PART (A) : PHYSICS

ANSWERS & SOLUTION

1. (B)

Let total distance = s

Let the time taken to cover first one third distance $= t_1$, then

$$t_1 = \frac{s/3}{4} = \frac{s}{12}$$

Now, let t_2 be the time for the rest two journeys.

Then $\frac{2s}{3} = 2t_2 + 6t_2 = 8t_2$

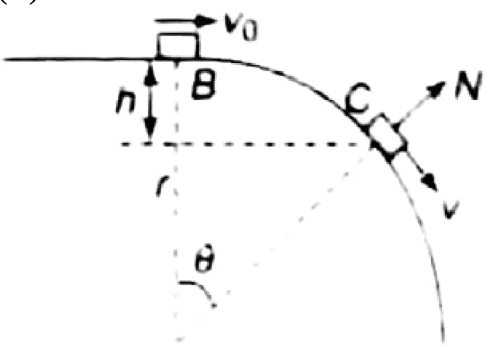
$\therefore \quad t_2 = \frac{2s}{24} = \frac{s}{12}$

$\therefore$ Average velocity $= \frac{\text{total displacement}}{\text{total time}}$

$$= \frac{s}{t_1 + 2t_2} = \frac{s}{\frac{s}{12} + \frac{s}{6}}$$

$$= \frac{12 \times 6}{12 + 6} = 4\,m/s$$

2. (B)



At point C : $mg\cos\theta - N = \frac{mv^2}{r}$

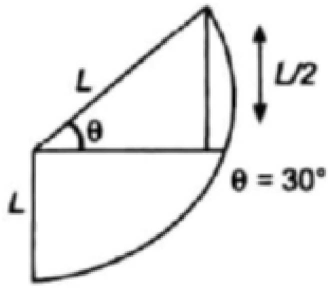
(When block leaves the surface normal force becomes zero, so putting $N = 0$) $\Rightarrow \; g\cos\theta = \frac{v^2}{r}$

$$v^2 = v_0^2 + 2gh,\; h = r - r\cos\theta$$

$$gr\cos\theta = \left(0.5\sqrt{gr}\right)^2 + 2g\left(r - r\cos\theta\right)$$

$$\Rightarrow \quad \cos\theta = \frac{1}{4} + 2 - 2\cos\theta \Rightarrow \cos\theta = \frac{3}{4}$$

3. (C)



String slacks at height $h = \frac{u^2 + gR}{3g} = 1.5L$

4. (D)

Since, the maximum tension T_B in the string moving in the vertical circle is at the bottom and minimum tension T_T is at the top.

$$\therefore \quad T_B = \frac{mv_B^2}{L} + mg \text{ and } T_T = \frac{mv_T^2}{L} - mg$$

$$\therefore \quad \frac{T_B}{T_T} = \frac{\frac{mv_B^2}{L} + mg}{\frac{mv_T^2}{L} - mg} = \frac{4}{1} \text{ or } \frac{v_B^2 + gL}{v_T^2 - gL} = \frac{4}{1}$$

or $\quad v_B^2 + gL = 4v_T^2 - 4gL$ but $v_B^2 = v_T^2 + 4gL$

$$\therefore \quad v_T^2 + 4gL + gL = 4v_T^2 - 4gL \Rightarrow 3v_T^2 = 9gL$$

$$\therefore \quad v_T^2 = 3 \times g \times L = 3 \times 10 \times \frac{10}{3} \text{ or } v_T = 10 \text{ m/sec}$$

5. (B)

Common acceleration of system,

$$a = \frac{3 \times 10 + 1 \times 10 - 2 \times 10}{3 + 1 + 2} = \frac{10}{3} \frac{m}{s^2}$$

FBD of 3 kg gives the equation

$$3 \times 10 - kx = 3a$$

Or $\quad 30 - (100)x = 3 \times \frac{10}{3}$

$$x = 0.2\,m$$

6. (B)

$$v = \frac{dS}{dt} = 2t + 2$$

From work–energy theorem;

