# YAKEEN NEET 2.0

2026

## Units and Measurements

PHYSICS

Lecture -09

By - Saleem Ahmed Sir

## Todays Goal

- Propagation of error

Q In a experiment value of 'g' is found to be

10.2, 10.0, 9.8, 10.5, 9.5

Our experiment o/p will be $g = (10.0 \pm .28)$

$$\text{True value} = \frac{10.2 + 10.0 + 9.8 + 10.5 + 9.5}{5} = 10.0 \equiv$$

Gadwadi in exp 1 ≡ Absolute error in Exp 1 = $10.0 - 10.2 = -.2$

" " " Exp 2 = $10.0 - 10.0 = 0$

" " " Exp 3 = $10.0 - 9.8 = +.2$

" " " Exp 4 = $10.0 - 10.5 = -.5$

" " " Exp 5 = $10.0 - 9.5 = +.5$

$$\text{Mean Absolute error} = \frac{|-.2| + |0| + |.2| + |-.5| + |.5|}{5} = .28$$

# $g = (10.0 \pm .28) \equiv (g_0 \pm \Delta g)$

$$\begin{pmatrix} g_{max} = 10.28 \\ g_{min} = 9.72 \end{pmatrix}$$

$\frac{\Delta g}{g_0} \equiv$ fractional error / Relative error $= \frac{.28}{10}$

$\frac{\Delta g}{g_0} \times 100 \equiv$ % error $= \frac{.28}{10} \times 100 = 2.8\%$

Representation $\Rightarrow$ $g \equiv (10.0 \pm .28) \equiv (10.0 \pm 2.8\%)$

Q $g \equiv (10.0 \pm .2) \equiv g_0 \pm \Delta g$

fractional error / Relative error $= \frac{\Delta g}{g_0} = \frac{.2}{10}$

% error $= \frac{\Delta g}{g_0} \times 100 = \frac{.2}{10} \times 100 = 2\%$

Q Velocity $= (50 \pm .2)$

fractional error / Relative error $= \frac{.2}{50}$

% error $= \frac{.2}{50} \times 100 = .4\%$

Q $r = (10 \pm 1)$ mm

% error $= \frac{1}{10} \times 100 = 10\%$.

$y \equiv (y \pm \Delta y)$

% error $= \frac{\Delta y}{y} \times 100$

Suppose in a exp. $a_1\ a_2\ a_3\ a_4 \ldots\ldots a_n$ are exp. value.

True value / Mean value $= \dfrac{a_1+a_2+a_2+\ldots\ldots a_n}{n} = a_m$

Gadwadi in Exp 1 $\Rightarrow$ Absolute error in Exp 1 $= a_m - a_1 = \Delta a_1$

" " " Exp 2 $= a_m - a_2 = \Delta a_2$

" .

.

.

$$\text{mean absolute error} = \frac{|\Delta a_1| + |\Delta a_2| + \ldots\ldots |\Delta a_n|}{n} = \Delta \bar{a}_m$$

Result $\equiv a_m \pm \Delta \bar{a}_m$

fractional error / Relative error $= \dfrac{\Delta \bar{a}_m}{a_m}$

% error $= \dfrac{\Delta \bar{a}_m}{a_m} \times 100$

ghanpar

Q Kaddu ≡ 10, 9, 11, 9.5, 10.5, 12 ≡ a

Mean Valu = $\frac{10+9+11+9.5+10.5+12}{6} = \frac{62}{6} = 10.3$

$\frac{5}{6} = .833$

(Kaddu ≡ $10.3 \pm \Delta a$)

$\Delta a = \frac{.3+1.3+.7+.8+.2+1.7}{6} = .8$ (check)

% error ⇒ $\frac{.8}{10.3} \times 100$

## Propagation of error

$y_1 = a \pm \Delta a$

$y_2 = b \pm \Delta b$

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$y_1 + y_2 = (a+b) \pm (\Delta a + \Delta b)$

$y_1 - y_2 = (a-b) \pm (\Delta a + \Delta b)$

SKC

{ Sabse pahle error ko bhool jao aur exact Value Nikalo.

Q $R_1 = (10 \pm .2)\ \Omega$

$R_2 = (30 \pm .4)\ \Omega$

If $R_1$ & $R_2$ are in series find Req

Sol$^n$ $R_{eq} = 40 \pm (.2 + .4)$

$R_{eq} = 40 \pm .6$

Q If $T_i = (50 \pm 3)\ ^\circ C$

$T_f = (80 \pm 2)^\circ C$

Change in temp $= (30 \pm 5)^\circ C$

$\simeq T_f - T_i$

$(30 \pm 1)^\circ C$

VVV Imp.

$$y = a^2 b^3 c^4$$

$$\frac{\Delta y}{y} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$$

$$\left(\frac{\Delta y}{y}\right) = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$$

max permissible error.

