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# NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

## Paper Code: UN421

## Solutions for Class : 11 (PCM)

### Mathematics

1. **(A)** Let A(1, 3) and C(5, 1) and Equation to $\overleftrightarrow{BD}$ is $y = 2x + c$

Midpoint of $\overline{AC}$ is P(3, 2).

P lies on $\overleftrightarrow{BD}$

$\Rightarrow 2 = 2(3) + c$

$\Rightarrow C = -4$

$\therefore$ A point on $y = 2x - 4$ is B(t, 2t – 4)

Slope of $\overleftrightarrow{AB}$ × slope of $\overleftrightarrow{BC}$ = –1

$$\Rightarrow \frac{2t-7}{t-1}\times\frac{2t-5}{t-5} = -1$$

$\Rightarrow (2t - 7)(2t - 5) = -(t - 1)(t - 5)$

$\Rightarrow 4t^2 - 24t + 35 = -(t^2 - 6t + 5)$

$\Rightarrow 5t^2 - 30t + 40 = 0$

$\Rightarrow t^2 - 6t + 8 = 0$

$\Rightarrow (t - 4)(t - 2) = 0$

$\Rightarrow t = 2, 4$

$\therefore$ The verticles are **(2, 0), (4, 4)**.

2 **(A)** $$\frac{5\sin\theta - 3\cos\theta}{\sin\theta + 2\cos\theta}$$

$$= \frac{5\tan\theta - 3}{\tan\theta + 2}$$

$$= \frac{5(4/5) - 3}{4/5 + 2}$$

$$= \frac{\mathbf{5}}{\mathbf{14}}$$

3. **(B)** $$\sum_{k=1}^{n} a_k = \sum_{k=1}^{n} \frac{1}{k(k+1)}$$

$$= \sum_{k=1}^{n}\left[\frac{1}{k} - \frac{1}{k+1}\right]$$

$$= 1 - \frac{1}{n+1} = \frac{n}{n+1}$$

$$\Rightarrow \left[\sum_{k=1}^{n} a_k\right] = \frac{\mathbf{n^2}}{\mathbf{(n+1)^2}}$$

4. **(D)** Let the population of the city be 100.

Let A denote the set of citizens who like tea and B denote the set of citizens who like coffee.

$\therefore$ n(A) = 63 and n(B) = 76

$n(A \cup B) = n(A) + n(B) - (A \cap B)$,

$n(A \cup B) \le 100$

$\Rightarrow 63 + 76 - n(A \cap B) \le 100$

$\Rightarrow 39 \le n(A \cap B) \rightarrow (1)$

Also $n(A \cap B) \le n(A)$ and $n(A \cap B) \le n(B)$

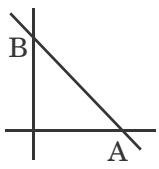
$\Rightarrow n(A \cap B) \le 63$ and $n(A \cap B) \le 76$

$\Rightarrow n(A \cap B) \le 63 \rightarrow (2)$

From (1) and (2) : $39 \le n(A \cap B) \le 63$

$\Rightarrow$ **$39 \le x \le 63$**

5. **(B)**




A (a, 0), B (0, b)

$$\text{Centroid} = \left(\frac{a}{3}, \frac{b}{3}\right) = \mathbf{(1, 2)}$$

$\Rightarrow a = 3, b = 6$

Equation of AB is $\frac{x}{3} + \frac{y}{6} = 1$

$\Rightarrow \mathbf{2x + y = 6}$

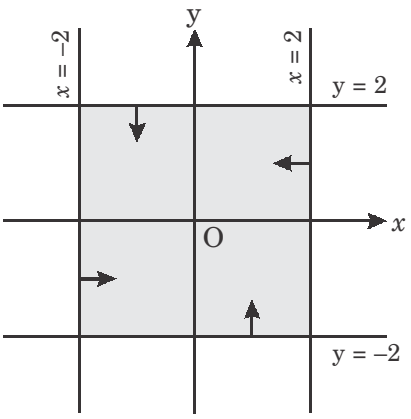
6. **(B)** $6^{th}$ term $= (4\cos^2\alpha + 1)/\cos^2\alpha$

