WEEKLY TEST MEDICAL PLUS -02 TEST - 03 Balliwala SOLUTION Date 21-07-2019

[PHYSICS]

1.

2. $F = \frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{r^2}$; $\therefore$ unit of $\varepsilon_0 = \frac{(\text{coulomb}^2)}{(\text{newton} - m^2}$

3. Here, $\frac{2\pi}{\lambda}(ct - x)$ is dimensionless. Hence, $\frac{ct}{\lambda}$ is also dimensionless and unit of ct is same as that of x.
Therefore, unit of λ is same as that of x. Also unit of y is same as that of A, which is also the unit of x.

4. We know that the units of physical quantities which can be expressed in terms of fundamental units are called derived units. Mass, length and time are fundamental units but volume is a derived unit (as $V = L^3$)

5.

6. $CR = \frac{q}{V} \times \frac{V}{I} = \frac{q}{q/t} = t$
$[CR] = [T]\ [M^0L^0T]$

7. $[a] = [PV^2]$
$= \left[\frac{FV^2}{A}\right] = \frac{[ML^{-2}T^6]}{[L^2]} = [MLT^{5-2}]$

8. $E = hv$ or $[h] = \left[\frac{E}{v}\right] = \frac{[ML^2T^{-2}]}{[T^{-1}]} = [ML^2T^{-1}]$

9. We know that dimension of velocity of light $[c] = [M^0LT^{-1}]$; dimension of gravitational constant $[G] = [M^1L^3T^{-2}]$ and dimension of Planck's constant $[h] = [M^1L^2T^{-2}]$. Solving the above three equations, we get; $[M] = [c^{1/2}G^{-1/2}h^{1/2}]$.

12. $\frac{\Delta V}{V} = 3 \times \frac{\Delta r}{r} = 3 \times \frac{1}{100} = \frac{3}{100} = 3\%$

13. Given length (ℓ) = 3.124 m and breadth (b) = 3.002 m. We know that area of the sheet (A) = $\ell \times b$ = 3.124× 3.002 = 9.378248 m^2. Since, both length and breadth have four significant figures, therefore area of the sheet after rounding off to four significant is 9.378 m^2.

14. $\frac{[h]}{[I]} = \frac{[E\lambda]}{[CI]} = \frac{[ML^2T^{-2}][L]}{[LT^{-1}][ML^2]}$
$= [T^{-1}] = [\text{frequency}]$.

15. Unit of energy = $[F]^x\ [A]^y\ [T]^z$
$[M]^1\ [L]^2\ [T]^{-2} = [MLT^{-2}]^x\ [M^0LT^{-2}]^y\ [M^0L^0T^1]^z$
or $[M]^1\ [L]^2\ [T]^{-2} = M^xL^{x+y}T^{-2x-2y+z}$
For equality,
$x = 1,\ x + y = 2$ or $y = 1$
$-2x - 2y + z = -2$ or $z = 2$
$\therefore$ Unit of energy = $[F]^1\ [A]^1\ [T]^2$

16. $P = \frac{\sqrt{abc^2}}{d^3 e^{1/3}}$

$= \frac{\Delta P}{P} \times 100$

$= \left[\frac{1}{2} \times \frac{\Delta a}{a} + \frac{1}{2} \times \frac{\Delta b}{b} + \frac{\Delta c}{c} + 3 \times \frac{\Delta d}{d} + \frac{1}{3} \times \frac{\Delta e}{e}\right] \times 100$

$= \left[\frac{1}{2} \times 2\% + \frac{1}{2} \times 3\% + 2\% + 3 \times \% + \frac{1}{3} \times 6\%\right]$

= [1% + 1.5% + 2% + 3% + 2%]

The minimum amount of error is contributed by the measurement of a.

17. $y = \frac{a^4 b^2}{(cd^4)^{1/3}}$

Taking log on both sides,

$\log y = 4\log a + 2\log b - \frac{1}{3}\log c - \frac{4}{3}\log d$

Differentiating,

$\frac{\Delta y}{y} = 4\frac{\Delta a}{a} + 2\frac{\Delta b}{b} - \frac{1}{3}\frac{\Delta c}{c} - \frac{4}{3}\frac{\Delta d}{d}$

Percentage error in y,

$\frac{\Delta y}{y} \times 100 = 4\left(\frac{\Delta a}{a} \times 100\right) + 2\left(\frac{\Delta b}{b} \times 100\right) + \frac{1}{3}\left(\frac{\Delta c}{c} \times 100\right) + \frac{4}{3}\left(\frac{\Delta d}{d} \times 100\right)$

