WEEKLY TEST MEDICAL PLUS -02 TEST - 07 RAJPUR SOLUTION Date 18-08-2019

[PHYSICS]

1. $[n]$ = Number of particles crossing a unit area in unit time = $[L^{-2}T^{-1}]$

$[n_2] = [n_1]$ = number of particles per unit volume = $[L^{-3}]$

$[x_2] = [x_1]$ = positions

$\therefore \quad D = \frac{[n][x_2 - x_1]}{[n_2 - n_1]} = \frac{[L^{-2}T^{-1}] \times [L]}{[L^{-3}]} = [L^2T^{-1}]$

2. Given equation is dimensionally correct because both sides are dimensionless but numerically wrong because the correct equation is $\tan\theta = \frac{v^2}{rg}$.

3. By the principle of dimensional homogeneity

$$[P] = \left[\frac{a}{V^2}\right] \Rightarrow [a] = [P] \times [V^2] = [ML^{-1}T^{-2}][L^6]$$

$$= [ML^5T^{-2}]$$

4. Given, $A = 1.0 \text{ m} \pm 0.2 \text{ m}$, $B = 2.0 \text{ m} \pm 0.2 \text{ m}$

Let, $Y = \sqrt{AB} = \sqrt{(1.0)(2.0)}\ 1.414 \text{ m}$

Rounding off to two significant digit $Y = 1.4$ m

$$\frac{\Delta Y}{Y} = \frac{1}{2}\left[\frac{\Delta A}{A} + \frac{\Delta B}{B}\right]$$

$$= \frac{1}{2}\left[\frac{0.2}{1.0} + \frac{0.2}{2.0}\right] = \frac{0.6}{2 \times 2.0}$$

$$\Rightarrow \quad \Delta Y = \frac{0.6Y}{2 \times 2.0} = \frac{0.6 \times 1.4}{2 \times 2.0} = 0.212$$

Rounding off to one significant digit

$\Delta Y = 0.2$ m

Thus, correct value for

$$\sqrt{AB} = r + \Delta r = 1.4 \pm 0.2 \text{ m}$$

5. $g = 4\pi^2 \cdot \frac{l}{T^2}$

$$\Rightarrow \frac{\Delta g}{g}\times 100 = \frac{\Delta l}{l}\times 100 + 2\frac{\Delta T}{T}\times 100$$
$$= \frac{\Delta l}{l}\times 100 + 2\cdot\frac{\Delta t}{t}\times 100$$
$$= \frac{0.1}{20.0}\times 100 + 2\times\frac{1}{90}\times 100$$
$$= \frac{100}{200} + \frac{200}{90} = \frac{1}{2} + \frac{20}{9} \cong 3\%$$

6. (d) $F = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q_1Q_2}{r^2}$

$\Rightarrow \varepsilon_0 \propto \frac{Q^2}{F\times r^2}$

So ε_0 has units of $Coulomb^2/Newton\text{-}m^2$

7. (a) $[E] = [ML^2T^{-2}]$, $[m] = [M]$, $[l] = [ML^2T^{-1}]$ and $[G] = [M^{-1}L^3T^{-2}]$ Substituting the dimension of above quantities in the given formula :

$$\frac{El^2}{m^5G^2}\ \frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M^5][M^{-1}L^3T^{-2}]^2} = \frac{M^3L^6T^{-4}}{M^3L^6T^{-4}} = [M^0L^0T^0]$$

8. C

9. (a) Formula for viscosity $\eta = \frac{\pi pr^4}{8Vl} \Rightarrow V = \frac{\pi pr^4}{8\eta l}$

10. (c) From the principle of dimensional homogenity $[v] = [at] \Rightarrow [a] = [LT^{-2}]$. Similarly $[b] = [L]$ and $[c] = [T]$

