/phys141_2005/

(4) Mon Holiday

Homework:

(5) Read Chapter 2 Sec 1-3 and 5 for Wednesday and do online pre-class quiz (you can skip 2.4)

(6) First HW due Friday 9/9

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Phys141: Principles of Physics Summary of lecture 1

Basic tool of physics: Standardized units

Question: Are the following quantities standardized (SI) unit:

- Second
- Minute

- Gram
- Kilogram

- Kilometer
- Meter

Information for the homework: Working with other students

- You **have to** work on the homework problems yourself first for a reasonable time
- After you have tried yourself, you are encouraged to work in groups on solving the problems (fellow students in discussion sections, lab partners)
  - Benefits to the explainer: Learn to explain how to solve a problem, then you are sure you really understand it.
  - Note of caution: Do not let others solve problems for you without having tried yourself: You need to learn how to solve problems, not just how to plug into equations to pass the exams
- Carry the calculations out independently, explain in your own words in the HW you hand in on paper.

Remember: You need to hand in HW on paper and submit online

Example of non standard (non-SI) units:

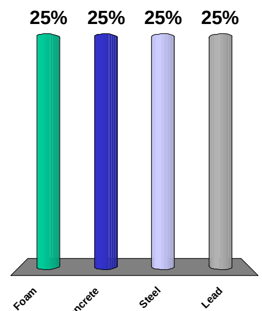
- Mass of atoms often measured in **atomic mass units u**: Measures the total number of protons and neutrons.
- Example: Carbon C
  - 6 protons, 6 neutrons,
  - Mass in Atomic mass units: m =12 u
  - Mass in kg:
    - Mass of proton and neutron are same: 1.6605387 x 10^{-27} kg
    - Mass =12 u = 12 x mass of proton
      = 12 x 1.6605387 x 10^{-27} kg

General customs on symbols

- Lengths: x, y, z, r, d, h, many other letters, or letters with subscripts x_1, x_2, x_A
- Mass often is m, m_1 , m_2 , m_{Ball}
- Time very often is *t, or greek symbol:* τ

Which of the materials has the largest density: foam, concrete, steel, or lead

1. Foam
2. Concrete
3. Steel
4. Lead



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Derived quantity: Density

- Density is an example of a *derived* quantity
- It is defined as mass per unit volume

$$\rho \equiv \frac{m}{V}$$

- **Units are kg/m³**
- **Usual Symbol ρ (greek letter r)**
- **In Lab 1: Calculate the density of an object from measured Mass and Volume**

Next Basic tool: Dimension of quantities

- Dimension has a specific meaning – it denotes the physical nature of a quantity
- Dimensions are denoted with square brackets
  - Length [L]
  - Mass [M]
  - Time [T]

Dimensional Analysis

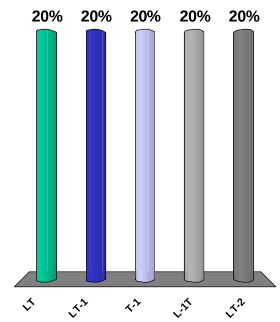
- Both sides of equation must have the same dimensions

-> Check whether dimensions on both sides of an equation match! – this is one way of Dimensional Analysis

The equation for the position x of a train starting at x=0 is given by x =***a*** t +1/2 b t^2

The dimensions of *a* are:

1. **LT**
2. **LT^{-1}**
3. **T^{-1}**
4. **$L^{-1}T$**
5. **LT^{-2}**



1	2	3	4	5															

Dimensional Analysis, example

- Given the equation: $x = \frac{1}{2} a t^2$
- x: position [L] ; t time [T]
- What is dimension of acceleration a?

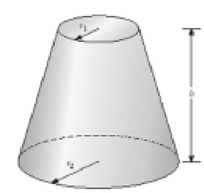
• Dimensions on both sides of an equation have to be same: $L = ?? \cdot T^2$

•Algebraic manipulation of dimensions allowed! $L = \frac{L}{T^2} \cdot T^2$

Acceleration has dimension Length/(Time)^2 = L/T^2=L T^{-2}

An example from HW

The *"frustrum"* of a cone



Which of the following expressions **could possibly** describe the surface area of the curved surface

a. $2\pi(r_1 + r_2)$ b. $\pi(r_1 + r_2)\left[h^2 + (r_1 - r_2)^2\right]^{\frac{1}{2}}$ c. $\frac{1}{3}\pi h\left(r_1^2 + r_1 r_2 + r_2^2\right)$

Next Basic Tool: Order of Magnitude Estimate

Estimate something very roughly
(e.g., how many cells in our body: a million, billion, or trillion?)

