IIT – JEE: 2025 **TW TEST** **DATE: 22/07/23**

TOPIC: UNITS & DIMENSIONS
ERRORS & MEASUREMENTS

SOLUTIONS

1. (B)

$\therefore\ E = \frac{1}{2}mv^2$

$\therefore$ % Error in $K.E.$

= % error in mass + 2 × % error in velocity

= 2 + 2 × 3 = 8 %

2. (B)

Number of significant figures are 3, because 10^3 is decimal multiplier.

3. (B)

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

$\therefore$ % error is volume = 3 × % error in radius

= 3 × 1 = 3%

4. (C)

$L + B = 2.331 + 2.1$

$= 4.431$

$= 4.4$ (Since least decimal place is 1)

5. (C)

Since C has maximum power among A, B, C & D

6. (A)

7. (D)

$$\left[\frac{0.003}{0.3} + \frac{2\times 0.005}{0.5} + \frac{0.06}{6}\right]\times 100$$

$$= \left[10^{-2} + 2\times 10^{-2} + 10^{-2}\right]\times 100 = \left[4\times 10^{-2}\right]\times 100 = 4$$

8. (B)

$$F = \frac{Gm_1m_2}{d^2} \Rightarrow G = \frac{Fd^2}{m_1m_2}$$

$$\therefore [G] = \frac{[MLT^{-2}][L^2]}{[M^2]} = [M^{-1}L^3T^{-2}]$$

9. (C)

Let $v^2 = k\rho^x g^y \lambda^z$.

Now by substituting the dimensions of each quantities and equating the powers of *M*, *L* and *T* we get $x = 0, y = 1, z = 1$.

10. (A)

By substituting the dimension of each quantity we get $T = [ML^{-1}T^{-2}]^a[L^{-3}M]^b[MT^{-2}]^c$

By solving we get $a = -\frac{3}{2}$, $b = \frac{1}{2}$ and $c = 1$

11. (A)

Acceleration $= \frac{\text{distance}}{\text{time}^2} \Rightarrow A = LT^{-2} \Rightarrow L = AT^2$

12. (D)

$\because$ Density, $\rho = \frac{M}{V} = \frac{M}{\pi r^2 L} \Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 2\frac{\Delta r}{r} + \frac{\Delta L}{L}$

$= \frac{0.003}{0.3} + 2\times\frac{0.005}{0.5} + \frac{0.06}{6}$

$= 0.01 + 0.02 + 0.01 = 0.04$

$\therefore$ Percentage error $= \frac{\Delta\rho}{\rho}\times 100 = 0.04\times 100 = 4\%$

13. (A)

The result should have 3 significant figures.

14. (D)

ct^2 must have dimensions of L

15. (A)

1 C.G.S unit of density = 1000 M.K.S. unit of density

$\Rightarrow$ 0.5 gm/cc = 500 kg/m^3

16. (B)

$mv = \text{kg}\left(\frac{\text{m}}{\text{sec}}\right)$

17. (A)

Quantities having different dimensions can only be divided or multiplied but they cannot be added or subtracted.

18. (C)

19. (D)

20. (C)

Let $m \propto c^x G^y h^z$ or $m = K c^x G^y h^z$

Substituting the dimension of each quantity in both sides

$\left[M^1L^0T^0\right] = \left[LT^{-1}\right]^x\left[M^{-1}L^3T^{-2}\right]^y\left[ML^2T^{-1}\right]^z = \left[M^{-y+z}L^{x+3y+2z}T^{-x-2y-z}\right]$

Equating the power of *M*, *L* and *T* in both sides : $-y+z=1, x+3y+2z=0, -x-2y-z=0$

Solving above three equations $x = \frac{1}{2}$, $y = -\frac{1}{2}$ and $z = \frac{1}{2}$

$\therefore \quad m \propto c^{1/2} G^{-1/2} h^{1/2}$

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TOPIC: PERIODIC TABLE

SOLUTIONS

21. (C)
Newland, Lother Meyer and Mendeleev's all are based on Atomic weight.