$\Rightarrow a + 5d = 4 + \sec^2\alpha$

$\Rightarrow a + 5 = 4 + \sec^2\alpha$

$\Rightarrow a = \sec^2\alpha - 1 = \mathbf{\tan^2\alpha}$

7. **(C)** The graph of given inequalities is common to the graphs of $x \geq -2$, $x \leq 2$, $y \geq -2$, $y \leq 2$.




8. **(C)** $S(n) = i^n + i^{-n} = i^n + \frac{1}{i^n} = \frac{i^{2n}+1}{i^n} = \frac{(-1)^n+1}{i^n}$

For (n) = 1, 2, 3, 4, . . . . values of S(n) are 0, –2, 0, 2, 0. . . .

9. **(C)** Here, B = A, therefore, $A \times B = A \times A$.

10. **(D)** $(x - h)^2 + b(x - h) + c = x^2 + qx + r$

$\Rightarrow -2hx + h^2 + bx - bh + c = qx + r$

$\Rightarrow b - 2h = q$

$\Rightarrow h = \mathbf{(b - q)/2}$

11. **(A)**

12. **(C)** $\cos x = \tan y = \frac{1}{\cot y} = \frac{1}{\tan z} = \cot z = \tan x$

$\Rightarrow \cos^2 x = \sin x$

$\Rightarrow 1 - \sin^2 x = \sin x$

$\Rightarrow \sin^2 x = \sin x - 1 = 0$

$\Rightarrow \sin x = \frac{-1 \pm \sqrt{1+4}}{2}$

$\Rightarrow \sin x = \frac{\sqrt{5}-1}{2}$

$= \mathbf{2 \sin 18^o}$

13. **(A)** Given that

$^nC_{r-1} : {}^nC_r : {}^nC_{r-1} = 1 : 7 : 42$

$\frac{{}^nC_r}{{}^nC_{r-1}} = \frac{7}{1} \Rightarrow \frac{n - r + 1}{r} = 7$

$\Rightarrow 8r = n + 1$

$\Rightarrow r = \frac{n+1}{8}$

$\frac{{}^nC_{r+1}}{{}^nC_r} = \frac{42}{7} \Rightarrow \frac{n - r + 1}{r} = 6$

$\Rightarrow n = 7r + 6$

$\Rightarrow n - 6 = 7\frac{(n+1)}{8}$

$\Rightarrow 8n - 48 = 7n + 7$

$\Rightarrow \mathbf{n = 55}$

14. **(B)** $A \subseteq B \Rightarrow A \cap B = A$

$\Rightarrow n(A \cap B)$

$= \mathbf{n(A) = 25}$

15. **(D)** Since P(1, 2) bisects the part intercepted between the axes.

$x$-intercept $= 2 \times 1 = 2$, y-intercept $= 2 \times 2 = 4$

Required line equation is $\frac{x}{2} + \frac{y}{4} = 1$

$\Rightarrow 2x + y = 4$

$\Rightarrow \mathbf{2x + y - 4 = 0}$

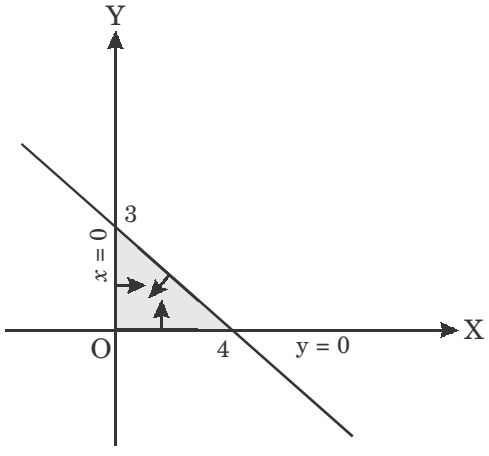
16. **(A)** $1 + 5 + 5^2 + \ldots . < 4321$