11. (a) By substituting the dimensions in $T = 2\pi\sqrt{\frac{R^3}{GM}}$

we get $\sqrt{\frac{L^3}{M^{-1}L^3T^{-2}\times M}} = T$

12. (a) Dimension of $\alpha t = [M^0L^0T^0]$ $\therefore$ $[\alpha] = [T^{-1}]$

Again $\left[\frac{v_0}{\alpha}\right] = [L]$ so $[v_0] = [LT^{-1}]$

13. (d) $P = \frac{F}{A} = \frac{F}{l^2}$, so maximum error in pressure (P)

$$\left(\frac{\Delta P}{P}\times 100\right)_{\max} = \frac{\Delta F}{F}\times 100 + 2\frac{\Delta l}{l}\times 100$$

$=4\%+2\times 2\%=8\%$

14. $H = \frac{v^2 \sin^2\theta}{2g}$ and $R = \frac{v^2 \sin^2 2\theta}{g}$

Since, R = 2H, so $\frac{v^2 \sin 2\theta}{g} = 2\times\frac{v^2\sin^2\theta}{2g}$

or 2sinθ cosθ = sin²θ or or tanθ = 2

$\therefore$ $R = v^2 \times \frac{2}{g}\times \sin\theta\cos\theta$

$= \frac{2v^2}{g}\times\frac{2}{\sqrt{5}}\times\frac{1}{\sqrt{5}} = \frac{4v^2}{5g}$

15. For the preson to be able to catch the ball, the horizontal component of velocity of the ball should be same as the speed of the person, i.e.,

$v_0 \cos\theta = \frac{v_0}{2}$

or $\cos\theta = \frac{1}{2}$ or $\theta = 60^o$

16. Let, u_x = 3 m/s, a_x = 0

u_y = 0, a_y = 1 m/sec² and t = 4 sec

If v_x and v_y be the velocities after 4 sec respectively, then

$v_x = u_x + a_x t = 3\ ms^{-1}$

and $v_y = u_y + a_y t = 0 + 1 \times 4 = 4\ ms^{-1}$

$\therefore$ $v = \sqrt{v_x^2 + v_y^2} = \sqrt{3^2+4^2} = \sqrt{9+16} = 5\ m/s$

Angle made by the result velocity w.r.t. direction of initial velocities, i.e., x-axis, is

$\beta = \tan^{-1}\frac{v_y}{v_x} = \tan^{1}\left(\frac{4}{3}\right)$

17. $h = \frac{u^2\sin^2\theta}{2g}$, hence, $\frac{\Delta h}{h} = 2.\frac{\Delta u}{u}$

Since, $\frac{\Delta u}{u} = 2\%$, hence, $\frac{\Delta h}{h} = 4\%$

18. $R_{max.} = R = \frac{u^2}{g}$ or $u^2 = Rg$

Now, as $\text{range} = \frac{u^2 \sin 2\theta}{g}$

then, $\frac{R}{2} = \frac{Rg\sin 2\theta}{g}$

or $\sin 2\theta = \frac{1}{2} = \sin 30^o$

or $\theta = 15^o$

19. The horizontal range is the same for the angles of projection θ and $(90^o - \theta)$

$$t_1 = \frac{2u\sin\theta}{g}$$

$$t_2 = \frac{2u\sin(90^o - \theta)}{g} = \frac{2u\cos\theta}{g}$$

$$\therefore \quad t_1 t_2 = \frac{2u\sin\theta}{g} \times \frac{2u\cos\theta}{g} = \frac{2}{g}\left[\frac{u^2\sin 2\theta}{g}\right] = \frac{2}{g}R$$

where $R = \frac{u^2 \sin 2\theta}{g}$

Hence, $t_1 t_1 \propto R$.