$= [4 \times 2\% + 2 \times 3\% + \frac{1}{3} \times 4\% + \frac{4}{3} \times \%] = 22\%$

18. E = $[ML^2T^{-2}]$, G = $[M^{-1}L^3T^{-2}]$, I = $[MLT^{-1}]$ and M = [M]

$\therefore$ Dimensions of $\frac{GIM^2}{E^2}$

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

19. Let $v \propto \sigma^a \rho^b \lambda^c$

Equation dimensions on both sides,

$[M^0L^1T^{-1}] \propto [MT^{-2}]^a [ML^{-3}]^b [L]^c$

$\propto [M]^{a+b} [L]^{-3b+c} [T]^{-2a}$

Equation the powers of M, L, T on the both sides, we get;

a + b = 0

– 3b + c =1

– 2a = – 1

Solving, we get;

$a = \frac{1}{2}, b = -\frac{1}{2}, c = -\frac{1}{2}$

$\therefore$ $v \propto \sigma^{1/2} \rho^{-1/2} \lambda^{-1/2}$

$\therefore$ $v^2 \propto \frac{\sigma}{\rho\lambda}$

20. 1/8th of the circumference $= \frac{360^o}{8} = 45^o$

Change in velocity, $\sqrt{v^2 + v^2 - 2v^2 \cos 45^o} = 0.765v$

23. $[\text{Energy density}] = \left[\dfrac{\text{Work done}}{\text{Volume}}\right] = \dfrac{[MLT^{-2}.L]}{[L^3]}$

$[\text{Young's modulus}] = [Y] = \left[\dfrac{\text{Force}}{\text{Area}}\right] \times \dfrac{[\ell]}{\Delta\ell}$

$= \dfrac{[MLT^{-2}]}{[L^2]} . \dfrac{[L]}{[L]} = [ML^{-1}T^{-2}]$

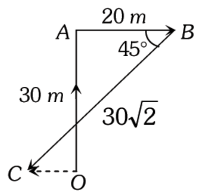
The dimensions of 1 and 4 are the same.

26. (a) $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \quad \therefore r = \sqrt{x^2 + y^2 + z^2}$

$r = \sqrt{6^2 + 8^2 + 10^2} = 10\sqrt{2}\ m$

27. (a) $\vec{r} = 20\hat{i} + 10\hat{j} \qquad \therefore r = \sqrt{20^2 + 10^2} = 22.5\ m$

28. (c) From figure, $\overrightarrow{OA} = 0\hat{i} + 30\hat{j}$, $\overrightarrow{AB} = 20\hat{i} + 0\hat{j}$



$\overrightarrow{BC} = -30\sqrt{2}\cos 45°\hat{i} - 30\sqrt{2}\sin 45°\hat{j} = -30\hat{i} - 30\hat{j}$

$\therefore$ Net displacement, $\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AB} + \overrightarrow{BC} = -10\hat{i} + 0\hat{j}$

$|\overrightarrow{OC}| = 10\ m.$

29. (a) An aeroplane flies 400 *m* north and 300 *m* south so the net displacement is 100 *m* towards north.

Then it flies 1200 *m* upward so $r = \sqrt{(100)^2 + (1200)^2}$

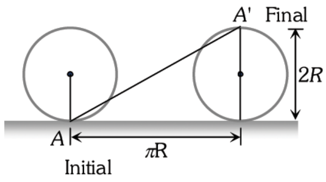
$= 1204\,m \simeq 1200\,m$

The option should be 1204 *m*, because this value mislead one into thinking that net displacement is in upward direction only.

30. (b) Total time of motion is 2 *min* 20 *sec* = 140 *sec*.

As time period of circular motion is 40 *sec* so in 140 *sec*. athlete will complete 3.5 revolution *i.e.*, He will be at diametrically opposite point *i.e.*, Displacement = 2*R*.

31. (c) Horizontal distance covered by the wheel in half revolution = πR.



So the displacement of the point which was initially in contact with ground = $AA' = \sqrt{(\pi R)^2 + (2R)^2}$

$= R\sqrt{\pi^2+4} = \sqrt{\pi^2+4}$ (As $R = 1m$)

32. (d) As the total distance is divided into two equal parts therefore distance averaged speed $= \frac{2v_1v_2}{v_1+v_2}$

33. (d) $\frac{v_A}{v_B} = \frac{\tan\theta_A}{\tan\theta_B} = \frac{\tan 30°}{\tan 60°} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

34. (b) Distance average speed $= \frac{2v_1v_2}{v_1+v_2} = \frac{2\times 20\times 30}{20+30}$

