PART (A) : PHYSICS

ANSWER KEY

1.	(B)	2.	(A)	3.	(B)	4.	(C)	5.	(B)
6.	(D)	7.	(C)	8.	(B)	9.	(D)	10.	(C)
11.	(D)	12.	(B)	13.	(C)	14.	(B)	15.	(B)
16.	(B)	17.	(C)	18.	(C)	19.	(D)	20.	(A)
21.	(1)	22.	(10)	23.	(9)	24.	(2)	25.	(2)
26.	(1)	27.	(2)	28.	(1)	29.	(2)	30.	(3)

SOLUTIONS

1. (B)
$u = \sqrt{2}u\cos\theta$

2. (A)
$H = \frac{R\tan\theta}{4}$

3. (B)
Sum of two sides $\geq$ biggest side

4. (C)

5. (B)
In an elevator going downward decreasing speed then acceleration will be in upward direction.
$N = mg + ma$

6. (D)
$\frac{dP}{dt} = 0$ at t_2 & t_3

7. (C)
Doesn't depend.

8. (B)
Acceleration is only due to gravity.

9. (D)
$\frac{d\left(\sqrt{x}\right)}{dx}e^x + \sqrt{x}\frac{d\left(e^x\right)}{dx}$

10. (C)
$\int \frac{x-1}{x-1}dx + \int \frac{dx}{x-1} = x + \ln(x-1) + C$

11. (D)
Only same dimensions can be added.

12. (B)
Relative errors $=\frac{0.2/3}{2}=0.033$.

13. (C)
% error $=2\times\frac{1}{2}+3\times\frac{1}{3}+\frac{1}{2}\times2+\frac{1}{3}\times\frac{3}{2}=3.5\%$

14. (B)
Velocity depends on length and time, so cannot be taken as base quantities.

15. (B)
$v=\sin t+t\cos t$.
Average acceleration $=\frac{\left[\sin\left(\frac{\pi}{2}\right)+\frac{\pi}{2}\cos\left(\frac{\pi}{2}\right)\right]-\left[\sin(0)+0\cos(0)\right]}{\frac{\pi}{2}-0}$

16. (B)
$400=(v-40)20 \Rightarrow v=60\text{ m/s}$

17. (C)
Area = v – 5

18. (C)
$\frac{s}{\frac{s}{4v_1}+\frac{3s}{4v_2}}$

19. (D)
Concave upward graph means +ve acceleration.

20. (A)
Along Y, $6-2t=0 \Rightarrow t=3\text{sec}$.
Along X, $\frac{1}{2}\times2\times3^2=9\text{m}$.

21. (1)

22. (10)
$20=2a \Rightarrow a=20\text{ m/s}^2$

23. (9)
$T=\frac{Fx}{\ell}=\frac{10\times9}{10}=9\text{N}$

24. (2)

For minimum, $\frac{dy}{dx}=0$; $\frac{d^2y}{dx^2}>0$

25. (2)

$$\int_{1}^{-1} -3x^2 dx = \left[-x^3\right]_1^{-1} = 2$$

26. (1)

$$\text{Area } = \frac{1}{2}\left|\left(\hat{i}-\hat{j}\right)\times\left(\hat{i}+\hat{j}\right)\right|$$

27. (2)

$20^2 = -2a\times 20 \Rightarrow a = -10 \text{ m/s}^2$

Now, $0 = 20 - 10t$

28. (1)

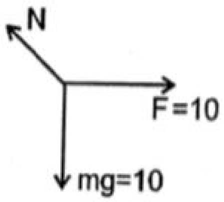
$2\cos\theta/2 = \sqrt{3} \Rightarrow 2\sin\theta/2 = 1$

29. (2)

F.B.D. of block

$N^2 = F^2 + (mg)^2$

$N = 10\sqrt{2}$ N

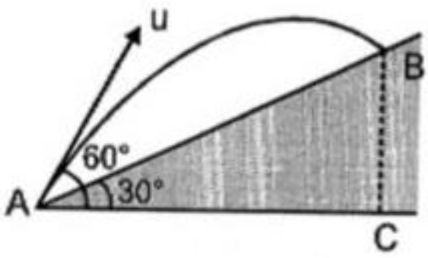


30. (3)