20. Range = 150 = ut and

$$h = \frac{15}{100} = \frac{1}{2} \times gt^2$$

or $t^2 = \frac{2 \times 15}{100 \times g} = \frac{30}{1000}$

or $t = \frac{\sqrt{3}}{10}$

$$\therefore \quad u = \frac{150}{t} = \frac{150 \times 10}{\sqrt{3}} = 500\sqrt{3}\ ms^{-1}$$

21. $H = \frac{u^2 \sin^2\theta}{2g}$ or $80 = \frac{u^2\sin^2\theta}{2 \times 10}$

or $u^2 \sin\theta = 1600$

or $u\sin\theta = 40\ ms^{-1}$.

Horizontal velocity = $u\cos\theta$ = at

= 3 × 30 = 90 ms^{-1}

$$\frac{u\sin\theta}{u\cos\theta} = \frac{40}{90}$$

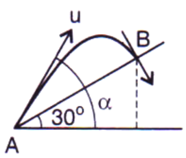
or $\tan\theta = \frac{4}{9}$ or $\theta = \tan^{-1}\left(\frac{4}{9}\right)$

22. $h = (u\sin\theta)t - \frac{1}{2}gt^2$

$d = (u\cos\theta)t$

or $t = \frac{d}{u\cos\theta}$

23. t_{AB} = time of flight of projectile $= \frac{2u\sin(\alpha - 30^o)}{g\cos 30^o}$



Now component of velocity along the plane becomes zero at point B.

$\therefore \quad 0 = u\cos(\alpha - 30^o) - g\sin 30^o \times T$

or $u\cos(\alpha - 30^o)$

$$= g\sin 30^o \times \frac{2u\sin(\alpha - 30^o)}{g\cos 30^o}$$

or $\tan(\alpha - 30^{o}) = \dfrac{\cot 30^{o}}{2} = \dfrac{\sqrt{3}}{2}$

$\therefore \quad \alpha = 30^{o} + \tan^{-1}\left(\dfrac{\sqrt{3}}{2}\right)$

24. Horizontal component of velocity,

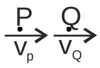
$u_H = u\cos 60^{o} = \dfrac{u}{2}$

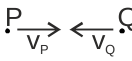
$\therefore \quad AC = u_H \times t = \dfrac{ut}{2}$

and AB = AC sec 30^{o}

$= \left(\dfrac{ut}{2}\right)\left(\dfrac{2}{\sqrt{3}}\right) = ut/\sqrt{3}$

25.

26.  $v_P - v_Q = 2.4$ m/s

 $v_P + v_Q = 6.0$ m/s

$\therefore$ $v_P = 4.2$ m/s; $v_Q = 1.8$ m/s

27. For the motion of first ball,
u = 0, a = g, t = 3s.
Let S_1 be the distance covered by the first ball in 3 sec.

$\therefore \quad S_1 = ut + \dfrac{1}{2}gt^2 = 0 + \dfrac{1}{2} \times 10 \times (3)^2 = 45$ m

Let S_2 be the distance covered by the second ball in 2 sec. Then

$S_2 = 0 + \dfrac{1}{2} \times 10 \times (2)^2 = 20$ m

$\therefore$ Separation between the two balls
= $S_1 - S_2$ = 45 – 20 = 25 m.

29. $s = 4t + \dfrac{1}{2}(1)t^2 = 2t + \dfrac{1}{2}(2)t^2$

$4t + 0.5t^2 = 2t + t^2$

Solving we get, t = 0 and t = 4s.

