TURBO

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Units and Dimensions

Class 11 Physics • Complete Formula Sheet

Sr.	Concept	Formulas	Other Information
1	Classification	Physical quantities are classified as: **Fundamental:** Independent of other quantities **Derived:** Dependent on other quantities	Examples of derived quantities: (1) Area (2) Force (3) Density
2	Fundamental quantities and their SI units	**Physical Quantity - Unit - Symbol** Length - metre - m Mass - kilogram - kg Time - second - s Temperature - kelvin - K Electric current - ampere - A Luminous intensity - candela - cd Amount of substance - mole - mol	These 7 quantities form the foundation of SI system
3	Relation between magnitude, numerical value and unit	$n_1 u_1 = n_2 u_2 = $ constant Or, $nu = $ constant	$n = $ numerical value $u = $ size of unit Product remains constant when unit changes
4	Supplementary quantities and their SI units	**Plane angle:** Radian (rad) $d\theta = \frac{ds}{r}$ **Solid angle:** Steradian (sr) $d\Omega = \frac{dA}{r^2}$	$r = $ radius $ds = $ arc length $dA = $ subtended area
5	Dimensional representation	$[M] \rightarrow$ for mass $[L] \rightarrow$ for length $[T] \rightarrow$ for time $[A] \rightarrow$ for electric current $[K]$ or $[\Theta] \rightarrow$ for temperature $[cd] \rightarrow$ for luminous intensity $[mol] \rightarrow$ for amount of substance	Square brackets denote dimensions of a physical quantity
6	Principle of Homogeneity	Only physical quantities having same dimension can be added or subtracted. For example: $A + B = C - D$ The quantities $A, B, C,$ and D have the same dimension.	Dimensions must match on both sides of equation
7	Converting physical quantity from one system to other	If dimension is $[M^a L^b T^c]$, then: $n_2 = n_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$	$n_1 = $ numerical value in 1st system $n_2 = $ numerical value in 2nd system $M_1, L_1, T_1 = $ units in 1st system $M_2, L_2, T_2 = $ units in 2nd system
		Significant Figures Rules	

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8	Rules to find significant figures (SF)	**Rule I:** All non-zero digits are significant. e.g. 1984 has 4 SF. **Rule II:** All zeros between two non-zero digits are significant. e.g. 10806 has 5 SF. **Rule III:** Zeros to left of first non-zero digit are not significant. e.g. 00108 has 3 SF. **Rule IV:** For numbers < 1, zeros right of decimal but left of first non-zero are not significant. e.g. 0.002308 has 4 SF. **Rule V:** Trailing zeros in number with decimal are significant. e.g. 01.080 has 4 SF. **Rule VI:** Trailing zeros without decimal may not be significant. e.g. 010100 has 3 SF. **Rule VII:** For $x \times 10^A$, SF determined by value of x only.	In multiplication/division, result has same SF as smallest number of SF in factors. e.g. $2.4 \times 3.65 = 8.8$ (2 SF)

Rounding Off Rules

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9	Rounding off	**Rule I:** If digit > 5, increase preceding digit by 1. e.g. $6.87 \rightarrow 6.9$ **Rule II:** If digit < 5, leave preceding digit unchanged. e.g. $3.94 \rightarrow 3.9$ **Rule III:** If digit $= 5$, increase preceding if odd, leave if even. e.g. $14.35 \rightarrow 14.4$ and $14.45 \rightarrow 14.4$	These rules minimize rounding errors in calculations
10	Significant figures for addition & subtraction	Answer equals smallest number of decimal places in original numbers. **Example:** $3.1421 + 0.241 + 0.09 = 3.4731$ Since 0.09 has 2 decimal places, answer $= 3.47$	Focus on decimal places, not total SF
11	Significant figures for multiplication & division	Answer equals smallest number of significant figures in any original number. **Example:** $51.028 \times 1.31 = 66.84668$ Since 1.31 has 3 SF, answer $= 66.8$	Focus on total SF, not decimal places

