PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

ERRORS AND THEIR MEASUREMENTS

Example

1. The measures of length and breadth of a rectangle are $l = (30.0 \pm 0.2)$ cm and $b = (10.0 \pm 0.1)$ cm. What is the percentage error and absolute error in area?

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2. The measure of the radius of a sphere is $(3.00 \pm 2\%)$ cm. Calculate the percentage error in volume and area. Also calculate the absolute error in volume and surface area.

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3. Show that the percentage error in the measurement of resistance by a metre bridge is minimum when the null point is near about the centre of the wire.

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Exercises

1. A student makes measurements of the diameter of a wire with the help a screw gauge and he gets the following readings : $0.38, 0.40, 0.39, 0.37, 0.41, 0.40, 0.38, 0.39, 0.40$ and 0.41 mm. Calculate the average error and standard deviation of his measurements.

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2. Two students A and B make measurement of the focal length of the same lens

Readings of A :

16.35, 16.30, 16.27, 16.35, 16.50, 16.25, 16.30, 16.50, 16.20, and 16.40 cm.

Reading of B :

15.83, 16.38, 15.88, 16.22, 16.30, 16.43, 16.00, 15.80, 16.40, and 16.30.

Whose measurements are move reliable and why?

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3. The ammeter and voltmeter connected in series and parallel with a resistor read as follows

Voltmeter	2.50	2.00	1.50	1.00	0.52
Ammeter	0.52	0.42	0.29	0.21	0.10

Write a report on the resistance of the resistor in terms of S. D.

[Hind : Calculate R using Ohm's law $R = \frac{V}{C}$ and then proceed as in example 1.]

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4. Time of fall of a body $= (10.0 \pm 0.5)$ sec

Acceleration due to gravity $= (9.80 \pm 0.02) ms^{-2}$

What (i) percentage error in the distance described, (ii) absolute error in the distance described?

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5. The mass of a body $= (100 \pm 2\,\%)ms^{-2}$ kg and the volume of the body $= (10 \pm 3\,\%)m^3$ What is the (i)

percentage error in density, (ii) absolute error in denstiy?

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6. The measures of the length and breadth of a rectangle are $(30 \pm 3\%)$ and $(10.0 \pm 0.5\%)$ m. Calcualte the percentage error in the perimeter of the rectangle.

[Hint : Perimeter = (length + breadth).]

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7. In a simple pendulum $l = (100.0 \pm 0.5)$ cm and $t = (2.00 \pm 0.01)$ sec. What is the percentage error in g?

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8. The modulus of rigidity of a wire is given by the formula $W_g = \frac{n\pi r^4 \theta}{2l}$. Which of these quantities should be measured very accurately and why?

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9. Show that percentage error in the measurement of m/B by a deflection magnetometer is minimum when deflection is near about 45°.

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10. In a prisim $\mu = \frac{\sin[(A+D)/2]}{\sin(A/2)}$. Find the formula for the propagation of error in μ due to error in A and D.

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11. The voltage across a resistor is 8.0 ± 0.2 volt and the current through it is (3.8 ± 0.1) ampere. What is the power consumed? The errors quoted are the standard deviations in the measurements.

[Hint : Use W = VI and $\left(\frac{\sigma w}{W}\right)^2 = \left(\frac{\sigma v}{V}\right)^2$+((sigmal) (I))^(2)`]

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12. Calculate the volume of a sphere of radius (3.0 ± 0.1) cm, if the error quoted is the standard deviation in the measurement.

[Hint: $V = \frac{4\pi}{3} r^3, \left(\frac{\delta V}{V}\right)^2 = 3^2 \times \left(\frac{\delta r}{r}\right)^2$]

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13. A physical quantity P is related to four observables a, b, c and d as $P = a^3b^2 / \sqrt{c}d$. The percentage errors in the measurements of a, b, c and d are 1%, 3% 4% and 2% respectively. What is the percentage error in the quantity P? If the value of P calculated using this formula turns out to be 3.763, to what value should you round off the result?

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14. The length, breadth and thickness of a sheet are 4.234m, 1.005 m and 2.01cm respectively. Give the

volume of the sheet to the correct significant figures.

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15. In a simple pendulum experiment the length of the pendulum is measered by a scale with mm divisions and the length is about 100 cm. The time resolution of stop watch used is 1 s. Find the number of oscillations for which time should be recorded. Time period is nearly 2s.

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16. Show that if two sets of measured quantities have mean values m_1 and m_2 with respective standard

errors α_1 and α_2 the standard error of $m_1 m_2$ is $\left(m_1^2 \alpha_2^2 + m_2^2 \alpha_1^2\right)^{1/2}$.

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17. A body is moving at speed of $0.3 m/s$. To measure its speed with an accuracy of about 1% using a sampling distance 3 mm, find the least count that the measuring clock must have.

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