Chapter 02

Unit & Measurement

JEE-RANKER'S STUFF

SINGLE CORRECT QUESTIONS

Q.1 The value of g = 9.81 m/s^2. Its numerical value in CGS system will be:

(1) 981 (2) 9.81

(3) 98.1 (4) 0.981

Q.2 Position of a body moving with acceleration 'a' is given by x = Ka^{m}t^n, here t is time. The values of m and n are given as (K is dimensionless)

(1) m = 1, n = 1 (2) m = 1, n = 2

(3) m = 2, n = 1 (4) m = 2, n = 2

Q.3 The position (x) of a particle at time t, is given by the relation, $x(t)=\frac{v_0}{\alpha}(1-e^{-\alpha t})$ at where v_0 is constant $\alpha > 0$. Find the The dimensions of v_0 and α are respectively

(1) [M^{0}L^{1}T^0], [T^{-1}] (2) [M^{0}L^{1}T^{-1}], [T]

(3) [M^{0}L^{1}T^{-1}], [T^{-1}] (4) [M^{1}L^{1}T^{-1}], [LT^{-2}]

Q.4 A unitless quantity:

(1) never has a nonzero dimension

(2) always has a nonzero dimension

(3) may have a nonzero dimension

(4) does not exit

Q.5 A quantity is represented by X = M^a L^b T^c. The percentage error in measurement of M, L and T are α%, β % and γ % respectively. The percentage error in X would be

(1) (α a + βb + γc) % (2) (αa – βb + γc) %

(3) (α a – βb– γc) % (4) None of these

Q.6 In a vernier calliper, N divisions of vernier scale coincide with (N – 1) divisions of main scale (in which 1 division represents 1mm). The least count of the instrument in cm. should be

(1) N (2) N – 1

(3) $\frac{1}{10N}$ (4) $\frac{1}{N-1}$

Q.7 The length of a cylinder is measured with a metre rod having least count 0.1 cm. Its diameter is measured with vernier callipers having least count 0.01 cm. Given the length is 5.0 cm. and radius is 2.00 cm. The percentage error in the calculated value of volume will be –

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

Q.8 A vernier callipers has 20 divisions on the vernier scale which coincide with 19 divisions on the main scale. The least count of the instrument is 0.1 mm. The main scale divisions are of

(1) 0.5 mm (2) 1 mm

(3) 2 mm (4) 1/4 mm

Q.9 In determination of acceleration due to gravity (g) using the formula $T=2\pi\sqrt{\frac{L}{g}}$, the errors in measurement of L and T are 1% and 2% respectively. The maximum percentage error in the value of g is :

(1) 5% (2) 4% (3) 3% (4) 1.5%

Q.10 The length and breadth of a metal sheet are 3.124 m and 3.002 m respectively. The area of this sheet upto four correct significant figures is:

(1) 9.37 m^2 (2) 9.378 m^2

(3) 9.3782 m^2 (4) 9.378248 m^2

Q.11 The length, breadth and thickness of a block are given by ℓ = 12cm, b = 6 cm and t = 2.45 cm. The volume of the block according to the idea of significant figures should be :

(1) 1×10^2 cm^3 (2) 2×10^2 cm^3

(3) 1.763×10^2 cm^3 (4) none of these

Q.12 A student performs an experiment for determination of $g=\left(\frac{4\pi^2\ell}{T^2}\right)$, $\ell \approx 1$m, and he commits an error of $\Delta\ell$. For The takes the time of n oscillations with the stop watch of least count ΔT and he commits a human error of 0.1 sec. For which of the following data, the measurement of g will be most accurate ?