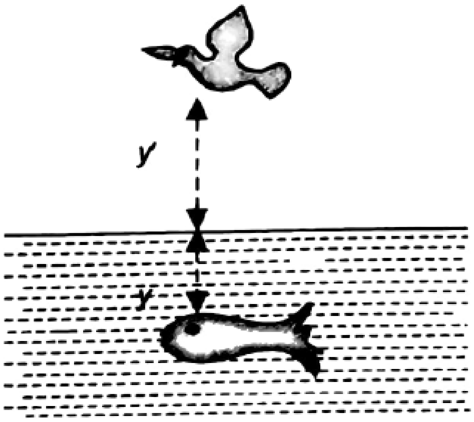
$$W_{net} = \Delta KE$$

$$= K_t - K_i = \frac{1}{2} m \left(v_f^2 - v_i^2\right)$$

$$=\frac{1}{2}\times 2\left[(2\times 4+2)^2-(2\times 2+2^2)\right]$$
$$=64\,\text{J}$$

7. (B)

Effective height of the bird as seen by the fish, Y



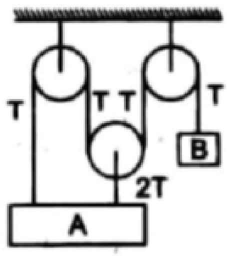
$$=y+my'$$
$$\frac{dy}{dt}=\frac{dy}{dt}+\mu\frac{dy'}{dt}$$
$$9=3+\frac{4}{3}\frac{dy'}{dt}$$

or $\frac{dy'}{dt}=\frac{6\times 3}{4}=\frac{18}{4}=\frac{9}{2}=4.5\,\text{ms}^{-1}$

∴ Actual velocity of bird

$$=4.5\,\text{ms}^{-1}$$

8. (A)



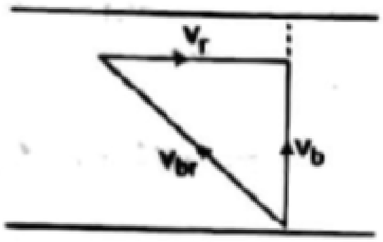
$T_A=3T$ and $T_B=T$

In such problems,

$$v\propto\frac{1}{T}$$

T_B is one third. Therefore v_B will be three times.

9. (B)



$$v_b = \frac{60}{5} = \sqrt{v_{br}^2 - v_r^2}$$

Or $12 = \sqrt{v_{br}^2 - 5^2}$

$\therefore \quad v_{br} = 13\,m/s$

10. (C)

Block P moves due to friction. Therefore maximum acceleration of 4 kg block may be:

$$a = \frac{\text{Maximum friction between P and Q}}{\text{mass of block P}}$$

$$= \frac{0.2 \times 4 \times 10}{4}$$

$$= 2\,m/s^2$$

11. (C)

Area under $F - t$ graph = Impulse $= \Delta P = m(v_f - v_i)$

$\therefore \quad v_f = \dfrac{\text{Area under F} - \text{t graph}}{m}$ as $v_i = 0$

$$= \frac{16-3}{2} = 6.5\,m/s$$

12. (B)

$\dfrac{P_1}{P_2} = -\dfrac{2}{3}$ and $\dfrac{F_2}{F_1} = \dfrac{-2}{3}$

$$\frac{1}{F_{eff}} = \frac{1}{F_1} + \frac{1}{F_2} = \frac{1}{30}$$

$\dfrac{1}{F_1} - \dfrac{3}{2F_1} = \dfrac{1}{30}$ or $F_1 = -15cm$

And $F_2 = 10\,cm$

13. (C)

The position of image of

M from surface is $= t/\mu$

$\therefore$ Distance of image from mirror $= d + t/\mu$

14. (B)

Initial length of spring $=\sqrt{(2R)^2+(1.5R)^2}=2.5R$

So, $x=2.5R-2R=0.5R$

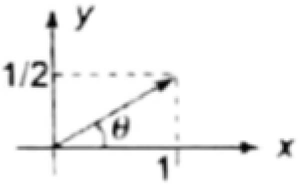
From conservation of energy : $\frac{1}{2}mv^2=mgh+\frac{1}{2}kx^2$

$\Rightarrow \frac{1}{2}mv^2=mg1.5R+\frac{1}{2}\frac{4mg}{R}(0.5R)^2$

$\Rightarrow v=2\sqrt{gR}$

15. (C)

$\vec{a}_{cm}=\frac{\vec{F}}{m}=\frac{16\hat{i}+8\hat{j}}{16}=\hat{i}+\frac{1}{2}\hat{j}$