Measuring Instruments

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12	Least Count (Vernier Caliper)	Least Count = 1 MSD − 1 VSD $LC = 1\,MSD - \frac{1\,MSD}{n} = \frac{1\,MSD(n-1)}{n}$	If n VSD coincides with $(n-1)$ MSD Then: $1\,VSD = \frac{(n-1)\,MSD}{n}$ MSD = Main Scale Division VSD = Vernier Scale Division
13	Total reading (Vernier Caliper)	Total Reading = MSR + (Coinciding VSD × LC) TR = MSR + VSR = MSR + ($n\times$ VC)	$n = n^{\text{th}}$ division of vernier scale coinciding with main scale MSR = Main Scale Reading VC = Vernier Constant (LC)
14	Screw Gauge	Pitch $= \frac{\text{Distance moved in rotation}}{\text{No. of full rotations}}$ Least Count $= \frac{\text{Pitch}}{\text{Total divisions on circular scale}}$	Pitch is distance moved by screw in one complete rotation
15	Total reading (Screw Gauge)	Total Reading = L.S.R. + C.S.R. L.S.R. = Linear Scale Reading = N (pitch) C.S.R. = Circular Scale Reading = $n\times$ L.C. $\therefore$ TR = $N + n\times$ (L.C.)	n = division of circular scale coinciding with linear scale line

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16	Zero Error in Screw Gauge	**Negative Zero Error:** Zero of circular scale is below reference line **Positive Zero Error:** Zero of circular scale is above reference line Correct reading = (Reading) − (zero error)	Always subtract zero error from measured reading
17	Zero Error in Vernier Caliper	**Positive:** Zero of vernier scale is to right of main scale zero **Negative:** Zero of vernier scale is to left of main scale zero	Positive error: subtract Negative error: add
Error Analysis			
18	Absolute Error (Δa)	Absolute Error = True Value − Measured Value $\Delta a = a_T - a$ Mean absolute error: $\Delta a_{\text{mean}} = \frac{\Delta a_1 + \Delta a_2 + ... + \Delta a_n}{n} = \frac{1}{n}\sum_{i=1}^{n}\Delta a_i$	a_T = True (accepted) value a = Measured value n = number of measurements
19	Percentage Error	Percentage Error = Relative Error × 100% Percentage Error = $\frac{\text{Mean Absolute Error}}{\text{True Value}}$ × 100%	Relative Error = $\frac{\Delta a_{\text{mean}}}{a_T}$
20	Calculation of percentage errors (All Cases)	**Operation - Formula - Max % Error** **Sum:** $Z = A + B$ $\frac{\Delta Z}{Z} \times 100 = \left(\frac{\Delta A + \Delta B}{A+B}\right) \times 100$ **Difference:** $Z = A - B$ $\frac{\Delta Z}{Z} \times 100 = \left(\frac{\Delta A + \Delta B}{A-B}\right) \times 100$ **Product:** $Z = A \times B$ $\frac{\Delta Z}{Z} \times 100 = \left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right) \times 100$ **Division:** $Z = \frac{A}{B}$ $\frac{\Delta Z}{Z} \times 100 = \left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right) \times 100$ **Power:** $Z = A^n$ $\frac{\Delta Z}{Z} \times 100 = n\left(\frac{\Delta A}{A}\right) \times 100$	A, B = values of different physical quantities $\Delta A, \Delta B$ = absolute errors For product/division: errors add For power: multiply by exponent
21	Combination of errors (General rule)	If $Z = \frac{A^p B^q}{C^r}$, then maximum fractional error: $\frac{\Delta Z}{Z} = p\frac{\Delta A}{A} + q\frac{\Delta B}{B} + r\frac{\Delta C}{C}$ Percentage error: $\frac{\Delta Z}{Z} \times 100 = p\left(\frac{\Delta A}{A}\right) \times 100 + q\left(\frac{\Delta B}{B}\right) \times 100 + r\left(\frac{\Delta C}{C}\right) \times 100$	p, q, r = powers of variables Errors in product/quotient are additive when expressed as relative/percentage errors

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