So, $s = 4 \times 4 + \dfrac{1}{2}(1)4^2 = 24$ m

30. $0 = 30t + \dfrac{1}{2}(-10)t^2 \Rightarrow t = 6$

31. Distance $= \sqrt{(dx)^2 + (dy)^2}$

$= \sqrt{\left(\dfrac{dy}{dt}\right)^2 + \left(\dfrac{dx}{dt}\right)^2}\, dt$

$= \sqrt{(24\sin 6t)^2 + (24\cos 6t)^2}\, dt$

$= 24\int_0^4 dt = 96$ m

32. Clearly A is the point such that OA is tangent to $y = (x-1)^3 + 1$ at the point A. Let point A be (x_1, y_1).

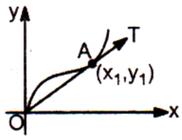
$\therefore$ $y = (x-1)^3 + 1$

$\Rightarrow \left[\dfrac{dy}{dx}\right]_{x = x_1} = 3(x_1 - 1)^2$

Hence equation of tangent at (x_1, y_1) is $(y - y_1) = 3(x_1 - 1)^2 (x - x_2)$

But this tangent passes through origin. Hence

$-y = -3x_1(x_1 - 1)^2 \Rightarrow y_1 = 3x_1(x_1 - 1)^2$



$\Rightarrow$ $(x - 1)^3 + 1 = 3x_1(x_1 - 1)^2$

$\Rightarrow$ $(2x_1 + 1)(x_1 - 1)^2 =$

$\Rightarrow$ $2x_1^3 - 3x_1^2 + 1 = 1 \Rightarrow x_1^2(2x_1 - 3) = 0$

$\Rightarrow$ $x_1 = \frac{3}{2}$

$\therefore$ A is $\left(\frac{3}{2}, \frac{9}{8}\right)$

33. $d = \int |\vec{v}|\, dt = \int_0^4 |t - 2|\, dt$

$= \int_0^2 (2 - t)dt + \int_2^4 (t - 2)\, dt = 4\text{metre}$

34. $d = \int_{t_2}^{t_1} |\vec{v}|\, dt = \int_4^5 |9 - 2t|\, dt$

$= \int_4^{4.5} (9 - 2t)dt + \int_{4.5}^5 (2t - 9)dt = \frac{1}{2}$ m

35. $\vec{\mathbf{r}} = a(1 - \cos\omega t)\hat{\mathbf{i}} + a\sin\omega t\,\hat{j}$

$\Rightarrow$ $x = a(1 - \cos\omega t)$ and $y = a\sin\omega t$

$\Rightarrow$ $(x - a) = -a\cos\omega t$ and $y = a\sin\omega t$

$\Rightarrow$ $(x - a)^2 + y^2 = a^2$

36. $12 = u(1) + \frac{1}{2}(a)(1)^2 = u + \frac{a}{2}$ ......(i)

$12 = (u + a)\left(\frac{3}{2}\right) + \frac{1}{2}(a)\left(\frac{3}{2}\right)^2$

$= \frac{13u}{2} + \frac{21}{8}a$ .....(ii)

Solving $a = -3.2$ m/s^2

37. $H = \frac{u^2 \sin^2\theta}{2g}$

or $80 = \frac{u^2 \sin^2\theta}{2 \times 10}$

or $u^2 \sin^2\theta = 1600$

or $u \sin\theta = 40$ ms^{-1}.

Horizontal velocity = $u\cos\theta = at$

$= 3 \times 30 = 90$ ms^{-1}

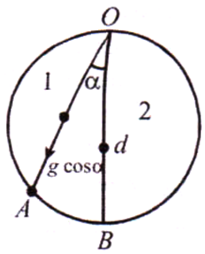
$\frac{u\sin\theta}{u\cos\theta} = \frac{40}{90}$

or $\tan\theta = \frac{4}{9}$ or $\theta = \tan^{-1}\left(\frac{4}{9}\right)$

38. $OA = d\cos\alpha$, $a_{OA} = g\cos\alpha$

Along

$\Rightarrow$ $v_A^2 = 2g\cos\alpha.\cos\alpha$



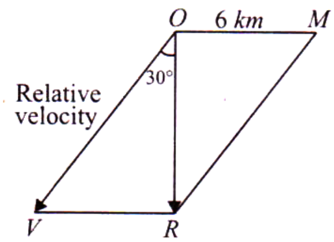
Along OB

$v^2_B = 2gd$

$\Rightarrow \quad \frac{v_B}{v_B} = \cos\alpha$

Hence, (C) is correct option.