The horizontal displacement in time t is

$AC = u\cos 60^\circ t = \frac{ut}{2}$

$\therefore$ Range on inclined plane $= \frac{AC}{\cos 30} = \frac{ut}{\sqrt{3}}$



PART (B) : CHEMISTRY

ANSWER KEY

31.	(D)	32.	(A)	33.	(A)	34.	(C)	35.	(C)
36.	(B)	37.	(B)	38.	(D)	39.	(B)	40.	(B)
41.	(B)	42.	(D)	43.	(C)	44.	(B)	45.	(D)
46.	(C)	47.	(D)	48.	(C)	49.	(A)	50.	(B)
51.	(5)	52.	(8)	53.	(9)	54.	(5)	55.	(8)
56.	(5)	57.	(2)	58.	(3)	59.	(5)	60.	(4)

SOLUTION

31. (D)

P $(1s^2, 2s^2 2p^6, 3s^2 3p^3)$ has 6 electrons in *s*-subshells as in *d*-shell or Fe^{2+} *i.e.*, $3d^6$.

32. (A)

$$E_{\text{Photon absorbed}} = \underset{\text{Energy released}}{E_1 + E_2}$$

or $\dfrac{hc}{\lambda} = \dfrac{hc}{\lambda_1} + \dfrac{hc}{\lambda_2}$ or $\dfrac{1}{\lambda} = \dfrac{1}{\lambda_1} + \dfrac{1}{\lambda_2}$

$$\frac{1}{300} = \frac{1}{496} + \frac{1}{\lambda}$$

$$\frac{1}{\lambda} = \frac{1}{300} - \frac{1}{496} = \frac{196}{300 \times 496}$$

or $\lambda = 759\text{ nm}$

33. (A)

1.8 mL H_2O = 1.8 g H_2O.

Also 18 g H_2O has 10 N electrons; Find electrons in 1.8 g H_2O.

34. (C)

According to de Broglie wavelength $\lambda = \dfrac{h}{mu} = \dfrac{h}{p}$

or $\lambda \propto \dfrac{1}{p}$ or $p \propto \dfrac{1}{\lambda}$

35. (C)

Fact

36. (B)

Smaller is atom, more is energy needed to remove electron, *i.e.*, ionisation energy.

Also removal of two electrons needs more energy.

37. (B)

The size of isoelectronic decreases with increase in atomic number.

38. (D)

Mole of carbon $= \frac{24}{12} = 2$ mole

Mole O_2 $= \frac{40}{32} = \frac{5}{4}$ mole

Let x mole carbon forms CO.

$$C \quad + \quad \frac{1}{2}O_2 \quad \rightarrow \quad CO$$

x mole $\quad \frac{x}{2}$ mole $\quad x$ mole

$$C \quad + \quad O_2 \quad \rightarrow \quad CO$$

$(2-x)$ mole $\quad (2-x)$ mole $\quad (2-x)$ mole

Total mole of O_2 $\Rightarrow \frac{x}{2} + 2 - x = \frac{5}{4}$

$$\frac{x}{2} = \frac{3}{4} \Rightarrow x = \frac{3}{2} \text{ mole}$$

So mole of CO and CO_2 are $\frac{3}{2}$ mole & $\frac{1}{2}$ mole.

Mass of CO = $\frac{3}{2} \times 28 = 42$ gm.

Mass of CO_2 $= \frac{1}{2} \times 44 = 22$ gm

39. (B)

Mass of oxygen is fixed.

Let 32 gram oxygen is combined.

In case of CO, 24 gram carbon will be consumed and in CO_2, 12 gram carbon will consumed.

So ratio of combination of carbon is

$24 : 12 \Rightarrow 2 : 1$

Answer $\Rightarrow$ (B)

40. (B)

$n + l$ rule.