$\Rightarrow \frac{5^n - 1}{5 - 1} < 4321$

$\Rightarrow 5^n - 1 < 17284$

$\Rightarrow \mathbf{5^n < 17285}$

17. **(B)**



18. **(A)** $\frac{kn}{n+1} = \left[\frac{1}{2.4} + \frac{1}{4.6} + \frac{1}{6.8} + \ldots \text{ n terms}\right]$

$= \frac{1}{2}\left[\frac{4-2}{2.4} + \frac{6-4}{4.6} + \frac{8-6}{6.8} + \ldots + \frac{1}{2n(2n+2)}\right]$

$= \frac{1}{2}\left[\frac{1}{2} - \frac{1}{4} + \frac{1}{4} - \frac{1}{6} + \frac{1}{6} - \frac{1}{8} + \ldots \frac{1}{2n} - \frac{1}{2n+2}\right]$

$= \frac{1}{2}\left[\frac{1}{2} - \frac{1}{2(n+1)}\right]$

$= \frac{n}{4(n+1)} \Rightarrow k = \mathbf{\frac{1}{4}}$

19. **(C)** Here $n(A) = 3$

$\Rightarrow n(A \times A) = n(A) \times n(A) = 3 \times 3 = 9$

Number of relations on A (i.e. from A to A) is equal to the number of subsets of $A \times A$

$= n(2^{A \times A}) = 2^{n(A \times A)} = \mathbf{2^9}$.

20. **(D)** If $\alpha, \beta$ are the roots then $\alpha + \beta = \frac{b}{5+\sqrt{2}}$,

$\alpha\beta = \frac{8+2\sqrt{5}}{5+\sqrt{2}}$

Harmonic mean of $\alpha, \beta$ is $4 \Rightarrow \frac{2\alpha\beta}{\alpha+\beta} = 4$

$\Rightarrow \alpha\beta = 2(\alpha + \beta)$

$\Rightarrow \frac{8+2\sqrt{5}}{5+\sqrt{2}}$

$= \frac{2b}{5+\sqrt{2}} = \mathbf{4 + \sqrt{5}}$.

21. **(C)** Given, $\frac{3}{1} = \frac{\cos(x-y)}{\cos(x+y)}$

$\Rightarrow \frac{3+1}{3-1}\frac{\cos(x-y)+\cos(x+y)}{\cos(x-y)-\cos(x+y)}$

$\Rightarrow \frac{4}{2}\frac{2\cos x \cos y}{2\sin x \sin y}$

$\Rightarrow \cot x \cot y = \mathbf{2}$

22. **(B)** $\left(2+\frac{x}{3}\right)^n = 2^n\left(1+\frac{x}{6}\right)^n$

Coefficient of $x^7$ is $\frac{2^n \cdot {}^nC_7}{6^7}$

Coefficient of $x^8$ is $\frac{2^n \cdot {}^nC_8}{6^8}$

Coefficient of $x^7$ = Coefficent of $x^8$

$\Rightarrow \frac{2^n \cdot {}^nC_7}{6^7} = \frac{2^n \cdot {}^nC_8}{6^8}$

$\Rightarrow 6({}^nC_7) = {}^nC_8$

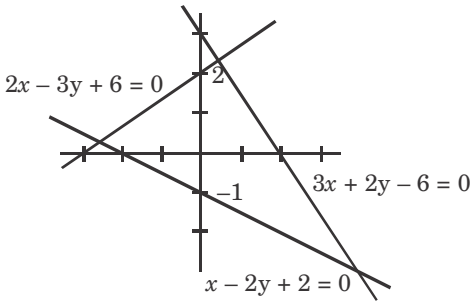
$\Rightarrow 6.\frac{n!}{(n-7)!\,7!} = \frac{n!}{(n-8)!\,8!}$

$\Rightarrow \frac{6}{n-7} = \frac{1}{8}$

$\Rightarrow n - 7 = 48$

$\Rightarrow \mathbf{n = 55}$

23. **(C)** Given lines are as in the figure.