$|\vec{a}_{cm}|=\sqrt{1^2+\left(\frac{1}{2}\right)^2}=\frac{\sqrt{5}}{2}\,\text{m/s}^2$

$\tan\theta=\frac{1.2}{1}\Rightarrow\theta=\tan^{-1}\left(\frac{1}{2}\right)$

16. (B)

Tension in the string:

$T=M(g-a)=M(g-g/2)=Mg/2$

$W=$ Force $\times$ Displacement $=-M(g/2)h$

17. (A)

$PV=\frac{m}{M}RT;\quad\therefore\frac{P}{T}=Cm$

or $\frac{\text{slope of } B}{\text{slope of } A}=\frac{m_B}{m_A}=\frac{3m}{m}=3$

18. (A)

$X_{cm}=\frac{m\times0+m\ell+m\times2\ell+\frac{m}{2}\frac{3\ell}{2}}{3.5m}$

$\Rightarrow X_{cm}=\frac{15m\ell}{4\times\frac{7}{2}m}=\frac{15\ell}{14}$

$Y_{cm}=\frac{m\times0+m\ell+m\ell+\frac{m}{2}2\ell}{\frac{7}{2}m}$

$$\Rightarrow \quad Y_{cm} = \frac{3m\ell}{\frac{7m}{2}} = \frac{6\ell}{7}$$

19. (D)

At $30^{o}C$, the copper rod will be of length $L_0(1+\alpha_C\Delta\theta)$ while adjacent centimeter marks on the steel tape will be separated by a distance of $(1cm)(1+\alpha_S\Delta\theta)$. Therefore, the number of centimeters read on the tape will be

$$\frac{L_0(1+\alpha_C\Delta\theta)'}{(1cm)(1+\alpha_S\Delta\theta)} \simeq 90.01cm$$

20. (B)

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

i.e., $v_{rms} \propto \sqrt{T}$

When temperature is increased from 120 K to 480 K (i.e., four times), the root mean square speed will become $\sqrt{4}$ or 2 times i.e., 2v.

21. (0.33 to 0.34)

Change in temperature of each rod,

$$\Delta T = 250 - 40 = 210\ ^{o}C$$

Clearly, change in length of the brass bar

$$\Delta L_b = \alpha_0 L\Delta T = (2.0\times10^{-5})\times50\times210 = 0.21\text{ cm}$$

and change in length of steel rod

$$\Delta L_S = \alpha_S L\Delta T = (1.2\times10^{-5})\times50\times210 = 0.126\text{ cm}$$

Since the ends of the rod are free to expand, change in the length of the combined rod

$$\Delta L = \Delta L_b + \Delta L_s = 0.21 + 0.13 = 0.34\text{ cm}$$

22. (375)

Temperature of mixture $\theta = \frac{m_1c_1\theta_1 \times m_2c_2\theta_2}{m_1C_1 + m_2\theta_2}$

$$\Rightarrow \quad 32 = \frac{m_1\times0.2\times40+100\times0.5\times20}{m_1\times0.2+100\times0.5}$$

$$\Rightarrow \quad m_1 = 375\text{ gm}$$

23. (64)

$$(mg)\left(\frac{1}{2}\frac{\text{cal}}{g\text{ - }^{o}C}\right)(T\ ^{o}C)+(mg)\left(80\ \frac{\text{cal}}{g}\right)\times\frac{40}{100}$$

$$=(mg)\left(1\frac{\text{cal}}{g\text{ - }^{o}\text{C}}\right)(T\ ^{o}\text{C})$$

or $(T/2)+32=T$

or $T=64\ ^{o}\text{C}$

24. (4)

$$T=\frac{2u_y}{g}$$

$\therefore$ $u_y=\frac{gT}{2}$

$$h_A=u_y t_A-\frac{1}{2}gt_A^2$$

$$=u_y\left(\frac{2u_y}{3g}\right)-\frac{1}{2}g\left(\frac{2u_y}{3g}\right)^2$$

$$=\frac{4}{9}\frac{u^2y}{g}=\left(\frac{4}{9g}\right)\left(\frac{gT}{2}\right)^2=\frac{gT^2}{9}$$

$$h_B=u_y\left(\frac{5}{6}\times\frac{2u_y}{g}\right)-\frac{1}{2}\times g\times\left(\frac{5}{6}\times\frac{2u_y}{g}\right)^2$$

$$=\frac{5}{18}\frac{u_y^2}{g}=\frac{5}{18g}\left(\frac{gT}{2}\right)^2=\frac{5}{72}gT^2$$