41. (B)

Mole and milli mole do not change on dilution.

Thus $\quad 500 \times 5 = 1500 \times M$

$\therefore \qquad M = \frac{5}{3} = 1.66\,\text{M}$

42. (D)

Higher is the number of mole, more will be number of atoms.

Mole of He $= \frac{4}{4} = 1$

Mole of Na = $\frac{46}{23} = 2$

Mole of He = $\frac{12}{4} = 3$

43. (C)

44. (B)

44 g CO_2 = N molecules,

$\therefore$ 4.4 g CO_2 = $\frac{N}{10}$ molecules,

22.4 litre H_2 at STP = N molecules,

$\therefore$ 2.24 litre H_2 STP = $\frac{N}{10}$ molecules,

Thus total molecules $= \frac{N}{10} + \frac{N}{10} = \frac{N}{5}$.

45. (D)

$4Al + 3O_2 \rightarrow 2Al_2O_3$.

46. (C)

(n + 1) for 4f and 5d is same but n being lesser in 4f and thus, energy order, $4f < 5d$.

47. (D)

n, l, m were the result of Schrodinger wave equation. Spin quantum number was proposed by Uhlembeck.

48. (C)

From Bohr's concept $\frac{mu^2}{r} = \frac{e^2}{r^2}$ or $\frac{mr^2 \cdot mu^2}{r} = \frac{e^2 mr^2}{r^2}$

or (angular momentum)^2 = $e^2 mr$; where n is integer and thus discrete value.

49. (A)

Elements from atomic no. 21 to 100, each has 3d electron in its configuration.

50. (B)

$_{12}Mg : 1s^2, 2s^2 2p^6, 3s^2$, *i.e.*, six s- and six p-electrons.

51. (5)

52. (8)
Subshell satisfying $n + l = 5$ are 5*s*, 4*p*, 3*d*.
$|m| = 1 \Rightarrow m = +1$ or -1.
4*p* and 3*d* have +1 and –1 orbitals and each orbitals can have maximum 2 electrons.
So, maximum 8 electrons.

53. (9)
Radius $= 0.53\dfrac{n^2}{Z}$ Å

54. (5)
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
1 mole or 22.4 L C_3H_8 at STP requires 5 mole or 5 × 22.4 L O_2 at STP.

55. (8)
Here, $V_{\text{solution}} \approx V_{\text{solvent}}$
Since, in 1 L solution, 3.2 moles of solute are present.
So, 1 L solution ≈ 1 L solvent (d = 0.4 g/mL) ≈ 0.4 kg
So, molality (m) $= \dfrac{\text{moles of solute}}{\text{mass of solvent (kg)}} = \dfrac{3.2}{0.4} = 8$

56. (5)
E.C of Fe^{+3} is [Ar] $3d^5$
So,5 unpaired electron.

57. (2)
$\Delta H = 5.41 - 3.61 = 1.8$ eV/atom
$= 1.8 \times 96.5$ kJ / mole
$= 1.737 \times 10^2$ kJ / mole

58. (3)
$\text{E.N} = \dfrac{13+3.8}{5.6} = 3$

59. (5)
E.C. = [Ar] $4s^2\ 3d^3$
Group No. = 2 + 3 = 5

60. (4)
$\text{M.M.} = \sqrt{n(n+2)} \Rightarrow n = 3$.
Mn^{+4} have 3 unpaired electrons.