P(0, b) lies on y-axis and lies in the triangle

$\Rightarrow -1 \le b \le 2$

Range of b is **[–1, 2]**.

24. **(B)** $a \times ar \times ar^2 \times ar^3 \times ar^4 \times ar^5 \times ar^6 \times ar^7 \times ar^8 \times$

$a^9 r^{36} = (ar^4)^9 = 2^9 = \mathbf{512}$.

25. **(A)** The number of arrangements that begin with S and end with E is 4! = **24**

26. **(D)** $1 + 3 + 5 + \ldots + (2k + 1)$

$= [1 + 3 + 5 + \ldots + (2k - 1)] + (2k + 1)$

$= 3 + k^2 + 2k + 1 = 3 + (k + 1)^2$

$\therefore S(k) \Rightarrow \mathbf{S(k + 1)}$

27. **(C)** $(x - 1)^3 - 8 = 0$

$\Rightarrow \left(\frac{x-1}{2}\right) = 1 \Rightarrow \frac{x-1}{2} = (1)^{1/3} = 1, \omega, \omega^2$

$\Rightarrow x - 1 = 2, 2\omega, 2\omega^2$

$\Rightarrow x = \mathbf{3, 1 + 2\omega, 1 + 2\omega^2}$.

28. **(A)** The required equation is $ax^{2/3} + bx^{1/3} + c = 0$

$\Rightarrow ax^{2/3} + bx^{1/3} = -c \Rightarrow (ax^{2/3} + bx^{1/3})^3 = -c^3$

$\Rightarrow a^3x^2 + b^3x + 3abx(-c) = -c^3$

$\Rightarrow \mathbf{a^3x^2 + (b^3 - 3abc)x + c^3 = 0}$

29. **(D)** $T_{n+1} - T_n = 10$

$\Rightarrow {}^{(n+1)}C_3 - {}^nC_3 = 10$

$\Rightarrow {}^nC_2 + {}^nC_3 - {}^nC_3 = 10$

$\Rightarrow {}^nC_2 = 10$

$\Rightarrow {}^nC_2 = {}^5C_2$

$\Rightarrow \mathbf{n = 5}$

30. **(B)** $(1 + ab + bx^2)(1 - 2x)$

$= (1 + ax + bx^2)[1 + 18c_1(-2x) + 18c_2(-2x)^2 + 18c_3(-2x)^3 + \ldots]$

Coefficient of $x^3$ is $0 \Rightarrow 18c_3(-2)^3 + a\,18c_2(-2)^2 + b\,18c_1(-2) = 0$

$\Rightarrow -6528 + 612a - 36b = 0$

$\Rightarrow 51a - 3b = 544 \rightarrow (1)$

Coefficient of $x^4$ is $0 \Rightarrow 18c_4(-2)^4 + a\,18c_3(-2)^3 + b\,18c_2(-2)^2 = 0$

$\Rightarrow 48960 - 6528a + 612b = 0$

$\Rightarrow 32a - 3b = 240 \rightarrow (2)$

$(1) - (2) \Rightarrow 19a = 304$

$\Rightarrow \mathbf{a = 16}$ ; (2)

$\Rightarrow 512 - 3b = 240$

$3b = 272$

$\therefore \mathbf{b = \frac{272}{3}}$

31. **(A)** $A = \{x : \cos x > -1/2,\ 0 \le x \le \pi\} = \{x : 0 \le x \le 2\pi/3\}$