$\therefore$ $h_A-h_B=\frac{gT^2}{24}$

25. (1)

Net external force $F=\sqrt{(4)^2+(3)^2}=5\text{N}$

Maximum friction $f_{max}=\mu mg=(0.09)(5)(10)=4.5\text{N}$

Since $F>f_{max}$ block will not move with an acceleration,

$$a=\frac{F-f_{max}}{m}=\frac{5-4.5}{5}=0.1\text{m}/\text{s}^2$$

26. (0)

Heat rejected by 100 g of water at 80^{o}C when its temperature becomes 0^{o}C is

$Q=ms\Delta\theta=(100)(1)(80)=8000\,\text{cal}$

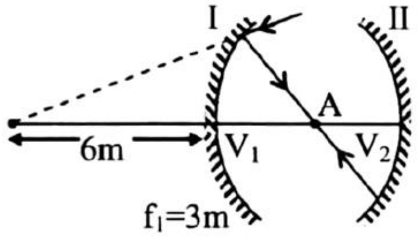
But this heat can melt $m=\frac{Q}{L}$

Or $\frac{8000}{80}=100\,\text{g}$ of ice only

Hence, the temperature of the mixture is 0^{o}C.

27. (2)

Ray passes from the point A after reflecting from first mirror. We do our calculations by taking point A object of second mirror.



$$\frac{1}{f}=\frac{1}{u}+\frac{1}{6}$$

$$-\frac{1}{3}-\frac{1}{6}=\frac{1}{u}$$

$u=-2m$

Point A is the center of the second mirror.

$V_1V_2=6m$

Center of the second mirror $=-4m=2f$

$f=-2m$

28. (6.1 to 6.5)

Conservation of energy principle

KE at $A=\frac{1}{2}\times1.0\times3.0^2=4.5\,J$

Loss in PE between A and B $=1.0\times10\times2=20\,J$

Gain in KE from A to B if there has been no friction = 20 J

Total KE at B if there had been no friction

$=4.5+20=24.5\,J$

But actual KE at $B=\frac{1}{2}\times1.0\times6^2=18\,J$

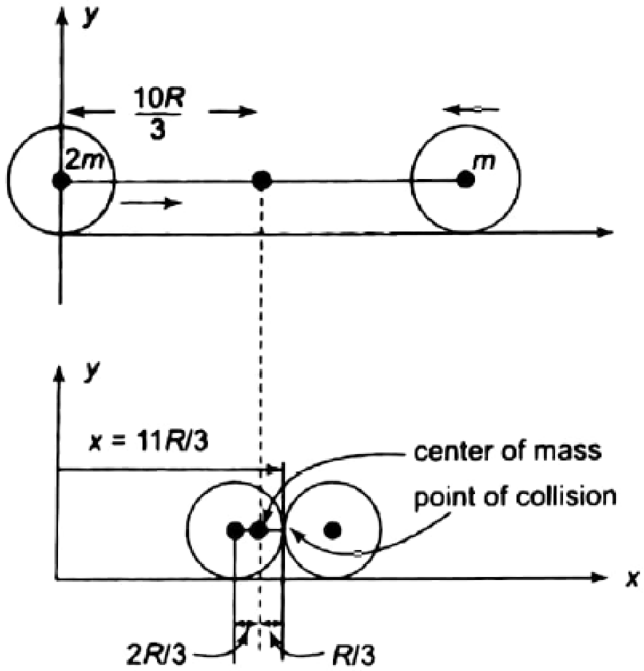
Loss in energy due to friction = 24.5 – 18 = 6.5 J

29. (11)

There is no external force on system (ball A and ball B). The balls moves due to mutual attraction that is internal force to the system. The centre of mass of the system will not move. The will collide at the position of centre of mass of ball A and B. It is easy to calculate the position of centre of mass at initial stage.