Q

$$y = \frac{a^2 b^3}{c^4}$$

$$\frac{\Delta y}{y} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} - 4\frac{\Delta c}{c}$$ (maths)

$$\left(\frac{\Delta y}{y}\right) = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$$

max persimissible Value

ignore

$$y = \frac{5 a^2 b^3}{c^4}$$

$$\left(\frac{\Delta y}{y}\right)_{max} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$$

const

$$y = k a^3$$

$$\frac{\Delta y}{y} = 3\frac{\Delta a}{a}$$

$$\frac{\Delta y}{y} = \frac{\Delta k}{k}^{0} + 3\frac{\Delta a}{a}$$

Proof

$$y = 5\frac{a^2 b^3}{c^4}$$

$$\ln y = \ln a^2 + \ln b^3 - \ln c^4$$

$$\ln y = 2\ln a + 3\ln b - 4\ln c$$

$$\frac{1}{y}dy = \frac{2}{a}da + 3\frac{db}{b} - \frac{4}{c}dc$$

$dy \equiv \Delta y$ , $da \equiv \Delta a$

$$\frac{\Delta y}{y} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} - 4\frac{\Delta c}{c}$$

(maths)

$$\left(\frac{\Delta y}{y}\right)_{\substack{\text{max} \\ \text{permissible} \\ \text{Value}}} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$$

Error.

Error

$$\frac{\Delta y}{y} \times 100 = 2\frac{\Delta a}{a} \times 100 + 3\frac{\Delta b}{b} \times 100 + 4\frac{\Delta c}{c} \times 100$$

Q $y = \frac{a^2 b^3}{c^4}$

If % error in a, b, c are 1%, 2%, 3%
find % error in y

Soln $\frac{\Delta y}{y} = 2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + 4\frac{\Delta c}{c}$

$\frac{\Delta y}{y} \times 100 = 2 \times 1 + 3 \times 2 + 4 \times 3$

$= 2 + 6 + 1.2$

$= 9.2\%$

Q $a = \frac{x^3 y^2}{z^5}$

if % error in x, y, z are $\frac{1}{3}\%$, $1\%$, $\frac{1}{2}\%$
find % error in a

Soln $\frac{\Delta a}{a} = 3\frac{\Delta x}{x} + 2\frac{\Delta y}{y} + 5\frac{\Delta z}{z}$

$= 3 \times \frac{1}{3} + 2 \times 1 + 5 \times \frac{1}{2}$

$= 1 + 2 + 2.5 = 5.5\%$

Q If $y = \frac{a^2 b^{3/2}}{c^{\frac{1}{2}} d^5}$

If % error in a, b, c, d are 1%, 2%, 4%, 1% respectively.

find max % error in 'y'

Sol Ans $\Rightarrow$ $2 \times 1 + \frac{3}{2} \times 2 + \frac{1}{2} \times 4 + 5 \times 1$

$= 2 + 3 + 2 + 5 = 12\%$

Notes

Q If % error in radius of a sphere is 2% find

(a) max % error in Volume = 3 × 2%.
= 6%.

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

$\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$

(2) max % error in surface area
= 2 × 2 = 4%.

$A = 4\pi r^2$

$\frac{\Delta A}{A} = 2\frac{\Delta r}{r}$

SKC Methode

Q $y = A\, e^{\alpha t}$

if % error in A is 2% & in time is 3% find % error in y at $t = 2\,sec$, $(\alpha = 2)$

soln $\ln y = \ln A + \alpha t \ln e$

$\ln y = \ln A + \alpha t$

$\frac{1}{y}(dy) = \frac{1}{A}(dA) + \alpha\, dt$

$\frac{1}{y}\Delta y = \frac{1}{A}(\Delta A) + \alpha \frac{\Delta t}{t} \times t$

$= 2 + 2 \times 3 \times 2$

$= 14\%$

Q Error in measurement of radius of a sphere is 1%, then

H.W

(1) the error in measurement of volume is 3%

(2) the error in measurement in volume is 1%

Ans 1, 2

(3) the error in measurement of surface area is 2%

(4) the error in measurement of surface area is 6%

Q Error in measurement of volume of a sphere is 9%, then

(1) the error in measurement of radius is 2%

Ans Soln next page

(2) the error in measurement of radius is 3%

(3) the error in measurement surface area is 4%

(4) the error in measurement surface area is 6%

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

$$\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$$

$$g\% = 3\frac{\Delta r}{r}$$

$$\frac{\Delta r}{r} = 3\%$$

$$A = 4\pi r^2$$

$$\frac{\Delta A}{A} = 2\frac{\Delta r}{r}$$

$$= 2 \times 3\% = 6\%$$

Homework

**Example 24:** The period of oscillation of a simple pendulum in an experiment is recorded as 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s respectively. Find (i) mean time period (ii) absolute error in each observation and percentage error.