22. (D)
They show variable oxidation states

23. (A)
Shielding effect order:
S > P > d > f

24. (A)
All the species are isoelectronic species and for such species radius $\propto \frac{1}{\text{number of nuclear charge}}$

25. (B)
Electron gain enthalpy is less negative down a group. But Cl has maximum negative value due to compact electronic configuration of F.

26. (D)
Electronegativity depends upon : charge on atom, Hybridisation and Effective Nuclear charge.

27. (D)
Li and Mg have diagonal relationship.

28. (B)
% ionic character
$= 16(x_A - x_B) + 3.5(x_A - x_B)^2$
$= 16\times0.5 + 3\cdot5(0.5)^2$
= 8.9

29. (B)
$11\text{Na} \rightarrow 1s^2\,2s^2\,2p^6\,3s^1$
$12\text{Mg} \rightarrow 1s^2\,2s^2\,2p^6\,3s^2$ extra stability due ns^2 configuration
$13\text{Al} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^1$
$14\text{Si} \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^2$
They are third period elements. Theoretical ionisation energy should be as follows
Na < Mg< Al < Si
But due to extra stability in its configuration ionisation energy of Al is less than the Mg.

30. (C)

→ increasing order

C	N
Si	P

↓ decreasing order

31. (C)
Electronic configuration of species after the removal of one electron i.e.,

${}_{6}C^{+1} = 1s^2 2s^2 2p^1$

${}_{7}N^{1+} = 1s^2 2s^2 2p^2$

${}_{8}O^{1+} = 1s^2 2s^2 2p^3$ (most stable configuration due to half filled subshell)

${}_{9}F^{1+} = 1s^2 2s^2 2p^4$

Thus O > F > N > C ionisation energy increases from left to right in a period.

32. (C)
Nitrogen has higher IE than oxygen due to the presence of half filled electronic configuration.

33. (C)

$$\text{size} \propto \frac{1}{\text{Nuclear charge}}$$

34. (C)
$1s^1$ and $1s^2 2s^2 2p^6 3s^1$ are first group elements. IE of first group is minimum. In first group IE decreases from top to bottom.

35. (A)

→ decreasing order

Li	Be
Na	
K	

↓ increasing order

36. (C)

$$E{\bullet}N = \frac{I{\bullet}E + E{\bullet}A}{5{\bullet}6}$$

Where $I{\bullet}E$ and $E{\bullet}A$ are in eV/atom.

$$E{\bullet}N = \frac{I{\bullet}E + E{\bullet}A}{544}$$

Where $I{\bullet}E$ and $E{\bullet}A$ are in kJ/mole.

37. (C)
Second electron affinity is endothermic due to repulsion between anion and electron.

38. (D)
Size: $P^{+3} > P^{+5}$

39. (C)

Size order: $N^{-3} > O^{-2} > F^{-}$

40. (B)

The elements with atomic number 9, 17, 35, 53 & 85 belong to halogens.

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TOPIC: TRIGONOMETRIC EQUATION

SOLUTIONS

41. (D)

$\frac{\sqrt{3}}{2}\cos\theta+\frac{1}{2}\sin\theta=\frac{\sqrt{2}}{2}$ dividing by $\sqrt{\left(\sqrt{3}\right)^2+1^2}=2$

$\Rightarrow \sin\left(\theta+\frac{\pi}{3}\right)=\frac{1}{\sqrt{2}}=\sin\left(\frac{\pi}{4}\right)$

$\Rightarrow \theta=n\pi+(-1)^n\frac{\pi}{4}-\frac{\pi}{3}$

42. (C)

$2\tan^2\theta=\sec^2\theta \Rightarrow 2\tan^2\theta=\tan^2\theta+1 \Rightarrow \tan^2\theta=1=\tan^2\left(\frac{\pi}{4}\right) \Rightarrow \theta=n\pi\pm\frac{\pi}{4}$