$B = \{x : \sin x > \frac{1}{2}, \frac{\pi}{3} \le x \le \pi\}$

$= \{x : \frac{\pi}{3} \le x \le 5\frac{\pi}{6}\}$

$\therefore A \cap B = \left[\mathbf{\frac{\pi}{3}, \frac{2\pi}{3}}\right]$

32. **(C)** In a $\Delta ABC$, $\Rightarrow \sin A = \sin(B + C)$

$\therefore \sin A + \sin(B - C)$

$= \sin(B + C) + \sin(B - C)$

$= \mathbf{2 \sin B \cos C}$

33. **(A)** $\frac{p+q}{2} > \sqrt{pq}, \frac{q+r}{2} > \sqrt{qr}, \frac{r+p}{2} > \sqrt{rp}$

$\Rightarrow \left(\frac{p+q}{2}\right)\left(\frac{q+r}{2}\right)\left(\frac{r+p}{2}\right) > \sqrt{pq}\sqrt{qr}\sqrt{rp}$

$\Rightarrow (p + q)(q + r)(r + p) > \mathbf{8\,pqr}.$

34. **(A)** Distance $= \left|\frac{1+2}{\sqrt{4+16}}\right| = \mathbf{\frac{3}{2\sqrt{5}}}$

35. **(A)** $\text{G.E.} = \sum_{k=1}^{5} \frac{k^2(k+1)^2}{4k^2}$

$= \frac{1}{4}\sum_{k=1}^{5}(k+1)^2$

$= \frac{1}{4}\left[\frac{6\times7\times13}{6} - 1\right] = \mathbf{22.5}$

36. **(C)** $x_1, x_2$ are the roots of $x^2 - kx + c = 0 \Rightarrow x_1 + x_2 = k,\ x_1 x_2 = c$

$AB = |x_1 - x_2| = \sqrt{(x_1 + x_2)^2 - 4x_1x_2}$

$= \mathbf{\sqrt{k^2 - 4c}}$

37. **(B)** The required number of ways

$= 2 \times 5! \times 5! = 2 \times 120 \times 120 = \mathbf{28800}.$

38. **(B)** $\log_2(x^2 - 2x + 5) = k \Rightarrow x^2 - 2x + 5 = 2^k$

$B2 - 4AC \ge 0 \Rightarrow 4 - 4(5 - 2^k) \ge 0$

$\Rightarrow 1 - 5 + 2^k \ge 0 \Rightarrow 2^k \ge 4$

$\Rightarrow 2^k \ge 2^2$

$\Rightarrow \mathbf{k \ge 2}$

39. **(D)** $T_{r+1} = {}^{11}C_r\left(\frac{x^2}{a}\right)^{11-r}\left(\frac{-b}{x}\right)^r$

$= {}^{11}C_r\left(\frac{1}{a}\right)^{11-r}(-b)^r x^{22-3r}$

Coefficient of $x^7$ is ${}^{11}C_5\left(\frac{1}{a}\right)^6(-b)^5$;

Coefficient of $x^4$ is ${}^{11}C_6\left(\frac{1}{a}\right)^5(-b)^6$

Given ${}^{11}C_5\left(\frac{1}{a}\right)^6(-b)^5 + {}^{11}C_6\left(\frac{1}{a}\right)^5(-b)^6 = 0$

$\Rightarrow -\frac{1}{a} + b = 0$

$\Rightarrow \mathbf{ab = 1}$

40. **(C)** $\cos\frac{2\pi}{15}\cos\frac{4\pi}{15}\cos\frac{8\pi}{15}\cos\frac{14\pi}{15} = \mathbf{\frac{1}{16}}$

## Physics

41. **(C)** Centripetal acceleration is R $\omega^2$. R is more for the second.

42. **(C)** Due to surface tension, the surface of a liquid behaves like a stretched membrane.

43. **(B)** At constant speed, there is no acceleration, so the forces acting on the train are in equilibrium.