$$x_{cm}=\frac{m_A\times A+m_B\times B}{m_A+m_B}=\frac{m_A\cdot0+m_B\cdot10R}{(m_A+m_B)}$$

$$m_A=\frac{4}{3}\pi R^3\rho_A \text{ and } m_B=\frac{4}{3}\pi R^3\rho_B$$



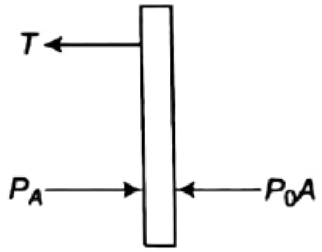
As $\rho A = 2\rho B \Rightarrow m_A = 2m_B$

Hence, $x_{cm} = \dfrac{m_B(10R)}{3m_B} = \dfrac{10R}{3}$

30. (11)

$T + P_0 A = PA$

$T = (P - P_0)A = \dfrac{3}{8}P_0 A$ (given)



$P = \dfrac{3}{8}P_0 + P_0 = \dfrac{11}{8}P_0$

Now volume is constant by string

So, $P \propto T$

Initial temperature is T_0.

PART (B) : CHEMISTRY

Answers & Solution

31. (C)

$$\Delta v = 150\left[\frac{1}{1^2} - \frac{1}{1\cdot 5^2}\right] = 83\,\text{V}$$

32. (D)

$$n_{N_2} = \frac{W}{28};\ n_{NH_3} = \frac{W}{17};\ n_{N_2O} = \frac{W}{44}$$

$$n_{NH_3} > n_{H_2} > n_{N_2O}$$

Also, $P \propto n$

33. (C)

Adding reactant (Cl_2) will drive reaction in forward direction.

34. (C)

$$K = \frac{(1.7)^2(5.1)}{(2.2)^2} = 3.04$$

35. (B)

$$\Delta H = \sum \Delta H_f^o \text{ (products)} - \sum \Delta H_f^o \text{ (reactants)}$$

$$= -246 - 242(-92\times 2 - 297) = -7\text{ kJ}$$

36. (A)

$$\Delta G^o = \Delta H^o - T\Delta S^o$$

$$\Rightarrow\ \Delta G_1^o - \Delta G_2^o = \Delta S^o(T_2 - T_1)$$

$$\Rightarrow\ \Delta S^o = \frac{(50-30)1000}{350-250} = 200$$

37. (B)

$$M_1V_1 + M_2V_2 + M_3V_3 = MV$$

$$\Rightarrow\ M = \frac{50\times 2 + 100\times 1 + 100\times 0.5}{250} = 1.0\text{ M}$$

38. (C)

$$dq = C_V dT + pdV + \frac{3}{2}R\,dT + pdV$$

Also given $p^2V = K$

$\Rightarrow\ V \times 2pdP + p^2dV = 0$

$\Rightarrow\ 2Vdp = -pdV$

For ideal gas : pV = RT

$\Rightarrow\ pdV + VdP = RdT$

$\Rightarrow\ pdV - \frac{pdV}{2} = \frac{pdV}{2} = RdT$ (from ii)

Substituting in (i) gives $dq = \frac{3}{2}RdT + 2RdT$

$\Rightarrow\ \frac{dq}{sT} = \frac{7}{2}R = C$

39. (C)

$n = 4 \Rightarrow l = 0, 1, 2, 3$

40. (B)

C_2^{2-} (14e system). Due to *s* and *p* mixing, the order of energy of molecular orbitals is

$\sigma 1s \sigma^* 1s \sigma 2s \sigma^* 2s \pi 2p(y \text{ and } z)\sigma 2p_x$

41. (B)

4-Ethylcyclobut-2-en-1-ol

42. (B)

43. (B)

Aldehyde / ketone

44. (B)

Gamma H will participate.

45. (A)

Chain is of three carbon only.

46. (A)

Electron releasing power via resonance.

47. (C)

Aromatic then resonance.

48. (C)

Phenol is less acidic than H_2CO_3.

49. (D)

Phenol > alcohol > amine

50. (D)
Active methyle.

51. (5)
SF_6 is octahedral molecule. In square plane, maximum atoms (5 atoms) are present.

