



PHYSICS

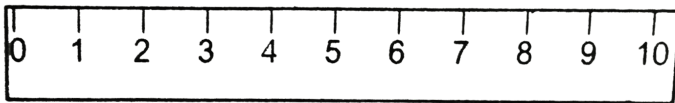
BOOKS - DC PANDEY ENGLISH

MEASUREMENT AND ERRORS

Example

1. Let us use a centimeter scale (on which only centimeter scales are there) to measure a length AB.

A  B

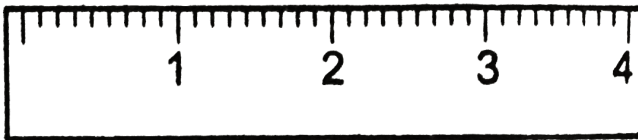


From the figure, we can see that length AB is more than 7cm and less than 8cm . In this case, Least Count (LC) of this centimeter scale is 1 cm, as it can measure accurately, upto centimeters only. If we note down the length (l) of line AB as $l = 7\text{cm}$ then maximum uncertainty or maximum possible error in l can be $1\text{cm}(=LC)$, because this scale can measure accurately only upto 1cm.



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2. Let us now use a millimeter scale (on which millimeter marks are there). This is also our normal meter scale which we use in our routine life. From the figure, we can see that length AB is more than 3.3 cm and less than 3.4 cm. If we note down the length,



$$l = AB = 3.4\text{cm}.$$

Then, this measurement has two significant figures 3 and 4 in which 3 is absolutely correct

and 4 is reasonably correct (doubtful). Least count of this scale is 0.1 cm because this scale can measure accurately only upto 0.1 cm. Further, maximum uncertainty or maximum possible error in l can also be 0.1 cm.



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$$3.1.2 + 3.45 + 6.789 = 11.439 \approx 11.4$$

Here, the least number of significant digits after the decimal is one. Hence, the result will be 11.4. (when rounded off to smallest number of decimal places).



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$$4. 12.63 - 10.2 = 2.43 \approx 2.4$$



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5. Calculate 1.2×36.72 If the result is rounded off to two significant digits.



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6. $\frac{1101ms^{-1}}{10.2ms^{-1}} = 107.94117647 \approx 108.$



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7. Find, volume of a cube of side $a = 1.4 \times (10^{-2})$ m.



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8. Radius of a wire is 2.50 mm. The length of the wire is 50.0 cm. If mass of wire was measured as

25g, then find the density of wire in correct significant figures.

[Given, $\pi = 3.14$, exact]



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9. The diameter of a wire as measured by screw gauge was found to be 2.620, 2.625, 2.630, 2.628 and 2.626 cm. Calculate

(a) mean value of diameter (b) absolute error in each measurement

(c) mean absolute error

(d) fractional error

(e) percentage error

(f) Express the result in terms of percentage error



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10. The volumes of two bodies are measured to be

$$V_1 = (10.2 \pm 0.02) \text{ cm}^3 \text{ and } V_2 = (6.4 \pm 0.01) \text{ cm}^3$$

. Calculate sum and difference in volumes with error limits.



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11. The mass and density of a solid sphere are measured to be $(12.4 \pm 0.1)kg$ and $(4.6 \pm 0.2)kg/m^3$.

Calculate the volume of the sphere with error limits .



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12. Calculate percentage error in determination of time period of a pendulum.

$$T = 2\pi \frac{\sqrt{l}}{g}$$

where, l and g are measured with $\pm 1\%$ and $\pm 2\%$.



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13. Round off 0.07284 to four, three and two significant digits.



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14. Round off 231.45 to four, three and two significant digits.





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15. Three measurements are $a = 483$, $b = 73.67$ and $c = 15.67$. Find the value $\frac{ab}{c}$ to correct significant figures.



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16. Three measurements are, $a = 25.6$, $b = 21.1$ and $c = 2.43$. Find the value of $a - b - c$ to correct significant figures.



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17. A thin wire has a length of 21.7 cm and radius 0.46 mm. Calculate the volume of the wire to correct significant figures.



