Unit 1

Physical World

Units and Measurements

Why do we have numerical problems in physics ?

One of the major objectives of involving learners in solving problems in teaching-learning process is to promote a more active learning and hence improve conceptual understanding

solving problems in physics

Any easy way to solve problems in physics ?

There is no single prescription which can help in solving each and every problem in physics

Most of the problems can be attempted if you follow certain steps in a sequence.

Simple Steps

1.Understand the problem

(a)Classify the problem by its method of solution.

(b) Summarise the situation with a diagram.

(c) Keep the goal in sight (perhaps by writing it down).

2. Execution tactics

(a) Work with symbols.
(b) Keep packets of related variables together
(c) Be neat and organised.
(d) Keep it simple.

3. Answer checking

(a) Dimensionally consistent?

(b) Numerically reasonable(including sign)?

(c) Algebraically possible? (Example: no imaginary or infinite answers)

(d) Functionally reasonable? (Example: greater range with greater initial speed)

(e) Check special cases and symmetry.

(f) Report numbers with units specified and with reasonable significant figures.

Example

Area of a rectangular sheet

The length and breadth of a rectangular sheet are 16.2 cm and 10.1cm, respectively. The area of the sheet in appropriate significant figures and error is

(a) $164 \pm 3cm^2$

(b) $163.62 \pm 2.6\ cm^2$

(c) $163.6 \pm 2.6\ cm^2$

(d) $163.62 \pm 3\ cm^2$

Answer (a) is correct

Let us remember Rules for determining the uncertainty

in the Results of arithmetic calculations

If the length and breadth of a thin rectangular sheet are measured using a meter scale

And length is

$$l = 16.2 \pm 0.1\ cm$$
$$= 16.2\ \ cm\ \ \pm 0.6\%$$

How did we get $\pm\mathbf{0.6\%}$?

As the length is measured by a meter scale the least count =0.1 cm hence relative error

$$\delta\, l = \frac{0.1}{16.2} = 0.00617$$

Now the corresponding percentage error can be obtained by multiplying the relative error by 100

Which in this case is 0.6 %

For breadth b

$$b = 10.1 \pm 0.1\ cm = 10.1cm \pm 1\%$$

Area of the plate =l x b

$$l \times b = 163.62 cm^2 \pm 1.6\%$$

Or

$$l \times b = 163.62 \pm 2.6 cm^2$$

How is $\pm 1.6\%$ *is equivalent to* $2.6\ cm^2$?

- $\delta\ A = \frac{percentage\ error \times value\ of\ area}{100}$
- $\delta A = \frac{1.6 \times 163.2}{100}$=2.6$cm^2$

- The result may be written as area = 164 $\pm 3cm^2$

- This is the uncertainty or error in the estimation of area of the rectangular sheet

But why not $163.6 \pm 2.6\ \boldsymbol{c\ m^2}$?

- Though looks more accurate we reject it because the estimated area is 164 cm^2

- The error is also rounded off

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