**Sol.** (*i*) Mean time period is given by

$$\bar{T} = \frac{2.63 + 2.56 + 2.42 + 2.71 + 2.80}{5}$$

$$= \frac{13.12}{5} = 2.62\text{s}$$

(*ii*) The absolute error in each observation is

$2.62 - 2.63 = -0.01,\ 2.62 - 2.56$

$= 0.06,\ 2.62 - 2.42$

$= 0.20,\ 2.62 - 2.71$

$= -0.09,\ 2.62 - 2.80$

$= -0.18$

$\frac{.11}{2.62} \times 100$

Mean absolute error, $\overline{\Delta T} = \frac{\Sigma |\Delta T|}{5}$

$$= \frac{0.01 + 0.06 + 0.2 + 0.09 + 0.18}{5} = 0.11\text{sec}$$

$\therefore$ Percentage error is

$$= \frac{\overline{\Delta T}}{\bar{T}} \times 100 = \frac{0.11}{2.62} \times 100 = 4.2\%$$

Rough Eg

$$T \Rightarrow \frac{.52 + .56 + .57 + .54 + .59}{5} = \frac{278}{500} = .556$$

$$= .56$$

% error in T $\Rightarrow$ $.56 \pm .02$

$$\overline{\Delta T} \Rightarrow \frac{.04 + 0 + .01 + .02 + .03}{5} = \frac{10}{500} = .02$$

$$\% \text{ err} = \frac{.02}{.56} \times 100 = 3.57\%$$

(3) 3 (4) 5

**52.** The dimensional formula for a physical quantity $x$ is $[M^{-1}L^{3}T^{-2}]$. The errors in measuring the quantities $M$, $L$, and $T$, respectively, are 2%, 3%, and 4%. The maximum percentage of error that occurs in measuring the quantity $x$ is

(1) 9 (2) 10

(3) 14 (4) 19

Ghar Copy

$\left(\frac{\Delta X}{X}\right)_{max} \Rightarrow 2 + 3\times3 + 2\times4$

$2 + 9 + 8 \equiv 19\%$

note kar lena copy me

The heat generated in a circuit is given by $Q = I^2Rt$, where $I$ is current, $R$ is resistance, and $t$ is time. If the percentage errors in measuring $I$, $R$, and $t$ are 2%, 1%, and 1%, respectively, then the maximum error in measuring heat will be

(1) 2%
(2) 3%
(3) 4%
(4) 6%

$$Q = i^2Rt$$

$$\frac{\Delta Q}{Q} = 2\frac{\Delta i}{i} + \frac{\Delta R}{R} + \frac{\Delta t}{t}$$

$$= 2\times2 + 1 + 1 = 6\%$$

**6.** In an experiment, the percentage of error occurred in the measurement of physical quantities $A$, $B$, $C$ and $D$ are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement of $X$, where $X = \frac{A^2 B^{1/2}}{C^{1/3} D^3}$ will be:

**[2019]**

(1) 10%

(2) $\left(\frac{3}{13}\right)\%$

(3) 16%

(4) −10%

7. In an experiment, four quantities $a$, $b$, $c$ and $d$ are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity $P$ is calculated as follows $p = \frac{a^3 b^2}{cd}$. % error in $P$ is:

[2013]

(1) 7%
(2) 4%
(3) 14%
(4) 10%

**9.** If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be:

H/W

**[2008]**

(1) 8%
(2) 2%
(3) 4%
(4) 6%

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

$$\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$$

$$= 3 \times 2\% = 6\%$$

An experiment measures quantities $a$, $b$, and $c$, and then $X$ is calculated from $X = \frac{a^{1/2}b^2}{c^3}$. If the percentage errors in $a$, $b$, and $c$ are $\pm 1\%$, $\pm 3\%$, and $\pm 2\%$, respectively, then the percentage error in $X$ can be

(1) $\pm 12.5\%$

(2) $\pm 7\%$

(3) $\pm 1\%$

(4) $\pm 4\%$

. According to Joule's law of heating, heat produced $H = I^2 Rt$, where $I$ is current, $R$ is resistance, and $t$ is time. If the errors in the measurement of $I$, $R$, and $t$ are 3%, 4%, and 6%, respectively, find error in the measurement of $H$. Ans 16%