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18. The radius of a sphere is measured to be (1.2 ± 0.2) cm. Calculate its volume with error limits.



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19. Calculate equivalent resistance of two resistors R_1 and R_2 in parallel where, $R_1 = (6 \pm 0.2)\text{ohm}$ and $R_2 = (3 \pm 0.1)\text{ohm}$



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Exercise 2 1

1. If we measure a length $l=6.24$ cm with the help of a vernier callipers, then

(a) What is least count of vernier callipers?

(b) How many significant figures are there in the

measured length?

(c) Which digits are absolutely correct and which is/are doubtful?



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2. If we measure a length $l=3.267$ cm with the help of a screw gauge, then

(a) What is maximum uncertainty or maximum possible error in l ?

(b) How many significant figures are there in the measured length ?

(c) Which digits are absolutely correct and which is/are doubtful?



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Exercise 2 2

1. Count total number of significant figures in the following measurements:

(a) 4.080cm (b) 0.079 cm (c) 950

(d) 10.00 cm (e) 4.07080 (f) 7.090×10^5



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Exercise 2 3

1. Round off the following numbers to three significant figures:

(a) 24572 (b) 24.937 (c) 36.350 (d) 42.450×10^9



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2. Round 742396 to four, three and two significant digits.



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Exercise 2 4

1. Round to the appropriate number of significant digits

(a) $13.214 + 234.6 + 7.0350 + 6.38$

(b) $1247 + 134.5 + 450 + 78$



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2. Simplify and round to the appropriate number of significant digits

(a) $16.235 \times 0.217 \times 5$

(b) 0.00435×4.6



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Single Correct

1. The number of significant figures in 3400 is

a)3 b)1 c)4 d)2

A. 3

B. 1

C. 4

D. 2

Answer: D



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2. The significant figures in the number 6.0023 are

A. 2

B. 5

C. 4

D. 3

Answer: B



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3. The length and breadth of a metal sheet are 3.124m and 3.002m respectively. The area of this sheet upto correct significant figure is

A. a) $9.378m^2$

B. b) $9.37m^2$

C. c) $9.4m^2$

D. d) None of these

Answer: A



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4. The length, breadth and thickness of a block are given by $l=12$ cm , $b=6$ cm and $t=2.45$ cm. The volume of the block according to the idea of significant figures should be

A. a) $1 \times 10^2 cm^3$

B. b) $2 \times (10^2) \text{ cm}^3$

C. c) $1.763 \times (10^2) \text{ cm}^3$

D. d) None of these

Answer: B



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5. If error in measurement of radius of a sphere is 1%, what will be the error in measurement of volume?

A. a) 0.01

B. b) $\frac{1}{3} \%$

C. c) 0.03

D. d) None of these

Answer: C



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6. The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the

maximum error in the measurement of density
will be

A. 0.07

B. 0.09

C. 0.12

D. 0.13

Answer: D



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7. Percentage error in the measurement of mass and speed are 2% and 3% respectively. The error in the measurement of kinetic energy obtained by measuring mass and speed will be

A. 0.12

B. 0.1

C. 0.08

D. 0.05

Answer: C



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8. A force F is applied on a square plate of side L . If the percentage error in the determination of L is 2% and that in F is 4%. What is the permissible error in pressure?

A. 0.08

B. 0.06

C. 0.04

D. 0.02

Answer: A



9. The heat generated in a circuit is dependent upon the resistance, current and time for which the current is flown. If the error in measuring the above are 1%, 2% and 1% respectively, then maximum error in measuring the heat is

A. 0.08

B. 0.06

C. 0.18

D. 0.12

Answer: B



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10. Let g be the acceleration due to gravity at the earth's surface and K the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2%. Keeping all other quantities constant, then

A. g increases by 2% and K increases by 2%

B. g increases by 4% and K increases by 4%

C. g decreases by 4% and K decreases by 2%

D. g decreases by 2% and K decreases by 4%

Answer: B



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11. A physical quantity A is dependent on other four physical quantities p, q, r and s as given by

$$A = \frac{\sqrt{pq}}{r^2 s^3}. \quad \text{The percentage error of}$$

measurement in p, q, r and s are 1%, 3%, 0.5% and

0.33% respectively, then the maximum percentage error in A is

A. 0.02

B. 0

C. 0.04

D. 0.03

Answer: C



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12. The length of a simple pendulum is about 100 cm known to have an accuracy of 1mm. Its period of oscillation is 2 s determined by measuring the time for 100 oscillations using a clock of 0.1s resolution. What is the accuracy in the determined value of g ?