52. (5)
Magnetic moment $=\sqrt{n(n+2)}\text{BM}$
$=\sqrt{5(5+2)}\ \text{BM}$
$=5.91\ \text{BM}$

53. (2)
$$\left[1-\frac{1}{n^2}\right]=\left[\frac{4}{4}-\frac{4}{16}\right]\Rightarrow n=2$$

54. (3)
For the reaction,
$$\text{A}+\text{D}\rightleftharpoons \text{P}+\frac{\text{C}}{2}$$
$$\text{K}=\frac{6}{\sqrt{4}}=3$$

55. (8)
1.0 mol of protein will contain at least 1.0 mol of Fe.
$$\Rightarrow\quad M\times 10^4\times\frac{0.07}{100}=56$$
$$\therefore\quad \text{M}=8$$

56. (6)
$$p=\frac{ZRT}{V}=\frac{0.8\times 0.08\times 300}{3.2}=6$$

57. (3)
$$5=\sqrt{\frac{4(7)^2+6\text{x}^2}{10}}$$
$$\Rightarrow\quad \text{x}=3\ \text{ms}^{-1}$$

58. (5)
Initial pH of water = 7
Final $[H^+]$ = $\frac{1}{100}=10^{-2}$, pH = 2
Change is pH = 7 – 2 = 5

59. (5)
[(2), (3), (6), (7), (8)]

60. (4)

$$K_a(\text{Formic}) = \frac{[\text{H}^+]^2}{[\text{HCOOH}]}$$

$$K_a(\text{Acetic}) = \frac{[\text{H}^+]^2}{[\text{CH}_3\text{COOH}]}$$

$$\Rightarrow \frac{K_a(\text{Formic})}{K_a(\text{Acetic})} = 4 = \frac{[\text{CH}_3\text{COOH}]}{[\text{HCOOH}]}$$ ($[H^+]$ are same in both solution).

PART (C) : MATHEMATICS

Answers & Solution

61. (D)

We have, $f(x)=\frac{\sqrt{-\log_{0.3}(x-1)}}{\sqrt{x^2+2x+8}}$, for domain

$$\frac{-\log_{0.3}(x-1)}{x^2+2x+8}\geq 8$$

$\Rightarrow \frac{\log_{0.3}(x-1)}{x^2+2x+8}\leq 0$, Since x^2+2x+8 is always positive, as $x^2+2x+8=(x+1)^2+7$

$\log_{0.3}(x-1)\leq 0$

$\Rightarrow x-1\geq (0.3)^o$

$x\geq 2$

62. (B)

63. (A)

Since we know that coefficient of $(1 + x)(1 – x)^{2014}$

= Coefficient of x^{2014} + Coefficient of x^{2013}

$=(-1)^{2014}.\frac{2014!}{2014!.0!}+(-1)^{2013}.\frac{2014!}{1!2013!}$

$=(-1)^{2014}\left[\frac{2014!}{2014!.0!}-\frac{2014!}{1!2013!}\right]$

= (1) [1 – 2014] = –2013

64. (C)

$\Rightarrow$ Maximum value of $|PA-PB|$ is $2\sqrt{2}$ when $\theta=0$

i.e., P lies on the line AB as well as on the given line

$\because$ equation of AB is

$y-2=\frac{4-2}{2-4}(x-4)$ or $x + y = 6$ …(1)

and given line is $3x + 2y + 10 = 0$ …(2)

solving (1) and (2), we get $P\equiv(-22,28)$

65. (B)

66. (B)

$$f(x)=\sqrt{\cos^{-1}\left(\frac{1-|x|}{2}\right)}$$

$$-1 \le \frac{1-|x|}{2} \le 1 \Rightarrow -2-1 \le -|x| \le 2-1$$
$$\Rightarrow -3 \le -|x| \le 1 \Rightarrow -1 \le |x| \le 3 \Rightarrow x \in [-3,3]$$

67. **(B)**

$$\sin\left(\frac{\pi x}{2\sqrt{3}}\right) = x^2 - 2\sqrt{3}x + 4$$
$$= \left(x-\sqrt{3}\right)^2 + 1$$

$\because$ R.H.S > 1. So, the solution exists if and only if $x-\sqrt{3}=0$

$\Rightarrow x=\sqrt{3}$ and then equation is obviously satisfied.

68. **(B)**

Since *x*, *y*, *z* are in GP,

Hence, y^2 = xz

$\therefore 2\log y = \log x + \log z$

$2(\log y + 1) = (1+\log x) + (1+\log z)$

1 + log x, 1 + log y, 1 + log z are in AP.