-> **Calculate result from quantities that can be approximated**
(e.g.: number of cells = volume of body / (Length of a cell)^3)

-> **Estimate each quantity to within an order of magnitude if possible**
(order of magnitude is the power of 10 that applies)

Length of cell: 10 micrometers
Volume of body: 30cm x 30cm x 2m

Total number of cells: 1.8×10^{14} cells -> 180 trillion

Uncertainty in Measurements

- There is uncertainty in every measurement (length of foot)
- this uncertainty "carries over" through the calculations (length of classroom = number of feet * length of foot)
  - -> Length of classroom measurements uncertain in TWO ways: How many feet exactly, and how long is a single foot.

-> We will use rules for significant figures to **approximate** the uncertainty in results of calculations

Lab 1 will show you more accurate ways to calculate uncertainty in calculations

Example – order of magnitude estimate

- *The city of Los Angeles is in a semi-desert area. It pumps huge amounts of water from Northern California.* ***Estimate how much water all the people in the city of Los Angeles use every day.***

Estimated number:

REAL NUMBER: *187,229,086,220*

Significant Figures, examples

- 0.0075 m has 2 significant figures
  - The leading zeros are placeholders only
  - Can write in scientific notation to show more clearly: 7.5×10^{-3} m for 2 significant figures
- 10.0 m has 3 significant figures
- 1500 m has 4 significant figures *(for the purposes of this class, more accurate treatment see book)*
  - Use 1.5×10^3 m for 2 significant figures
  - Use 1.50×10^3 m for 3 significant figures

Operations with Significant Figures – Multiplying or Dividing

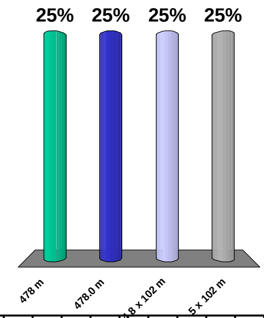
Number of significant figures in the answer:
~ smallest number of significant figures of the quantities that are multiplied/divided.

Example: 25.57 m x 2.45 m = 62.6 m^2

- The 2.45 m limits your result to 3 significant figures

932m x 0.5 + 12m = ??

1. 478 m
2. 478.0 m
3. 4.8 x 10^2 m
4. 5 x 10^2 m



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Operations with Significant Figures – Adding or Subtracting

Number of decimal places in the result:
~smallest number of decimal places in any term in the sum.

Example: 135 cm + 3.258 cm = 138 cm

- The 135 cm limits your answer to the units decimal value

Rounding

Last retained digit is increased by 1 if the last digit dropped is 5 or above
Last retained digit remains as it is if the last digit dropped is less than 5
Do not round before you get to the final result

Example: Round the sum of 1001 contributions of $0.40 to the nearest $

- Final result of calculation: $400.40
- Rounded final result: $400
- Round each contribution: $0
  -> sum (rounded too early) is $0

Review Chapter 1:
Basic Tools for classical mechanics

- Standardized quantities for measurements:
  - Length: meter, Mass: kilogram, Time:second
  - Density – an example of derived quantity
- Dimension: Characterizes physical nature of quantity
  - Length, Mass, Time: Basic dimension
  - Dimensional Analysis (Check dimensions in equations)
- Common sense checks:
  - "are results reasonable"
  - Order of magnitude estimate
- Uncertainty in measurement and calculation
  - Significant figures
  - rounding

To Do

- **Read Chapter 2.1-3 and 2.5 for Wed lecture and complete online Quiz** (skip 2.4)
- **Homework due next Fri**
- **No lab next week**
- **Discussions will take place next TUESDAY (feel free to attend any Tue discussion if you are in the Monday class, will review problems directly related to HW and exam)**