PART (C) : MATHEMATICS

ANSWER KEY

61.	(A)	62.	(B)	63.	(D)	64.	(A)	65.	(A)
66.	(C)	67.	(B)	68.	(B)	69.	(B)	70.	(A)
71.	(B)	72.	(D)	73.	(B)	74.	(B)	75.	(B)
76.	(B)	77.	(C)	78.	(D)	79.	(C)	80.	(C)
81.	(8)	82.	(6)	83.	(55)	84.	(3)	85.	(18)
86.	(1)	87.	(4)	88.	(8)	89.	(11)	90.	(11)

SOLUTIONS

61. (A)

$$x^2-3x+2\le\left(\frac{\sqrt{3}}{2}\right)^2$$

$$\therefore\quad x\in\left[\frac{1}{2},\frac{5}{2}\right]$$

Also, $x^2-3x+2>0$

$$(x-2)(x-1)>0$$

$$\therefore\quad x\in(-\infty,1)\cup(2,\infty)$$

$$\therefore\quad x\in\left[\frac{1}{2},1\right)\cup\left(2,\frac{5}{2}\right]$$

62. (B)

$$\sin^6\theta+\cos^6\theta+3\sin^2\theta\cos^2\theta$$

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

$$\Rightarrow\ \sin^4\theta+\cos^4\theta+2\sin^2\theta\cos^2\theta$$

$$\Rightarrow\ (\sin^2\theta+\cos^2\theta)^2$$

63. (D)

$$\sin^4\theta+\cos^4\theta\le\sin^2\theta+\cos^2\theta$$

$= 1$

64. (A)

$$\tan A-\tan B=x\ \ \&\ \ \cot B-\cot A=y$$

$$\Rightarrow\ \frac{\tan A-\tan B}{\tan A\tan B}=y$$

$$\Rightarrow\ \tan A\tan B=\frac{x}{y}$$

Now, $\cot(A-B)=\dfrac{1+\tan A\tan B}{\tan A-\tan B}=\dfrac{1+\frac{x}{y}}{x}=\dfrac{1}{x}+\dfrac{1}{y}$

65. (A)

$\tan 105°=-(2+\sqrt{3})$

66. (C)

The value of $\dfrac{\cos^2 33°-\cos^2 57°}{\sin 21°-\cos 21°}$

$=\dfrac{\sin^2 57°-\sin^2 33°}{\cos 69°-\cos 21°}$

$=\dfrac{\sin(57°+33°).\sin(57°-33°)}{-2\sin 45°\sin 24°}$

$=-\dfrac{1}{\sqrt{2}}$

67. (B)

Let α be a common root.

$\dfrac{\alpha^2}{-4k-15}=\dfrac{-\alpha}{-8+5}=\dfrac{1}{-6-k}$

$\Rightarrow\ 4k^2+39k+81=0$

$\Rightarrow\ k=-3 \text{ or } -27/4.$

68. (B)

Let $y=\dfrac{x^2}{x^2+x+1}$

$\Rightarrow\ x^2(y-1)+yx+y=0$

Since, $x\in R, D\geq 0$

69. (B)

The given equation $x^2-2x-\log_4 a=0.$

$\Rightarrow$ for real roots, $D\geq 0$

$\Rightarrow\ 4+4\log_4 a\geq 0$

$\Rightarrow\ \log_4 a\geq -1$

$\Rightarrow\ a\geq 4^{-1}$

$\Rightarrow\ a\geq \dfrac{1}{4}$

70. (A)

Since, the roots are less than a real number

$(2a)^2 - 4(1)\left[a^2 + a - 3\right] \geq 0$

$\Rightarrow a \leq 3 \qquad ...(1)$

Let $f(x) = x^2 - 2ax + a^2 + a - 3.$

Since, 3 lies outside the interval (α, β) where α, β are the roots.

$f(3) > 0 \Rightarrow a < 2$ or $a > 3 \qquad ...(2)$

Sum of the roots must be less than 6

$2a < 6 \Rightarrow a < 3 \qquad ...(3)$

From (1), (2), (3), we have

$a < 2$.

71. (B)

$|a+b| = |a| + |b|$

$\therefore \quad a \cdot b \geq 0$

$\therefore \quad \sin x \cdot \cos x \geq 0$

$\therefore$ Ist or IIIrd quadrant

72. (D)

According to identify we have $2^{x+2} > 2^{-2/x}$

Since the base 2 > 1, we have $x + 2 > -\frac{2}{x}$ (the sign of the inequality is retained).