$= \frac{120}{5} = 24\ km/hr$

35. (b) Distance average speed $= \frac{2v_1v_2}{v_1+v_2} = \frac{2\times 2.5\times 4}{2.5+4}$

$= \frac{200}{65} = \frac{40}{13} km/hr$

36. (c) Distance average speed $= \frac{2v_1v_2}{v_1+v_2} = \frac{2\times 30\times 50}{30+50}$

$= \frac{75}{2} = 37.5\ km/hr$

37. (d) Average speed $= \frac{\text{Total distance}}{\text{Total time}} = \frac{x}{t_1+t_2}$

$= \frac{x}{\frac{x/3}{v_1}+\frac{2x/3}{v_2}} = \frac{1}{\frac{1}{3\times 20}+\frac{2}{3\times 60}} = 36\ km/hr$

38. (a) Time average speed $= \frac{v_1+v_2}{2} = \frac{80+40}{2} = 60 km/hr$.

39. (b) Distance travelled by train in first 1 *hour* is 60 *km* and distance in next 1/2 *hour* is 20 *km*.

So Average speed $= \frac{\text{Total distance}}{\text{Total time}} = \frac{60+20}{3/2}$

$= 53.33\ km/hour$

40. D

41. (c) Total distance to be covered for crossing the bridge

= length of train + length of bridge

$= 150m + 850m = 1000m$

$\text{Time} = \frac{\text{Distance}}{\text{Velocity}} = \frac{1000}{45\times\frac{5}{18}} = 80\ sec$

42. (c) Displacement of the particle will be zero because it comes back to its starting point

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}} = \frac{30m}{10\ sec} = 3\ m/s$$

43. (d) Velocity of particle $= \frac{\text{Total diplacement}}{\text{Total time}}$

$$= \frac{\text{Diameter of circle}}{5} = \frac{2 \times 10}{5} = 4\ m/s$$

44. (d) A man walks from his home to market with a speed of $5\ km/h$. Distance $= 2.5\ km$ and time

$$= \frac{d}{\upsilon} = \frac{2.5}{5} = \frac{1}{2} hr.$$

and he returns back with speed of $7.5\ km/h$ in rest of time of 10 *minutes*.

Distance $= 7.5 \times \frac{10}{60} = 1.25\ km$

So, Average speed $= \frac{\text{Total distance}}{\text{Total time}}$

$$= \frac{(2.5 + 1.25)km}{(40/60)hr} = \frac{45}{8} km/hr.$$

45. (b) $\frac{|\text{Average velocity}|}{|\text{Average speed}|} = \frac{|\text{displacement}|}{|\text{distance}|} \le 1$

because displacement will either be equal or less than distance. It can never be greater than distance.

[CHEMISTRY]

46.

47.

$l = 3$ stands for f-subshell that can accomodate at the maximum **14 electrons.**

48.

49.

50.

$l = 3$ (f-subshell) $\Rightarrow (2l + 1)$, *i.e.*, **7 orbitals.**

51.

$$r = \frac{0.529n^2}{Z} \text{Å} \quad \Rightarrow \quad A = 2\pi \left(\frac{0.529n^2}{Z} \right)^2$$

$$\frac{A_2}{A_1} = \frac{(2^2)^2}{(1^2)^2} = \mathbf{16 : 1}$$

52.

53.

(ii) $l = 2$ is not allowed for $n = 2$.

(iv) $m = -1$ is not allowed for $l = 0$.

(v) $m = 3$ is not allowed for $l = 2$.

54.

A subshell has $(2l + 1)$ orbitals and $2(2l + 1)$, *i.e.*, $\mathbf{(4l + 2)}$ electrons.

55.

For $l = 2$, m value '– 3' is not possible.

56.

$$\text{KE per atom} = \frac{(4.4 \times 10^{-19}) - (4.0 \times 10^{-19})}{2} = \mathbf{2.0 \times 10^{-20}\ J}$$

57.

$2p^4$ is | ↑↓ | ↑ | ↑ | with **two** unpaired electrons.

58.

Co^{3+}, $Z = 27$ has V.S. electronic configuration $3d^6$.

59.

It is according to Aufbau principle, or $7s\,6f\,5d\,7p$.

60.

Orbital angular momentum

$$= \sqrt{l(l+1)} \times \frac{h}{2\pi}$$

$$= \sqrt{1(1+1)} \times \frac{h}{2\pi} \quad (\text{For } p,\ l = 1)$$

$$= \sqrt{2} \times \frac{h}{2\pi} = \frac{\mathbf{h}}{\sqrt{\mathbf{2}}\,\pi}$$

61.