$\frac{\Delta H}{H} \times 100 = 2 \times 3 + 4 + 6$

$= 6 + 4 + 6 = 16\%$

The density of a cube is measured by measuring its mass and the length of its sides. If the maximum errors in the measurement of mass and length are 3% and 2%, respectively, then find the maximum error in the measurement of the density of cube. Ans 9%

ghar par note

$$\rho = \frac{m}{\ell^3} = m\,\ell^{-3}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta \ell}{\ell}$$

$$100 \times \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} \times 100 + 3\frac{\Delta \ell}{\ell} \times 100$$

Ans $3 + 3 \times 2 = 9\%$

). The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate by using the formula $P = F/l^2$. If the maximum errors in the measurement of force and length are 4% and 2%, respectively, then what is the maximum error in the measurement of pressure?

Ans 8%

$$P = \frac{F}{l^2}$$

$$\frac{\Delta P}{P} = \frac{\Delta F}{F} + 2\frac{\Delta l}{l}$$

A physical quantity $x$ is calculated from the relation $x = \dfrac{a^2 b^3}{c\sqrt{d}}$.

If the percentage error in $a$, $b$, $c$, and $d$ are 2%, 1%, 3%, and 4%, respectively, what is the percentage error in $x$?

$2 \times 2 + 3 \times 1 + 1 \times 3 + \frac{1}{2} \times 4$

$= 4 + 3 + 3 + 2 = 12\%$

Ans $\pm 12\%$

The percentage errors in the measurement of mass and speed are 2% and 3%, respectively. How much will be the maximum error in the estimation of KE obtained by measuring mass and speed?

$KE = \frac{1}{2}mv^2$

(1) 5%

(2) 1%

(3) 8%

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

(4) 11%

$2 + 2 \times 3 = 8\%$

**8.** Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is :-

(1) 3% (2) 6% (3) zero (4) 1%

एक तार का प्रतिरोध इसमें प्रवाहित होने वाली धारा और इस पर लगायी गई वोल्टता अन्तर के मापन से प्राप्त किया जाता है। यदि धारा और वोल्टता अन्तर प्रत्येक के मापन में प्रतिशत त्रुटि 3% हैं, तब तार के प्रतिरोध में त्रुटि का मान है :-

(1) 3% (2) 6% (3) शून्य (4) 1%

**Ans. (2)**

$$R = \frac{V}{i}$$

$$\left(\frac{\Delta R}{R}\right)_{max} = \frac{\Delta V}{V} + \frac{\Delta i}{i}$$

$$3 + 3 = 6$$

**20.** In an experiment to determine the acceleration due to gravity g, the formula used for the time period of a periodic motion is $T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$. The values of R and r are measured to be $(60 \pm 1)$ mm and $(10 \pm 1)$ mm, respectively. In five successive measurements, the time period is found to be 0.52 s, 0.56 s, 0.57s, 0.54 s and 0.59 s. The least count of the watch used for the measurement of time period is 0.01 s. Which of the following statement(s) is(are) true? **[JEE-Advance 2016]**

(1) The error in the measurement of r is 10%

(2) The error in the measurement of T is 3.57 %

(3) The error in the measurement of T is 2%

(4) The error in the determined value of g is 11%

Bad Me Karay

**17.** Using the expression $2d \sin\theta = \lambda$, one calculates the values of d by measuring the corresponding angles $\theta$ in the range 0 to 90°. The wavelength $\lambda$ is exactly known and the error in $\theta$ is constant for all values of $\theta$. As $\theta$ increases from 0° :- **[JEE-Advance 2013]**

(A) the absolute error in d remains constant
(B) the absolute error in d increases
(C) the fractional error in d remains constant
(D) the fractional error in d decreases

व्यंजक $2d \sin 0 = \lambda$ का उपयोग करते हुए हम $\theta$ को माप कर d का मान जानना चाहते है। $\theta$ का मान 0 व 90° के बीच में है। तरंग दैर्ध्य का मान हमें परिशुद्धत: ज्ञात है तथा $\theta$ के मापन में त्रुटि $\theta$ के सभी मानों के लिए समान है। जैसे $\theta$ का मान 0° से बढ़ता है तब

(A) d में निरपेक्ष त्रुटि स्थिर रहती है।
(B) d में निरपेक्ष त्रुटि बढ़ती है।
(C) d में भिन्नात्मक त्रुटि स्थिर रहती है।
(D) d में भिन्नात्मक त्रुटि घटती है।