(1) ΔL = 0.5, ΔT = 0.1, n = 20

(2) ΔL = 0.5, ΔT = 0.1, n = 50

(3) ΔL = 0.5, ΔT = 0.01, n = 20

(4) ΔL = 0.1, ΔT = 0.05, n = 50

Q.13 The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate. If the maximum error in the measurement of force and length are respectively 4% and 2%, the maximum error in the measurement of pressure is –

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

Q.14 The unit of percentage error is

(1) Same as that of physical quantity

(2) Different from that of physical quantity

(3) Percentage error is unit less

(4) Errors have got their own units which are different from that of physical quantity measured

Q.15 A physical quantity *X* is related to four variables *a*, *b*, *c* and *d* as follows, $X=\frac{a^2b^3}{c\sqrt{d}}$. Errors in measurement of *a*, *b*, *c*, *d* are 1%, 3%, 2% and 2% respectively. What is percentage error in quantity *X*?

(1) 12% (2) 8% (3) 14% (4) 5%

Q.16 If the energy $E = m^a c^b$ where m is the mass and c is the velocity of light, then the values of a and b are, respectively

(1) 1, 2 (2) 2, 1 (3) –1, 2 (4) –2, 1

Q.17 The equation of a stationary wave is

$$y=2A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right)$$

Which of the following is correct ?

(1) Unit of ct is same as that of λ

(2) Unit of x is not same as that of λ

(3) Unit of $\frac{2\pi c}{\lambda}$ is not same as that of $\frac{2\pi x}{\lambda t}$

(4) Unit of $\frac{c}{\lambda}$ is same as that of $\frac{x}{\lambda}$

Q.18 A physical quantity z depends on four observables a, b, c and d, as $z=\frac{a^2b^{\frac{2}{3}}}{\sqrt{c}d^3}$. 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

(1) 13.5 % (2) 14.5 %

(3) 16.5 % (4) 12.25 %

Q.19 Plank's constant h, speed of light c and gravitational constant G are used to form a unit of length L and a unit of mass M. Then the correct option(s) is(are)

(1) $M \propto \sqrt{c}$ (2) $M \propto 1/\sqrt{G}$

(3) $L \propto 1/\sqrt{h}$ (4) $L \propto 1/\sqrt{G}$

Q.20 A dimensionless quantity

(1) May have a unit (2) Must have a unit

(3) Must not have a unit

(4) None of these

NUMERICAL VALUE TYPE QUESTIONS

Q.21 While measuring the diameter of a wire by screw gauge, three readings taken are 1.002 cm, 1.004 cm and 1.006 cm. The absolute error in the third reading is:

Q.22 While measuring acceleration due to gravity by a simple pendulum, a student makes a positive error of 2% in the length of the pendulum and a positive error of 1% in the value of time period. His actual percentage error in the measurement of the value of g will be

Q.23 The length of a strip measured with a meter rod is 10.0 cm. Its width measured with a Vernier calipers is 1.00 cm. The least count of the meter rod is 0.1 cm and that of Vernier calipers 0.01 cm. What will be error in its area (cm^2)?

Q.24 The accuracy of a clock is one part in 10^{10}. The maximum difference between two such clocks operating for 10^{10} second is :

Q.25 If units of measurement of two systems are in the ratio 2 : 1 then the ratio of units of angular momentum be as shown on the side:

Q.26 The dimension of T in the dimensional formula for mobility are:

Q.27 If C is capacitance, V is potential, ρ is specific resistance and $\in_0$ is electric permittivity of free space, then the dimension of ampere (A) in $\frac{CV}{p \in_0}$ are:

Q.28 If σ is stefan's constant and b is Wien's constant, then the dimensions of length in σb^4 are:

STATEMENT TYPE QUESTIONS

Each of the following contains two statements. Read the statements and choose any one of the following four responses:

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

Q.29 **Statement-I:** Time period of oscillation of a liquid drop depends on surface tension (*S*). If density of the liquid is ρ and radius of the Drop is *r*. then $T = k\sqrt{\frac{\rho r^3}{S^{\frac{3}{2}}}}$ is dimensionally correct, where k is dimensionless.

Statement –II: Using dimensional analysis we get RHS having different dimension that of time period.

(1) A (2) B (3) C (4) D

Q.30 **Statement – 1** : Out of three measurements l = 0.7 m; l = 0.70 m and l = 0.700 m, the last one is most accurate.