43. (B)

$\sqrt{3}\tan 2\theta+\sqrt{3}\tan 3\theta+\tan 2\theta\tan 3\theta=1 \Rightarrow \frac{\tan 2\theta+\tan 3\theta}{1-\tan 2\theta\tan 3\theta}=\frac{1}{\sqrt{3}} \Rightarrow \tan 5\theta=\tan\frac{\pi}{6}$

$\Rightarrow 5\theta=n\pi+\frac{\pi}{6} \Rightarrow \theta=\left(n+\frac{1}{6}\right)\frac{\pi}{5}$

44. (C)

$\sin 4\theta=\cos\theta-\cos 7\theta \Rightarrow \sin 4\theta=2\sin(4\theta)\sin(3\theta) \Rightarrow \sin 4\theta=0 \Rightarrow 4\theta=n\pi$

or $\sin 3\theta=\frac{1}{2}=\sin\left(\frac{\pi}{6}\right) \Rightarrow 3\theta=n\pi+(-1)^n\frac{\pi}{6} \Rightarrow \theta=\frac{n\pi}{4},\frac{n\pi}{3}+(-1)^n\frac{\pi}{18}$

45. (A)

It is obvious.

46. (A)

$3(\sin\theta-\cos\theta)=4\sin\theta\cos\theta \Rightarrow 3(\sin\theta-\cos\theta)=2\sin 2\theta$

Squaring both sides, we get $9(1-S)=4S^2$,

Where $S=2\sin 2\theta$ or $4S^2+9S-9=0$

$\therefore \quad (S+3)(4S-3)=0$ or $S=\frac{3}{4}$ as $S\neq -3$ or $\sin 2\theta=\frac{3}{4}=\sin\alpha$

$\therefore \quad 2\theta=n\pi+(-1)^n\alpha$ or $\theta=\frac{1}{2}\left[n\pi+(-1)^n\sin^{-1}\left(\frac{3}{4}\right)\right]$

47. (A)

We have $\cos 3x+\sin\left(2x-\frac{7\pi}{6}\right)=-2 \Rightarrow 1+\cos 3x+1+\sin\left(2x-\frac{7\pi}{6}\right)=0$

$\Rightarrow (1+\cos 3x)+1-\cos\left(2x-\frac{2\pi}{3}\right)=0$

$\Rightarrow 2\cos^2\frac{3x}{2}+2\sin^2\left(x-\frac{\pi}{3}\right)=0$

$\Rightarrow \cos\frac{3x}{2}=0$ and $\sin\left(x-\frac{\pi}{3}\right)=0$ is $x=2k\pi+\frac{\pi}{3}=\frac{\pi}{3}(6k+1)$ where $k\in Z$

48. (A)

$\tan(\pi\cos\theta)=\tan\left(\frac{\pi}{2}-\pi\sin\theta\right)$

$\therefore \sin\theta+\cos\theta=\frac{1}{2} \Rightarrow \cos\left(\theta-\frac{\pi}{4}\right)=\frac{1}{2\sqrt{2}}$

49. (B)

$(1+\tan\theta)(1+\tan\varphi)=2 \Rightarrow \frac{\tan\theta+\tan\varphi}{1-\tan\theta\tan\varphi}=1 \Rightarrow \tan(\theta+\varphi)=1 \Rightarrow \theta+\varphi=\frac{\pi}{4}=45^\circ$

50. (C)

$\tan\theta=-1=\tan\left(2\pi-\frac{\pi}{4}\right)$

$\cos\theta=\frac{1}{\sqrt{2}}=\cos\left(2\pi-\frac{\pi}{4}\right)$

Hence general value is $2n\pi+\left(2\pi-\frac{\pi}{4}\right)=2n\pi+\frac{7\pi}{4}$

51. (D)

We have,

$\cos^2\theta+\sin\theta+1=0 \Rightarrow 1-\sin^2\theta+\sin\theta+1=0 \Rightarrow \sin^2\theta-\sin\theta-2=0 \Rightarrow (\sin\theta+1)(\sin\theta-2)=0$

$\sin\theta=2$ which is not possible and $\sin\theta=-1$.