Solving the inequality we obtain $x \in (0, \infty)$

73. (B)

Let us first find out θ lying between 0 and 360°.

Since, $\sin\theta = \frac{-1}{2} \Rightarrow \theta = 210^\circ$ or 330°.

and $\tan\theta = \frac{1}{\sqrt{3}} \Rightarrow \theta = 30^\circ$ or 210°.

Hence, $\theta = 210^\circ$ or $\frac{7\pi}{6}$ is the value satisfying both.

$\therefore$ The general value of $\theta = \left(2n\pi + \frac{7\pi}{6}\right), n \in I$

Hence (B) is the correct answer.

74. (B)

$(a+1)^2 + \operatorname{cosec}^2\left(\frac{\pi a}{2} + \frac{\pi x}{2}\right) - 1 = 0$

or $\quad (a+1)^2+\cot^2\left(\frac{\pi a}{2}+\frac{\pi x}{2}\right)=0$

From option (B) if $a=-1 \Rightarrow \tan^2 \pi x/2=0 \Rightarrow \frac{x}{2}\in I$

75. (B)

$4\cos^2\theta-2\sqrt{2}\cos\theta-1=0$

$\cos\theta=\frac{2\sqrt{2}\pm\sqrt{8+16}}{8}=\frac{\sqrt{2}\pm\sqrt{6}}{4}$

$\cos\theta=\frac{\sqrt{6}+\sqrt{2}}{4} \Rightarrow \theta=\frac{\pi}{12};\ 2\pi-\frac{\pi}{12}=\frac{23\pi}{12}$

$\cos\theta=-\frac{\sqrt{6}-\sqrt{2}}{4}$

$\cos\theta=\cos\left(\pi-\frac{5\pi}{12}\right);\ \cos\left(\pi+\frac{5\pi}{12}\right)$

$\theta=\frac{7\pi}{12};\ \frac{17\pi}{12}$

76. (B)

Simplifies to $-\cos\theta|\sin\theta|+\sin\theta\cos\theta=0$ provided $\sin\theta\neq\cos\theta$

77. (C)

$\sin x+\sin 5x=\sin 2x+\sin 4x$

$2\sin 3x\cos 2x=2\sin 3x\cos x$

$2\sin 3x[\cos 2x-\cos x]=0$

On solving we get, $x=\frac{n\pi}{3}$

78. (D)

$\sin\theta=\frac{-1}{2},2$

$\therefore \quad \sin\theta=\frac{-1}{2}$

$\therefore \quad \sin\theta=\sin\left(\frac{-\pi}{6}\right)$

$\therefore \quad \theta=n\pi+(-1)^n\left(\frac{-\pi}{6}\right)$

79. (C)

$|x|\in[0,1]\cup(2,\infty)$

$\therefore \quad x \in (-\infty, -2) \cup [-1, +1] \cup (2, \infty)$

80. (C)

$$\frac{-1}{2} \le 4 - 3x \le \frac{1}{2}$$
$$\frac{-9}{2} \le -3x \le \frac{-7}{2}$$
$$\frac{3}{2} \ge x \ge \frac{7}{6}$$

81. (8)

$$-\sqrt{49+25} \le 2K + 1 \le \sqrt{49+25}$$

82. (6)

$$(\alpha\beta + \beta\gamma + \gamma\alpha) = \frac{1}{3}$$

83. (55)

Given: First quadratic equation: $x^2 - 5x + 16 = 0$ and its roots $= \alpha$ and β.

Second quadratic equation: $x^2 + px + q = 0$ and its roots $= (\alpha^2 + \beta^2)$ and $\frac{\alpha\beta}{2}$.

We know that the standard quadratic equation is: $ax^2 + bx + c = 0$.

Comparing the first equation with the standard equation, we get a = 1, b = –5 and c = 16.

We also know that sum of the roots $(\alpha + \beta) = -\frac{b}{a} = -\frac{(-5)}{1} = 5$.

And product of the roots $(\alpha\beta) = \frac{c}{a} = \frac{16}{1} = 16$.