39. Velocity of rain = Velocity of man + Relative velocity of rain OR gives the actual velocity.



$\tan 30^o = \frac{VR}{OR}$

$= \frac{1}{\sqrt{3}} = \frac{6}{OR}$

OR $= 6\sqrt{3}$

$\therefore$ Hence, the answer is (B)

40. $t = \frac{AB}{\sqrt{5^2 - 3^2}} = \frac{3}{4} = 45$ minutes

$\therefore$ Answer is (C)

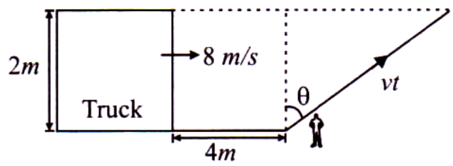
41. Disance covered in 15 minutes $= 5\text{km/hr} \times \frac{15}{60}\text{hr} = 1.25$ km

Extra distance along river covered $= \sqrt{(1.25)^2 - (1)^2} = 0.75$ km

Velocity of river $= \frac{0.75}{(15/60)\text{hr}} = \frac{0.75 \times 4}{1} = 3\text{km/hr}$

$\therefore$ Answer is (B)

42.



vt = 2secθ

Distance covered by truck = 8t = 4 + vtsinθ = 4 + 2 tanθ

$\Rightarrow \quad 8.\frac{2\sec\theta}{2+\tan\theta} = 4 + 2\tan\theta$

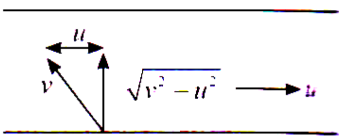
$\Rightarrow \quad v = \frac{8\sec\theta}{2+\tan\theta} = \frac{8}{2\cos\theta \times \sin\theta}$

For minimum velocity, $\frac{dv}{d\theta} = 0 \qquad \Rightarrow \tan\theta = \frac{1}{2}$

$\therefore \quad V_{min} = \frac{8\sqrt{1+1/4}}{2+1/2} = 1.6\sqrt{5}$

Hence (A) is correct option.

43. Let velocity of man in still water be v and that of water with respect to ground be u. Velocity of man downstream = v + u



As given, $\sqrt{v^2 - u^2}\ t = (v + u)T$

$\Rightarrow \quad (v^2 - u^2)t^2 = (v + u)^2T^2$

$\Rightarrow \quad (v - u)^2 = (v + u)T^2$

$\therefore \quad \frac{v}{u} = \frac{t^2 + T^2}{t^2 - T^2}$

∴ (C) is correct option

44.

[CHEMISTRY]

51. **Number of orbitals in an energy level $n^2 = 4^2 = 16$**

52. **Outermost electron of sodium is $3s^1$.**

53. **$_{29}Cu = [_{18}Ar]3d^{10}4s^1$ ∴ $Cu^{2+} = [_{18}Ar]3d^9 4s^0$**

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

54.

55.

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

∴ **$Ce^{3+} : [_{54}Xe]4f^1$**

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

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

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

86. $3d^3 5s^2$

Block-d

Period-5

Group-number electrons +(n –1) d electrons = 2 + 3 = 5 or (VB)

87. van der Waals Radii > Covalent radii

88. Orbitals bearing lower value of n will be more closer the nucleus and thus electron will experience greater attraction from nucleus and so its removal will be difficult, not easier.

89. (1) Be has completely filled stable valence shell configuration, i.e., $2s^2$ while in Be^+ because of positive charge, the removal of electron requires much higher energy. So, ionisation energy of Be^+ is greater than Be.

(2) Across the period, atomic size decreases and nuclear charge increases and thus valence shell electron(s) is/are tightly held by nucleus. So, ionisation energy of C is greatr than Be.

90. The difference of IP_4 and IP_5 is maximum

Valency = 4

Group = IVA or 14th

Family = Carbon family