Statement – 2 : In every measurement, only the last significant digit is not accurately known.

(1) A (2) B (3) C (4) D

Q.31 **Statement – 1** : nm is not same as m N

Statement – 2 : l nm = 10^{-9} m and 1 m N = 10^{-3} N

(1) A (2) B (3) C (4) D

Q.32 **Statement – 1:** Distance travelled in nth second has the dimensions of velocity.

Statement– 2 : Because it is the distance travelled in one (particular) second.

(1) A (2) B (3) C (4) D

Q.33 **Statement – 1:** Velocity gradient has the dimensions of frequency.

Statement – 2 : Velocity gradient is rate of change of velocity with distance.

(1) A (2) B (3) C (4) D

Q.34 **Statement – 1:** If error in measurement of distance and time are 3% and 2% respectively, error in calculation of velocity is 5%

Statement – 2 : Velocity = $\frac{\text{Distance}}{\text{time}}$

(1) A (2) B (3) C (4) D

Q.35 **Statement – 1 :** The dimensional formula of electric potential is $[ML^2T^{-3}A^{-1}]$

Statement – 2 : Electric potential is equal to work done.

(1) A (2) B (3) C (4)

MORE THAN ONE CORRECT TYPE QUESTIONS

Q.36 A student uses a simple pendulum of exactly 1m length to determine g, the acceleration due to gravity. He uses a stop watch with the least count of 1 sec for this and records 40 seconds for 20 oscillations. For this observation, which of the following statement(s) is (are) true?

(1) Error ΔT in measuring T, the time period, is 0.05 second

(2) Error ΔT in measuring T, the time period, is 1 second.

(3) Percentage error in the determination of g is 5%

(4) Percentage error in the determination of g is 2.5%

Q.37 Choose the correct statement(s):

(1) All quantities may be represented dimensionally in terms of the base quantities.

(2) A base quantity cannot be represented dimensionally in terms of the rest of the base quantities.

(3) The dimension of a base quantity in other base quantities is always zero.

(4) The dimension of a derived quantity is never zero in any base quantity.

Q.38 A parameter α is given by $\alpha = \frac{h}{\sigma\theta^4}$

(here σ = Stefan's constant, h = Planck's constant, θ = absolute temperature) then

(1) Dimension of 'α' will be $L^2 T^2$

(2) Unit of 'α' may be $m^2 s^2$

(3) Unit of 'α' may be $\frac{(\text{Weber})(\Omega)^2(\text{Farad})^2}{(\text{Tesla})}$

(4) Dimension of 'α' will be equal to dimension of $\left(\frac{Ri}{\phi_m}\right)$ where R = gas constant, i = Electrical current, ϕ_m = magnetic flux

COMPREHENSION TYPE QUESTIONS

Q.39 The Vander waal equation for 1 mole of a real gas is $\left(P+\frac{a}{V^2}\right)(V - b) = RT$ where P is the pressure,
V is the volume, T is the absolute temperature, R is the molar gas constant and a, b are Vander waal constants.

(i) The dimensions of a are the same as those of

(1) PV (2) PV^2 (3) P^2V (4) P/V

(ii) The dimensions of b are the same as those of

(1) P (2) V (3) PV (4) nRT

(iii) The dimensional formula for ab is

(1) ML^2T^{-2} (2) ML^4T^{-2}

(3) ML^6T^{-2} (4) ML^8T^{-2}

Q.40 If the measurement errors in all the independent quantities are known, then it is possible to determine the error in any dependent quantity. This is done by the use of series expansion and truncating the expansion at the first power of the error. For example, consider the relation z = x/y. If the errors in x, y and z are Δx, Δy and Δz, respectively, then

$$z \pm \Delta z = \frac{x \pm \Delta x}{y \pm \Delta y} = \frac{x}{y}\left(1+\frac{\Delta x}{x}\right)\left(1+\frac{\Delta y}{y}\right)^{-1}$$

The series expansion for $\left(1+\frac{\Delta y}{y}\right)^{-1}$, to power in $\Delta y/y$, is $1 \pm (\Delta y/y)$. The relative errors in independent variables are always added. So the error in z will be $\Delta z = z\left(\frac{\Delta x}{x}+\frac{\Delta y}{y}\right)$.