Therefore, solution of given equation lies in the interval $\left(\frac{5\pi}{4},\frac{7\pi}{4}\right)$.

52. (C)

The expression is $\frac{(1+\tan x+\tan^2 x)(1+\tan^2 x-\tan x)}{\tan^2 x}=\frac{(1+\tan^2 x)^2-\tan^2 x}{\tan^2 x}$

Obviously, $1+\tan^2 x\geq\tan^2 x, \forall x$

Hence, it is positive for all value of x.

53. (D)

$\operatorname{cosec}\theta+2=0 \Rightarrow \sin\theta=-\frac{1}{2} \Rightarrow \theta=210^\circ$ or 330°

54. (A)

Given $\sin x+\sin y+\sin z=-3$ is satisfied only when $x=y=z=\frac{3\pi}{2}$, for $x, y, z\in[0, 2\pi]$.

55. (D)

$3\cos x+4\sin x=6 \Rightarrow \frac{3}{5}\cos x+\frac{4}{5}\sin x=\frac{6}{5} \Rightarrow \cos(x-\theta)=\frac{6}{5}$ [where $\theta=\cos^{-1}\left(\frac{3}{5}\right)$]

So, that equation has no solution.

56. (C)

$3\sin^2 x-7\sin x+2=0 \Rightarrow 3\sin^2 x-6\sin x-\sin x+2=0 \Rightarrow 3\sin(\sin x-2)-(\sin x-2)=0$

$\Rightarrow (3\sin x-1)(\sin x-2)=0 \Rightarrow \sin x=\frac{1}{3}$ or 2

$\Rightarrow \sin x=\frac{1}{3}$ ($\because \sin x\neq 2$)

Let $\sin^{-1}\frac{1}{3}=\alpha$, $0<\alpha<\frac{\pi}{2}$ are the solutions in $[0, 5\pi]$.

Then $\alpha, \pi-\alpha, 2\pi+\alpha, 3\pi-\alpha, 4\pi+\alpha, 5\pi-\alpha$ are the solutions in $[0, 5\pi]$.

$\therefore$ Required number of solutions = 6.

57. (A)

$f(x)=\cos x-x+\frac{1}{2}$

$f(0)=\frac{3}{2}>0$

$f\left(\frac{\pi}{2}\right)=0-\frac{\pi}{2}+\frac{1}{2}=\frac{1-\pi}{2}<0$ $\left(\because \pi=\frac{22}{7}\text{ nearly}\right)$

$\therefore$ One root lies in the interval $\left[0, \frac{\pi}{2}\right]$.

58. (C)

$\sec\theta+\tan\theta=\sqrt{3}$ ...(i)

Also we have

$\sec^2\theta-\tan^2\theta=1$ ...(ii)

$\Rightarrow \sec\theta-\tan\theta=\frac{1}{\sqrt{3}}$ ...(iii)

Now (i) and (iii) gives,

$\tan\theta=\frac{1}{2}\left(\sqrt{3}-\frac{1}{\sqrt{3}}\right)=\frac{1}{\sqrt{3}}=\tan\left(\frac{\pi}{6}\right) \Rightarrow \theta n\pi+\frac{\pi}{6}$

$\therefore$ Solutions for $0\leq\theta\leq 2\pi$ are $\frac{\pi}{6}$ and $\frac{7\pi}{6}$.

Hence there are two solutions.

59. (D)

$\sin x \cos x = 2$ or $\sin 2x = 4$ which is impossible.

60. (A)

$\tan(3x-2x)=\tan x=1 \Rightarrow x=n\pi+\frac{\pi}{4}$

But this value does not satisfy the given equation.
Hence, option (A) is the correct answer.