We also know that $\alpha^2 + \beta^2 = \alpha + \beta - 2\alpha\beta = -9$

Comparing second equation with the standard equation.

Since, $(\alpha^2 + \beta^2)$ and $\frac{\alpha\beta}{2}$ are roots of equation $x^2 + px + q = 0$,

$$(\alpha^2 + \beta^2) + \frac{\alpha\beta}{2} = -p; \Rightarrow p = -1$$

$$(\alpha^2 + \beta^2)\left(\frac{\alpha\beta}{2}\right) = q; \quad \Rightarrow q = -56.$$

84. (3)

$$\cot 16° \cot 44° + \cot 44° \cot 76° - \cot 76° \cot 16°$$

$$\Rightarrow (\cot 16° \cot 44° - 1) + (\cot 44° \cot 76° - 1) - (\cot 76° \cot 16° + 1) + 3$$

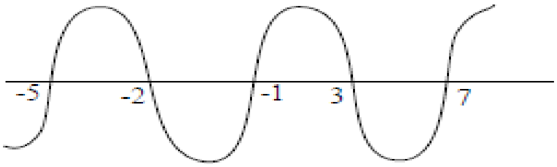
$$\Rightarrow \frac{\cos(44° + 16°)}{\sin 16° \sin 44°} + \frac{\cos(44° + 76°)}{\sin 44° \sin 76°} - \frac{\cos(76° - 16°)}{\sin 76° \sin 16°} + 3$$

$= 0 + 3 = 3$

85. (18)

Given, $f(x)=\dfrac{(x-3)\ (x+2)\ (x+5)}{(x+1)\ (x-7)}$

$f(x)<0 \Rightarrow x\in(-\infty,-5)\cup(-2,-1)\cup(3,7)$



86. (1)

Domain $x^2-x-2\geq 0$

$\Rightarrow (-\infty,-1]\cup[2,\infty)$

Now $x-1=0 \Rightarrow x=1$ (rejected)

and $x^2-x-2=0 \Rightarrow x=-1, 2$

Hence, the answer is {–1, 2}, so sum is –1 + 2 = 1

87. (4)

$3^{2x}.243-9.3^x-2=0$

$\Rightarrow 3^{2x}-\dfrac{3^x}{27}-\dfrac{2}{243}=0$

$\Rightarrow \left(3^x-\dfrac{1}{9}\right)\left(3^x+\dfrac{2}{27}\right)=0$

$\Rightarrow 3^x=\dfrac{1}{9}$ $\qquad$ $3^x=-\dfrac{2}{27}$ not possible.

$\Rightarrow 3^x=3^{-2} \Rightarrow x=-2$

88. (8)

89. (11)

domain of the inequation is, $\left[\dfrac{10}{3}, 6\right]$

Now both side is always non-negative. So squaring both the sides will give $x\in(4,\infty)$

Hence the answer is (4, 6]

90. (11)

Given: Quadratic equation: $x^2+px+q=0,$ where p and q are real and one of its roots $=\left(2+i\sqrt{3}\right)$.

We know that if one root $(\alpha)=2+i\sqrt{3},$ then second root $(\beta)=2-i\sqrt{3}$.

We know that the standard quadratic equation is: $ax^2+bx+c=0.$

Comparing the given equation with the standard equation, we get and $c = q$.

We also know that sum of the roots $(\alpha+\beta)=-\frac{b}{a}=-\frac{p}{1}=-p$

or $\left(2+i\sqrt{3}\right)+\left(2-i\sqrt{3}\right)=-p$ or $r=-p$ or $p=-4$.

And product of the roots $(\alpha\beta)=\frac{c}{a}=\frac{q}{1}=1$ or $\left(2+i\sqrt{3}\right)\left(2-i\sqrt{3}\right)=q$

or $(2)^2-\left(i\sqrt{3}\right)^2=q$ or $4+3=q$ or $q=7$.

Thus $P=-4$ and $q=7$.