Therefore, F = R

$\therefore$ F = $3\times10^4$ N or P = Fv

We have, power = $3\times10^4\times40$

= $1.2\times10^6$ W

44. **(D)** $\frac{\Delta\rho}{\rho}=\frac{\Delta M}{M}+3\times\frac{\Delta l}{l}=\frac{3}{100}+3\times\frac{2}{100}=\frac{9}{100}=9\%$

45. **(B)** Both, orbital speed of satellite $v=\sqrt{Gm/r}$ and time period of revolution of satellite, $T=\left[\frac{4\pi^2 r^3}{GM}\right]^{\frac{1}{2}}$ are independent of mass of satellite. Therefore orbital speed and time period of revolution of both the satellites are same.

The kinetic energy of a satellite, $K=\frac{GM\,m}{2\,r}$ and potential energy of a satellite, $U=-\frac{GM\,m}{r}$ both depend on mass of satellite, vary with mass of satellite.

46. **(D)** Velocity of ball on striking the roof of stationary lift $=\sqrt{2\,gh}=\sqrt{2\times10\times5}$ = 10 m/s. As lift is moving upwards with a velocity of 1 m/s ; relative velocity of ball on striking = 10 + 1 = 11 m/s.

The ball will rebound with this velocity if lift were stationary. As lift is moving upwards with a velocity of 1 m/s, therefore, ball will rebound with a velocity = 11 + 1 = 12 m/s upwards.

47. **(B)** Area under acceleration-time graph gives the change in velocity.

Hence, $v_{max}=\frac{1}{2}\times10\times11=55$ m/s

Therefore, the correct option is (B).

48. **(A)** The air through the horizontal tube will decreaase the pressure and more liquid will be pushed into the capillary tube.

49. **(B)** $a=\frac{v-u}{t}=\frac{3.5-2}{25}=0.06\ m\ s^{-2}$

F = ma = $6\times0.06$

= 0.36 N in the direction of motion.

50. **(A)** As isothermal at $T_1$ is farther from the origin than the isothermal at $T_2$, therefore, $T_1 > T_2$.

51. **(D)** One second is defined as 9192631770 periods of cesium clock.

52. **(A)** The gravitational potential energy of a body on the surface of earth is $E_p=-\frac{GM\,m}{R}$.

Inside the earth, $E_p=-GM\frac{\left(3\,R^2-r^2\right)}{2\,R^3}$.

Thus $E_p$ is minimum on the surface of earth.

53. **(C)** Let the origin be at the C atom. Then :

$R_{cm}=\frac{12\times0+16\times0.12\ nm}{12+16}\cong0.07$ nm.

54. **(C)** 1 Pitch = least count× [No. of divisions on the head or circular scale]

= 0.005 mm× 200 = 1.00 mm.

55. **(B)** F = $\mu$ Mg cos $\theta$ = $0.7\times2\times9.8\times\frac{\sqrt{3}}{2}$

= $0.7\times9.8\times\sqrt{3}$ N

56. **(A)** As no external force is applied, therefore, according to the law of conservation of linear momentum, $\vec{P_s}=\vec{P_1}+\vec{P_2}$ = constant.

As both the blocks are initially at rest, therefore, $\vec{P_1}+\vec{P_2}=0$ or $\vec{P_2}=-\vec{P_1}$

i.e., at any instant, the two blocks will have equal momentum (in magnitude), but opposite in direction.

57. **(C)** Taking vertical upward motion of balloon for 8 sec.

v = u + at = 0 + $1.25\times8$ = 10 m/s.

$s=\frac{1}{2}at^2=\frac{1}{2}\times1.25\times8^2=40$ m

Taking vertical downward motion of stone released from balloon, we have

u = – 10 m/s, a = 10 m/s$^2$, s = 40 m ; t = ?

as $s = ut + \frac{1}{2}at^2$

$40 = -10 \times t + \frac{1}{2} \times 10 \times t^2$

or $5t^2 - 10t - 40 = 0$

On solving, t = 4 s.