A. 0.002

B. 0.005

C. 0.001

D. 0.02

Answer: A



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13. The mass of a ball is 1.76kg. The mass of 25 such balls is

A. $0.44 \times 10^3 \text{ kg}$

B. 44.0 kg

C. 44kg

D. 44.00kg

Answer: B



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14. The least count of a stop watch is 0.2 s, The time of 20 oscillations of a pendulum is measured to be 25s. The percentage error in the time period is

A. 1.2 %

B. 0.8 %

C. 1.8 %

D. None of these

Answer: B



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Subjective

1. Write down the number of significant figures in the following (a) 6428 (b) 62.00 (c) 0.00628 cm (d) 1200N



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2. Write the number of significant digits in the following

(a) 1001 (b) 100.1 (c) 100.10 (d) 0.001001



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3. State the number of significant figures in the following

(a) 0.007 m^2 (b) $2.64 \times 10^{24} \text{ kg}$ (c) 0.2370 g/cm^{-3}



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4. Round the following numbers to 2 significant digits

(a)3472 (b)84.16 (c)2.55 (d)28.5



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5. Perform the following operations (a)703
+7+0.66 (b) 2.21 x 0.3 (c) 12.4 x 84



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6. Add $6.75 \times (10^3) \text{ cm}$ to $4.52 \times (10^2) \text{ cm}$ with regard to significant figures.



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7. Evaluate $\frac{25.2 \times 1374}{33.3}$. All the digits in this expression are significant.



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8. Solve with due regards to significant figures

$$4.0 \times (10^{-4}) - 2.5 \times 10^{-6}.$$



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9. The mass of a box measured by a grocer's balance is 2.300kg. Two gold pieces of masses 20.15 g and 20.17 g are added to the box. What is (a) the total mass of the box, (b) the difference in the masses of the pieces to correct significant figures?



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10. A thin wire has length of 21.7 cm and radius 0.46 mm. Calculate the volume of the wire to correct significant figures?



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11. A cube has a side of length 2.342m. Find volume and surface area in correct significant figures.



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12. Find density when a mass of 9.23 kg occupies a volume of $1.1m^3$. Take care of significant figures.



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13. Length, breadth and thickness of a rectangular slab are 4.234 m, 1.005 m and 2.01 m respectively. Find volume of the slab to correct significant figures.



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14. The radius of a sphere is measured to be (2.1 ± 0.5) cm. Calculate its surface area with error limits .



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15. The temperature of two bodies measured by a thermometer are $(2.1 \pm 0.5)^\circ C$ and $(50 \pm 0.5)^\circ C$. Calculate the temperature difference with error limits.



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16. The resistance $R = \frac{V}{I}$, where $V = (100 \pm 5.0)V$ and $I = (10 \pm 0.2)A$. Find the percentage error in R .



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17. Find the percentage error in specific resistance given by $\rho = \frac{\pi r^2 R}{l}$ where r is the radius having value $(0.2 \pm 0.02)cm$, R is the resistance of $(60 \pm 2)ohm$ and l is the length of $(150 \pm 0.1)cm$.



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18. A physical quantity ρ is related to four variables α , β , γ and η as

$$\rho = \frac{(\alpha^3)(\beta^2)}{\eta\sqrt{\gamma}}$$

The percentage errors of measurements in α , β , γ and η are 1%, 3%, 4% and 2% respectively. Find the percentage error in ρ .



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19. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{L/g}$. Measured value of L is 20.0cm known to 1mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1 s resolution. What is the accuracy in the determination of g ?



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