**Ans. (D)**

$2d\sin\theta = \lambda$ const

$\theta\uparrow$ $\tan\theta\uparrow$, $\cot\theta\downarrow$
$\sin\theta\uparrow$, $\cos\theta\downarrow$

$\frac{1}{\sin\theta}\cos\theta\, d\theta = \frac{1}{d}(\Delta d)$

$\boxed{\frac{\Delta d}{d} = \cot\theta\, d\theta}$

$\sin\theta = \frac{\lambda}{2d}$

$\ln\sin\theta = \ln\lambda - \ln 2 - \ln d$

const

$$2d\sin\theta = \lambda$$

$$\ln 2 + \ln d + \ln\sin\theta = \ln\lambda$$

$$\ln d = \ln\lambda - \ln 2 - (\ln\sin\theta)$$

$$\frac{1}{d}\Delta d = (\cot\theta)\, d\theta$$

max

$\theta \uparrow$ $\cos\theta \downarrow$

**2.** The energy of a system as a function of time $t$ is given as $E(t) = A^2 \exp(-\alpha t)$, wher $\alpha = 0.2\ s^{-1}$. The measurement of $A$ has an errror of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at $t = 5$ s is **(JEE Advanced 2015)**

$E = A^2 e^{-\alpha t}$

$$\frac{\Delta E}{E} = 2\frac{\Delta A}{A} (+) \alpha \frac{\Delta t}{t} \times t$$

$$= 2 \times 1.25 (+) 2 \times 1.5 \times 5$$

$$= 2.5 + 1.5 = 4\ \%$$

**11.** Taking into account of the significant figures, what is the value of 9.99 m – 0.0099 m?

**[2020]**

(1) 9.9801 m
(2) 9.98 m
(3) 9.980 m
(4) 9.9 m

**10.** The area of a rectangular field (in $m^2$) of length 55.3 m and breadth 25 m after rounding off the value for correct significant digits is:

[2022]

(1) $138 \times 10^1$

(2) 1382

(3) 1382.5

(4) $14 \times 10^2$

QUESTION

HW

A physical quantity $z$ depends on four observables $a$, $b$, $c$ and $d$, as $z = \frac{a^2 b^{\frac{2}{3}}}{\sqrt{cd^3}}$. The percentages of error in the measurement of $a$, $b$, $c$ and $d$ are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in $z$ is:

**[Main Sep. 05, 2020 (I)]**

1. 12.25%
2. 16.5%
3. 13.5%
4. 14.5%

Ans: (4)

QUESTION

JA/JM/NEET

The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1%, the maximum error in determining the density is: [Main, 2018]

$$\text{density} = \frac{m}{l^3}$$

$$\left(\frac{\Delta\rho}{\rho}\right)_{max} = \frac{\Delta m}{m} + 3\frac{\Delta l}{l}$$

$$\equiv 1.5 + 3 \times 1 = 4.5\ \%$$

1. 2.5%
2. 3.5%
3. 4.5%
4. 6%

Ans: (3)

## QUESTION

The percentage errors in quantities P, Q, R and S are 0.5%, 1%, 3% and 1.5% respectively in the measurement of a physical quantity $A = \frac{P^3Q^2}{\sqrt{RS}}$.

The maximum percentage error in the value of A will be: **[Main online April 16, 2018]**

$3 \times \frac{1}{2} + 2 \times 1 + \frac{1}{2} \times 3 + \frac{1}{2} \times 1.5$

$= \checkmark$

1. 8.5%
2. 6.0%
3. 7.5%
4. 6.5%

Ans: (4)

QUESTION

H/w

A physical quantity $P$ is describe by the relation $P = a^{1/2}\ b^2\ c^3\ d^{-4}$. If the relative errors in the measurement of $a$, $b$, $c$ and $d$ respectively, are 2%, 1%, 3% and 5%, then the relative error in $P$ will be:

**[Main online April 09, 2017]**

1. 8%
2. 12%
3. 32%
4. 25%

Ans: (3)

QUESTION

Hw

The density of a solid metal sphere is determined by measuring its mass and its diameter. The maximum error in the density of the sphere is $\left(\frac{x}{100}\right)\%$. If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of $x$ is _____.

**[Main Sep. 06, 2020(I)]**

Ans: (1050)

@SALEEMSIR_PW

Join it for imp pdf & update.

## Homework

- More than enough ques are attached in this ppt ... Aaj ke liye itna kafi hai Solve them on rough paper.
- Solve all ques of total class (again)
- Module page 27
  38, 40, 41, 42, 43, 48, 58
  Prabal → (1–6), 8, 17,

# THANK YOU