58. **(B)** Escape velocity $V_e$ = 11.2 km/s

Orbital velocity close to the earth

$V_o = \frac{11.2}{\sqrt{2}}$ km/s

$\therefore$ Additional velocity required to be given

$= V_e - V_o$

$= \left(11.2 - \frac{11.2}{\sqrt{2}}\right) = 11.2 - 7.9 = 3.3$ km/s.

59. **(B)** Since, there is no loss of heat in an ideal flask, hence mechanical energy spent in shaking the flask is changed into heat energy resulting in the rise of temperature.

60. **(A)** The respective maximum errors in length, breadth and thickness are

$\frac{0.1}{125.6}; \frac{0.1}{6.5}; \frac{0.01}{0.23}$.

Hence, thickness measurement is least accurate.

61. **(C)** Excess of pressure in a bubble, p = 4 S / r

i.e., $p \propto \frac{1}{r}$

Therefore pressure in a smaller bubble is more than that of a bigger bubble. When two bubbles of different radii are in communication, then the air flows from higher pressure to lower pressure i.e., from smaller bubble into larger one.

62. **(C)** Here, $m_1$ = 1 kg, $m_2$ = 6 kg, and $m_3$ = 3 kg. If a is acceleration of the system to the right, then the equations of motion of the three bodies are

$m_1 a = T_1 - m_1 g$

$m_2 a = T_2 - T_1$

$m_3 a = m_3 g - T_2$

Adding the three equations, we get

$(m_1 + m_2 + m_3) a = (m_3 - m_1)g$

$a = \frac{(m_3 - m_1)g}{m_1 + m_2 + m_3} = \frac{(3-1)10}{1+6+3} = 2$ m / s$^2$.

63. **(A)** dv = a dt

or change in velocity = area under a-t graph

Hence, $v_f - v_i = \frac{1}{2}$ (4) (4) = 8 m s$^{-1}$

$\therefore$ $v_f - v_i + 8 = (2 + 8) = 10$ m s$^{-1}$

64. **(B)** The velocity of rain drop measured by three observer's is found to be the same as the gravitational force on the rain drop is balanced by the force produced by the surrounding air.

65. **(C)** Solar system is an example of conservation of angular momentum, as all planets move around the sun in elliptical orbits and no torque is acting on them.

## ***Chemistry***

66. **(B)** Elements with Z = 4 (Be), 12 (Mg), 20 (Ca), 38 (Sr), 56 (Ba), 88 (Ra) belong to group 2 (alkaline earths) of the periodic table.

67. **(D)** Boric acid ($H_3BO_3$) contains $BO_3$ units which are planar and linked together by H- bonding to give layer structure.

68. **(B)** Ethyl alcohol undergoes combustion according to the reaction,

$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

$\Delta H = -1367$ kJ mol$^{-1}$

Then $\Delta_c H = \sum aH_{products} - \sum bH_{reactants}$

Since, the enthalpy of a compound is taken as equal to its heat of formation, and the enthalpy of an element is taken as zero, we can write,

$-1367 = [2\Delta_f H\ (CO_2) + 3\Delta_f H\ (H_2O)] - [\Delta_f H\ (C_2H_5OH) + 0]$

Therefore, $\Delta_f H\ (C_2H_5OH) = 2\ (-393.4) + 3\ (-285.9) + 1367 = -277.5$ kJ mol$^{-1}$

69. **(A)** In $CH_3Cl$ melecule, the bond dipole moments due to C–Cl bond and C–H bonds are supportive. As a result, $CH_3Cl$ has higher dipole moment as compared to other compounds.

70. **(B)** The O.N. of O in $H_2O_2$ is – 1. It can either increase to zero in $O_2$ or decrease to – 2 in $H_2O$. Therefore, $H_2O_2$ can act both as an oxidising as well as a reducing agent.

