PROF.PRATHIBHA

EDUCATION IS THE KEY TO THE FUTURE

NEET 2021- LECT 4

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We have studied various types of errors, their origins and the ways to minimize them.

Our accuracy is limited to the least count of the instrument used during the measurement.

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- Least count is the smallest measurement that can be made using the given instrument.

- E.g:

with the usual metre scale, one can measure 0.1 cm as the least value.

SIGNIFICANT FIGURES

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we measure the length of a metal rod using a metre scale of least count 0.1cm. The measurement is done three times and the readings are 15.4, 15.4, and 15.5 cm.

Avg value = 15 4 3 3

DEFINITION:

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The number of digits in a measurement about which we are certain, plus one additional digit, the first one about which we are not certain

is known as significant figures or significant digits.

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- The larger the number of significant figures obtained in a measurement, the greater is the accuracy of the measurement.

- If one uses the instrument of smaller least count, the number of significant digits increases.

RULES

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- All the nonzero digits are significant, for example if the volume of an object is 178.43 cm^3, there are five significant digits which are 1,7,8,4 and 3.

- All the zeros between two nonzero digits are significant, eg., m = 165.02 g has 5 significant digits.

RULES (CONTD)

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- If the number is less than 1, the zero/zeroes on the right of the decimal point and to the left of the first nonzero digit are not

  significant e.g. in 0.001405, the underlined zeros are not significant. Thus the above number has ------ significant digits.

RULES (CONTD)

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- The zeros on the right hand side of the last nonzero number are significant (but for this, the number must be written with a decimal point), e.g. 1.500 and 0.01500 have --- and -----significant figures each.

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- L = 125 m = 12500 cm = 125000 mm, it has only --------- significant digits.

3

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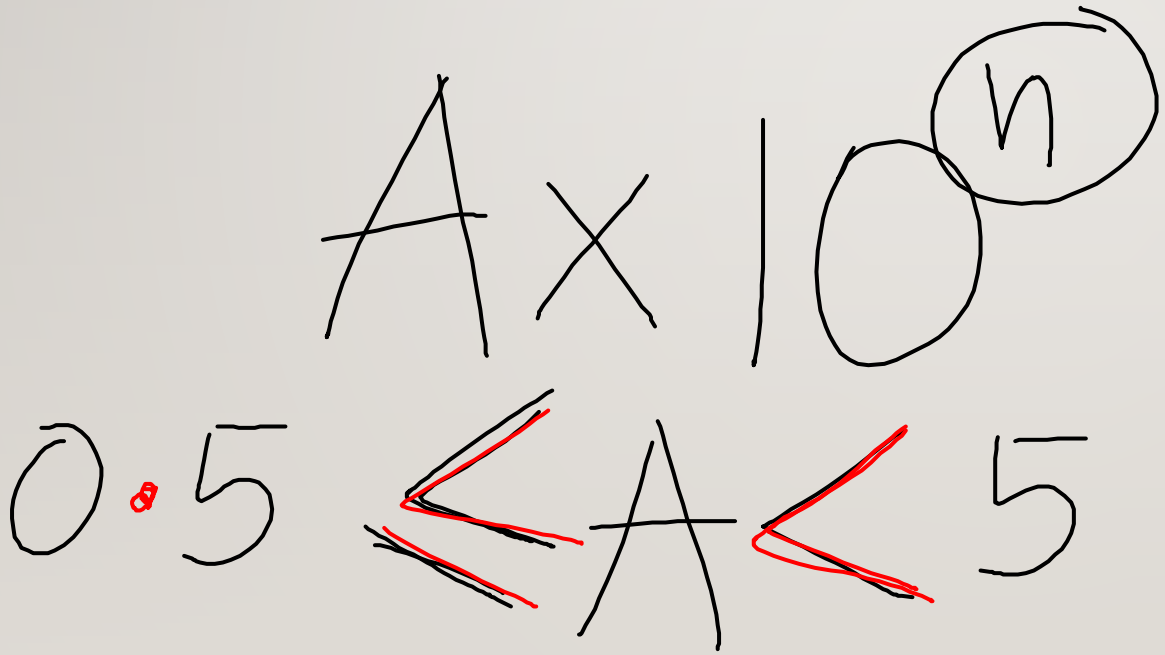
To avoid the ambiguities in determining the number of significant figures, it is necessary to report every measurement in scientific notation (i.e., in powers of 10) i.e., by using the concept of order of magnitude.

ORDER OF MAGNITUDE

- The magnitude of any physical quantity can be expressed as $A \times 10^n$ where 'A' is a number such that $0.5 <= A < 5$ and 'n' is an integer called the order of magnitude.



WHAT IS THE OOM AND SF?

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- Radius of Earth = 6400 km

  $= 0.64 \times 10^{7}$ m

- Magnitude of the charge on electron e = 1.6×10^{-19} C

OM = 7
SF = 2

) A large ball 2 m in radius is made up of a rope of square cross section with edge length 4 mm. Neglecting the air gaps in the ball, what is the total length of the rope to the nearest order of magnitude?