$\frac{1}{1+\log x}, \frac{1}{1+\log y}, \frac{1}{1+\log z}$ are in HP.

69. **(C)**

$x_1 + x_2 = 15; x_k \ge 0, r = 2, n = 15$

No. of non negative inetegral solutions = $= {}^{x+y-1}C_{y-1} = {}^{16}C_1 = 16$

$x_1 + x_2 + x_3 + x_4 + x_5 = 20$

$x_3 + x_4 + x_5 = 5 \Rightarrow {}^{5+3-1}C_{3-1} = {}^{7}C_2 = 21$

Total no. of solutions $= 16 \times 21 = 336$

70. **(B)**

$$\frac{(a^2+3a+1)(b^2+4b+1)(c^2+5c+1)}{abc}$$
$$= \left(a+\frac{1}{a}+3\right)\left(b+\frac{1}{b}+4\right)\left(c+\frac{1}{c}+5\right)$$

$\because x + \frac{1}{x} \ge 2\,;\ x > 0$

So minimum value of expression

= (5) (6) (7) = 210

71. **(D)**

$5x + 3y - 2 = 0$

$3x - y - 4 = 0$

$(x, y) = (1, -1)$

$x - y + 1 = 0$

$2x - y - 2 = 0$

$(x, y) = (3, 4)$

Required line passing through (1, –1) and (3, 4)

72. **(B)**

$a(x+y-1)+b(2x+3y-1)=0$

$x+y-1=0 \ \& \ 2x+3y-1=0$

$x=2, y=-1$

73. **(A)**

$$T_r = \frac{1}{\sqrt{a+rx}+\sqrt{a+(r-1)x}} = \frac{1}{x}\left[\sqrt{a+rx}-\sqrt{a+(r-1)x}\right]$$

$$\therefore S_n = \frac{1}{x}\left[\sqrt{a+nx}-\sqrt{a}\right] = \frac{n}{\sqrt{a}+\sqrt{a+nx}}$$

74. **(Bonus)**

75. **(B)**

76. **(B)**

77. **(B)**

78. **(D)**

79. **(C)**

The two particular persons can be arranged among themselves in ${}^2P_2$ ways.

Taking them as one person and keeping him fixed, we can arrange the remaining 5 Persons among themselves in 5!ways.

Hence the required no. of ways in which 2 particular persons come together

$= 5! \times 2! = 120 \times 2 = 240$

80. **(C)**

81. **(12)**

Here $21 = 3\times 7$. So 21 divides n! for every $n \geq 7$. The remainder when 1! + 2! + 3! + …. + 2014! Divided by 21 is same as the remainder 1! + 2! + 3! + 4! + 5! + 6! divided by 21.

$\therefore 1! + 2! + 3! + 4! + 5! + 6!$

= 1 + 2 + 6 + 24 + 120 + 720
= 873
= 21(41) + 12
$\therefore$ Remainder is 12

82. (4)
We have, $\sin^2 x - 2\sin x - 1 = 0$
$\Rightarrow (\sin x - 1)^2 = 2 \Rightarrow \sin x - 1 = \pm\sqrt{2}$
$\Rightarrow \sin x = 1 - \sqrt{2}$ as $\sin x \not> 1$.
There are 2 solutions in $[0, 2\pi]$ and two more in $[2\pi, 4\pi]$.
Thus, minimum value of n is 4.

83. (3)
Apply $D < 0$

84. (6)

85. (9)
Let $2015! + 3^{7886} = 2015! + 3^2 (3^4)^{1971}$
$= 2015! + 9(81)^{1971}$
This number clearly has 9 at the unit place because $9(81)^{1971}$ has 9 at the unit place and factorial of any greater than or equal to 5 has zero at the unit place.
$\therefore$ 2015! Has zero at the unit place
$\therefore 2015! + 3^{7886} = 0 + 9 = 9$ in the unit place of the given number.

86. (3720)
Total number required $= 7! - 6! - 6! + 5!$

87. (27)
$$(1+x)^n = 3 + \frac{8}{3} + \frac{80}{3^3} + \frac{240}{3^4} + ... = 1 + nx + \frac{n(n-1)x^2}{2} + ...$$
On comparison, n = –3 and $x = -\frac{2}{3}$

88. (18)

89. (15)

90. (3)