71. **(B)** Given : Wavelength of electron ($\lambda$) = Velocity (v) of electron

From de Broglie equation, for a material

particle (like electron) one can write,

$$\lambda = \frac{h}{mv}$$

But, $\lambda = v$

So, $v = \frac{h}{mv}$ or $v^2 = \frac{h}{m}$

This gives,

$$v = \sqrt{\frac{h}{m}} = \sqrt{\frac{6.6\times10^{-34}}{9.1\times10^{31}}} = \sqrt{7.25\times10^{-4}}$$

$= 2.7\times10^{-2}$ m $s^{-1}$

72. **(B)** Percentage of sulphur in the compound

$$= \frac{\text{Mass of } BaSO_4 \times 32}{233} \times \frac{100}{\text{Mass of compound}}$$

$$= \frac{0.668\times32\times100}{233\times0.468} = 19.6\ \%$$

73. **(C)** As $NH_3$ and HBr react, Dalton's law of partial pressures is not applicable.

74. **(B)** Relative formula mass of sodium silicate

$= 23\times2 + 28 + 16\times3 = 122$

% Mass of silicon in 100 g = $(28/122)\times100$

= 23.0 %

75. **(B)** Ice crystals have hollow hexagonal arrangement of $H_2O$ molecules.

76. **(C)** Hydration enthalpy decreases with an increase in the size of the metal ion.

77. **(C)** Eqm. const. changes with change of temperature.

78. **(B)** Hydrazine ($NH_2NH_2$) does not contain C and hence on fusion with Na metal, it cannot form NaCN. Therefore, hydrazine does not show Lassaigne's test.

79. **(C)**

| $N_1V_1$ | = | $N_2V_2$ |
|---|---|---|
| ($H_2SO_4$) | | (NaOH) |

$\therefore\ N_1\times25 = 1\times20$ or $N_1 = 0.8$.

80. **(C)** The metal M is calcium.

81. **(D)** $N_3H$ (hydrazoic acid) is the acidic hydride of nitrogen.

82. **(B)**

| $CuSO_4$ | = | Cu |
|---|---|---|
| (63.5 + 32 + 64) g | | 63.5 g |

= 159.5 g

Mass of copper obtained $= \frac{63.5\,g}{159.5\,g}\times40\,g$

= 15.9 g

83. **(C)** 'a' is directly related to forces of attraction. Hence, greater the value of 'a', more easily the gas is liquefied.

84. **(A)** Both have normal tetrahedral angle of 109.5°.

85. **(C)** $\lambda$ = 242 nm = $242\times10^{-9}$ m

$c = 3\times10^8$ m $s^{-1}$

Then, the energy per mol of photons of this wavelength is equal to the ionisation energy. So, $E = N_A\ h\ v = N_A\ \frac{hc}{\lambda}$

$$= \frac{6.02\times10^{23}\ mol^{-1}\times6.62\times10^{-34}\ J\,s\times3\times10^8\ m\,s^{-1}}{242\times10^{-9}\ m}$$

E = 494 kJ $mol^{-1}$

86. **(C)** $H_2PO_2$ carries one negative charge. Balancing the charges on all the atoms in this ion,

$2\,(+1) + x + 2\,(-2) = -1$

This gives $x = +1$

87. **(B)** Both $XeF_2$ and $CO_2$ are linear molecules.

88. **(C)** Both $Al(OH)_3$ and $Be(OH)_2$ are amphoteric in character. They react with acids as well as alkalies forming salts.

89. **(A)** Mass of aluminium, m = 60.0 g

Rise in temperature, $\Delta t$ = (55° C – 35° C)

= 20° C

Molar heat capacity, C = 24 J $K^{-1}$ $mol^{-1}$

Heat required

$$= \frac{60.0\,g}{27\,g/mol}\times24\,J\,K^{-1}\ mol^{-1}\times20^\circ\,C$$

$$= \frac{60\times24\times20}{27}\,J = 1066.7\,J = 1.07\,kJ$$

90. **(C)** Six. Since DBE = 1, therefore, all the acyclic isomers are alkenes. These are : 1-pentene, cis-2-pentene, trans-2-pentene, 2-methyl- 1-butene, 3-methyl-1-butene, 2- methyl-2-butene.