Valence electron is $5s^1$

$\Rightarrow \quad n = 5, l = 0, m = 0, s = +\frac{1}{2}$

62.

$n = 4, l = 3 \quad \Rightarrow 4f$ subshell

Total electrons $= 2\,(2l + 1)$

$= 2 \times (2 \times 3 + 1) = \mathbf{14}$

63.

The set of quantum number

$n = 3, l = 1, m = -1$

stands for a single p-orbital which will have at the most **2-electrons.**

64.

$m = 0$, represents only **one** orbital.

65.

Cr ($Z = 24$) : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

Total electrons in $l = 1$, *i.e.*, p-subshell $= 6 + 6 = \mathbf{12}$

Total electrons in $l = 2$, *i.e.*, d-subshell $= \mathbf{5}$**.**

66.

Cr^{2+}: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$: d-electrons = 4

Ne : $1s^2 2s^2 2p^6$: s-electrons = 2 + 2 = 4

Fe : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$: d-subshell has 4 unpaired electrons.

O : $1s^2 2s^2 2p^4$: p-electrons = 4

Fe^{3+}: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$: d-electrons = 5

67.

'$n + l$' rule is not applicable to H-atom. Energy system is

$$1s < 2s = 2p < 3s = 3p = 3d < \dots .$$

So, energy in H-atom is related with ***n* value** only.

68.

F $(Z = 9)$: $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2$.

9^{th} electron is $2p_y^1$, which has $n = 2, l = 1, m = \pm 1$ (By convention, for p_x and p_y),

$s = +\frac{1}{2}$ or $-\frac{1}{2}$.

69.

Number of spherical or radial nodes is $(n - l - 1)$.

For $1s$, $n - l - 1 = 1 - 0 - 1 = 0$ For $2p$, $n - l - 1 = 2 - 1 - 1 = 0$

For $3d$, $n - l - 1 = 3 - 2 - 1 = 0$ For $4f$, $n - l - 1 = 4 - 3 - 1 = 0$

70.

$\mathbf{Ti^{2+}}$ $(Z = 22)$, $\mathbf{V^{3+}}$ $(Z = 23)$, $\mathbf{Cr^{4+}}$ $(Z = 24)$ and $\mathbf{Mn^{5+}}$ $(Z = 25)$ have same electronic configuration [Ar] $3d^2$. They have the same number of $3d$-electrons, *i.e.*, 2.

71.

$$\frac{(\Delta x \cdot m \cdot \Delta v)_e}{(\Delta x \cdot m \cdot \Delta v)_p} = \frac{h/4\pi}{h/4\pi} = 1$$

$$\frac{m_e \cdot \Delta v_e}{m_p \cdot \Delta v_p} = \mathbf{1}$$

$$\frac{\Delta v_e}{\Delta v_p} = \frac{m_p}{m_e} = \mathbf{1836:1}$$

72.
73.
74.
75. **Mn^{2+} due to presence of five unpaired ele electrons has maximum magnetic moment**.
76.
77.
78.
79.
80.

81. $\lambda = \frac{h}{mv}; m = lg = 10^{-3}\ kg, v = 100 ms^{-1}, h = 6.626 \times 10^{-34}\ Js$

$\therefore \lambda \frac{6.626 \times 10^{-34}\ Js(kgm^2 s^{-1})}{10^{-3}\ kg \times 100\ ms^{-1}} = 6.626 \times 10^{-33}\ m$

82.

n = 3, l = 0 (3s); n = 3, l = 1(3p)
n = 3, l = 2(3d); n = 4, l = 4(4s)
3d has higher energy than 4s because it has higher (n + l) value. The increasing order of energies is :
3s < 3p < 4s < 3d

83.
84. **Number of orbitals in an energy level $n^2 = 4^2 = 16$**
85. **Outermost electron of sodium is $3s^1$.**
86. **$_{29}Cu = [_{18}Ar]3d^{10}4s^1$ $\therefore$ $Cu^{2+} = [_{18}Ar]3d^9 4s^0$**

98. Species :	**$_{19}K$**	**$_{20}Ca^{2+}$**	**$_{21}Sc^{3+}$**	
No. of es	**19–1 = 18**	**20–2 = 18**	**21–3 = 18**	**17 + 1 = 18**

87.
88.
89. **$_{58}Ce : [_{54}Xe]4f^2 5d^0 6s^2$**

$\therefore$ **$Ce^{3+} : [_{54}Xe]4f^1$**

90. **$_{37}Rb : [Kr]5s^1$**

$\therefore$ **Valence electron in R_b is $5s^1$ and its quantum numbers are :**

n = 5, l = 0, m = 0, $s = +\frac{1}{2}$