The above derivation makes the assumption the $\Delta x/x << 1$, $\Delta y/y << 1$. Therefore, the higher powers of these quantities are neglected.

Choose the correct answer :

Consider the ratio $r = \frac{(1-a)}{(1+a)}$ to be determined by measuring a dimensionless quantity a. If the error in the measurement of a is Δa ($\Delta a/a << 1$), then what is the error Δr in determining r ?

(i) (1) $\frac{\Delta a}{(1+a)^2}$ (2) $\frac{2\Delta a}{(1+a)^2}$

(3) $\frac{2\Delta a}{(1-a^2)}$ (4) $\frac{2a\Delta a}{(1-a^2)}$

(ii) In an experiment the initial number of radioactive nuclei is 3000. It is found that 1000 ± 40 nuclei decayed in the first 1.0 s. For $|x| << 1$, In (1 + x) = x up to first power in x. The error $\Delta\lambda$, in the determination of the decay constant λ, in s^{-1}, is

(1) 0.04 (2) 0.03

(3) 0.02 (4) 0.01

MATCH THE COLUMN TYPE QUESTIONS

Q.41 Suppose two students are trying to make a new measurement system so that they can use it like a code measurement system and others do not understand it. Instead of taking 1kg. 1m and 1 sec as basic unit they took unit of mass as a kg, the unit of length as b m and unite of time as γ second They called power in new system as ACME then match the two columns.

Column-I		Column-II	
I.	1N new system	**A.**	$\alpha^{-1}\beta^{-2}\gamma^2$
II.	1J in new system	**B.**	$\alpha^{-1}\beta^{-1}\gamma^2$
III.	1 pascal (SI unit of Pressure in new system)	**C.**	$\alpha^{-1}\beta\gamma^2$
IV.	**a ACME in watt**	**D.**	$\alpha^2\beta^2\gamma^{-3}$

Codes :-

	I	II	III	IV
(1)	B	A	C	D
(2)	C	B	D	A
(3)	A	B	D	C
(4)	C	D	A	B

Q.42 Match the column-I with the column –II and mark the correct option from the given codes.

Some physical quantities are given in column I and some SI units in which these quantities may be expressed are given in column-II Match the physical quantities in column-II and select the code.

Column-I		**Column-II**	
I.	Gravitational field intensity $I = \frac{GM_e}{R_e^2}$: where G = Gravitational constant M_e = mass of the earth R_e = radius of the earth	**A.**	$\frac{\text{joule}}{\text{mol}-\text{kelvin}}$
II.	Electric field intensity, $E = \frac{F}{Q}$ where F= force due to charge Q= electric charge	**B.**	$\frac{\text{newton}}{\text{kg}}$
III.	$R = \frac{V}{I}$: where V = potential difference across a resistance I = current in the resistance	**C.**	$\frac{\text{newton}}{\text{Coulomb}}$
IV.	Universal gas constant R = $\frac{PV}{nR}$,	**D.**	$\frac{\text{volt}}{\text{ampere}}$

	I	**II**	**III**	**IV**
(1)	B	A	C	D
(2)	C	B	D	A
(3)	B	C	D	A
(4)	C	D	A	B

ANSWER KEY

JEE-RANKER'S STUFF

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	3	1	1	3	3	3	1	2	2	4	4	3	3
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	1	1	2	1	1	0.002cm	0%	$\pm 0.2 cm^2$	1s	4	2	1	4	4	1
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39(i)**	**39(ii)**	**39(iii)**	**40(i)**	**40(ii)**	**41**	**42**
Ans.	1	1	1	2	3	1,3	1,2,3	1,2,3	2	2	4	2	3	1	3