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$R = 2m$, $d = 4mm = 4 \times 10^{-3} m$

$V = d^2 L = \frac{4}{3}\pi R^3 = 4R^3$

$(\pi \simeq 3)$

$d^2 L = 4R^3$

$L = \frac{4R^3}{d^2}$

$= \frac{4 \times (2)^3}{(4 \times 10^{-3})^2} = 2 \times 10^{+6}$

=


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Nuclear radius R has a dependence on the mass number (A) as $R = 1.3\times10^{-15}A^{1/3}$ m. For a nucleus of mass number A=125, obtain the order of magnitude of R expressed in metre.

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$O(R) = 10^{-14}$ m

$R = R_0 A^{1/3}$

$= 1.3\times10^{-15}\times(125)^{\frac{1}{3}}$

$= 1.3\times5\times10^{-15}$

$= 6.5\times10^{-15} = 0.65\times10^{-14}$


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The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m, and 2.01 cm respectively. Give the area and volume of the sheet to correct significant figures.

$A = 4255 \Rightarrow SF = 4$

$V = 4.234 \times 1.005 \times 2.01 \times 10^{-2}$

$= 8.553 \times 10^{-2}$

$\approx 8.55 \times 10^{-2}$

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The diameter of a sphere is 2.14 cm. Calculate the volume of the sphere to the correct number of significant figures.

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$$V = \frac{4}{3}\pi r^3$$

$$= \frac{1}{6}\pi d^3 = \frac{1 \times 3.142 \times (2.14)^3}{6}$$

$$= \underline{5.132\ cm^3}$$


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If the formula for a physical quantity is $X = \frac{a^4 b^3}{c^{1/3} d^{1/2}}$ and if the percentage error in the measurements of a, b, c and d are 2%, 3%, 3% and 4% respectively. Calculate percentage error in X.

$$\% \left(\frac{\Delta X}{X}\right) \times 100 = 4\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + \frac{1}{3}\frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}$$

$$= 4\left(\frac{\Delta a}{a} \times 100\right) + 3\left(\frac{\Delta b}{b} \times 100\right) + \frac{1}{3}\left(\frac{\Delta c}{c} \times 100\right) + \frac{1}{2}\left(\frac{\Delta d}{d} \times 100\right)$$

$$= 4(2) + 3(3) + \frac{1}{3}(3) + \frac{1}{2}(4)$$

$$=$$


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If the length of a cylinder is l = (4.00±0.001) cm, radius r = (0.0250 ±0.001) cm and mass m = (6.25±0.01) gm. Calculate the percentage error in the determination of density.



relative error

$$\rho = \frac{m}{\pi r^2 l}$$

$$= \frac{6.25}{(3.142)(2.5\times10^{-2})^2(4\ cm)}$$

$$= 795.7\ g/cm^3$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \frac{2\Delta r}{r} + \frac{\Delta l}{l}$$

$$= \frac{0.01}{6.25} + 2\left(\frac{0.0001}{0.0250}\right) + \frac{0.001}{4.000}$$

$$= 0.00016 + 0.08 + 0.0025$$

$$= 0.08185$$

$$\% = 8.185\% \approx 8\%$$


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When the planet Jupiter is at a distance of 824.7 million kilometers from the Earth, its angular diameter is measured to be 35.72" of arc. Calculate the diameter of the Jupiter.

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- Find the percentage error in kinetic energy of a body having mass 60.0+-0.3 g moving with a velocity 25.0 +- 0.1 cm/s.

$$m = (60.0 \pm 0.3)\ g$$

$$v = (25 \pm 0.1)\ cm/sec$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 60 \times (25)^2$$

$$= 1.8750 \times 10^4\ J \simeq 1.88 \times 10^4\ J$$

$$\frac{\Delta K}{K} = \frac{\Delta m}{m} + \frac{2\Delta v}{v}$$

$$= \frac{0.3}{60} + 2\left(\frac{0.1}{25}\right)$$

$$= 0.013$$

$$\left(\frac{\Delta K}{K} \times 100\right) = 1.3\%$$

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4. What is the number of significant figures in 0.310×10^3

(a) 2 (b) 3

(c) 4 (d) 6

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10. The decimal equivalent of 1/20 upto three significant figures is

(a) 0.0500 (b) 0.05000

(c) 0.0050 (d) 5.0×10^{-2}

$\frac{1}{20} = 0.05$

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25. The number of significant figures in all the given numbers 25.12, 2009, 4.156 and 1.217×10^{-4} is

(a) 1 (b) 2

(c) 3 (d) 4

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$24.6 \longrightarrow 3$

$4.877 \times 10^{9} \longrightarrow 4$

$7.89 \times 10^{-6} \longrightarrow 3$

$0.0035 \longrightarrow 2$

$0.003 \longrightarrow 1$

$0.1250 \longrightarrow 4$

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$6.673 \times 10^{-11}\ Nm^2/kg^2$

$0.6673 \times 10^{-10}\ Nm^2/kg$

$9.10938188 \times 10^{-31}\ kg$

$10^{-30}\ kg$

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2.99792458×10^{8}

$9.80665\ m/s^2$

$= 0.980665 \times 10^{1}$

$86400\ sec$

$0.864 \times 10^{5}\ sec$

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9.46×10^{15} m

0.946×10^{16}

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$M^1 L^1 T^{-1}$

Impulse = f x t

$R = M L^2 T^{-3} I^{-2}$

sp heat capacity $= L^2 T^{-2} K^{-1}$

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Thank You