Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-2 **Max.Marks:360**

IMPORTANT INSTRUCTIONS:

2) The test is of 3 hours duration.
3) The Test Booklet consists of 90 questions. The maximum marks are 360.
4) There are three parts in the question paper A, B, C consisting of **Mathematics, Physics** and **Chemistry** having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for correct response.
5) Candidates will be awarded marks as stated above in instruction No. 4 for correct response of each question. (1/4) (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
6) There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 5 above.

SYLLABUS

MATHS

Real numbers, Factor Theorem, Remainder Theorem, Finding roots of Polynomial Equation, Finding Polynomial with given roots using factor Theorem, Wavy curve method, Rational Inequations, Irrational Equation & Inequation, Modulus & its properties, Logarithm & its properties, Equations/Inequation involving Logarithms, Exponentials, Modulus; Greatest Integer, Least Integer & Fractional Part Functions (30%); Quadratic Equation (70%)

PHYSICS

Refraction at plane surface, TIR and Prism, Refraction at curved surface (exclude problems involving relative motion and differential and integral calculus)

CHEMISTRY

De-Broglie Equation, Heisenberg's Uncertainty principle, Schrodinger's wave equation; Quantum numbers, Pauli's exclusion Principle; Hund's rule; Electronic configuration of the elements, (70%)

Atomic Strucutre : Fundamental Particles - their characteristics; Thomson's, Rutherford's atomic model, Plank's Quantum theory, Bohr's atomic model, Applications of Bohr's atomic model - calculation of radius, velocity, frequency, time period and energy of electron in an orbit, Electromagnetic spectra, Hydrogen spectrum, Photoelectric effect, (30%)

MATHS

1. If $\left(b^2-4ac\right)^2\left(1+4a^2\right)<64a^2, a<0,$ then maximum value of quadratic expression ax^2+bx+c is always less than

   1) 0 2) 2

   3) –1 4) –2

2. Let $ax^2 + bx + c = 0$, a, b, $c \in R$, be a quadratic equation. If $|b| > |a + c|$ then the roots of the equation will be such that

   1) exactly one root lies between –1 and 1

   2) both roots lie between –1 and 1

   3) one root less than –1 and other greater than 1

   4) one root less than 1 and other greater than 1

3. Let α, β are roots of $x^2+12x-9=0$. If $a_n=\alpha^n+\beta^n$ for $n \geq 1,$ then the value of $\sum_{n=1}^{10}\left(\frac{9a_n-a_{n+2}}{2a_{n+1}}\right)=$

   1) 60 2) -60

   3) 120 4) -120

4. A certain polynomial $p(x)$ when divided by x-a, x-b, x-c, leaves remainders a, b, c respectively. The remainder `when $p(x)$ is divided by $(x-a)(x-b)(x-c)$ is (where a, b, c are all different non zero constants)

   1)0 2) x

   3) $ax+b-c$ 4) ax^2+bx+c

5. If the equation $\left|x^2+2x+a\right|=2$ has exactly 4 real and distinct solutions, then

   1) $a>3$

   2) $a \in (-\infty,-1] \cup (2,\infty)$

   3) $a \in (-\infty,1) \cup (3,\infty)$

   4) $a<-1$

6. Let $f(x)$ be a real valued function satisfying $af(x)+bf(-x)=px^2+qx+r,$ Where a and b are distinct real numbers and p, q and r are non-zero real numbers. Then $f(x)=0$ will have real solution when

   1) $\left(\frac{a+b}{a-b}\right)^2 \leq \frac{a^2}{4pr}$ 2) $\left(\frac{a+b}{a-b}\right)^2 \leq \frac{4pr}{q^2}$

   3) $\left(\frac{a+b}{a-b}\right)^2 \geq \frac{4pr}{q^2}$ 4) $\left(\frac{a+b}{a-b}\right)^2 \geq \frac{q^2}{4pr}$

7. The number of rational roots of the equation $\frac{x^2-13x+15}{x^2-14x+15}-\frac{x^2-15x+15}{x^2-16x+15}=-\frac{1}{12}$ is

1) 0 2) 1

3) 2 4) 3

8. If $x,y,z\in R; x+y+z=4$ and $x^2+y^2+z^2=6$, then the maximum possible value of z is

1) 1 2) 2

3) 3 4) 5/2

9. If $f(x)=\prod_{i=1}^{3}(x-a_i)+\sum_{i=1}^{3}a_i-3x,$ where $a_i<a_{i+1}$, then $f(x)=0$ has

1) Only one real root

2) Three real roots of which two of them are equal

3) Three distinct real roots

4) Three equal roots

10. Let $f(x)=x^2-bx+c, b$ is an odd positive integer $f(x)=0$ have two prime numbers as roots and $b+c=35$. Then global minimum value of $f(x)$ is

1) $-\frac{183}{4}$

2) $\frac{173}{6}$

3) $-\frac{81}{4}$

4) data is not sufficient

11. A root of the equation $(a+b)(ax+b)(a-bx)=(a^2x-b^2)(a+bx)$ is

1) $\frac{a+2b}{2a+b}$ 2) $\frac{2a+b}{a+2b}$

3) $\frac{a-2b}{2a-b}$ 4) $-\left(\frac{a+2b}{2a+b}\right)$

12. If $x^{15}-x^{13}+x^{11}-x^9+x^7-x^5+x^3-x=7,$ then

1) x^{16} is 15

2) x^{16} is less than 15

3) x^{16} greater than 15

4) Nothing can be said about x^{16}

13. If $f(x)=x^2+bx+c$ and $f(2+t)=f(2-t)$ for all real numbers t, then which of the following is true?

1) $f(1)<f(2)<f(4)$ 2) $f(2)<f(1)<f(4)$

3) $f(2)<f(4)<f(1)$ 4) $f(4)<f(2)<f(1)$

14. $x^2+(\log_3 2+\log_2 3)x+\log_2\sqrt{6}+\log_2\sqrt{\frac{2}{3}}<0$

then $x\in$

1) $(-\log_2 3,-\log_3 2)$ 2) $(\log_{1/2}3,\log_{1/3}2)$

3) $\left(\log_2\frac{1}{3},\log_3\frac{1}{2}\right)$ 4) All of these

space for rough work

15. If $\left(x^2+x+2\right)^2-(a-3)\left(x^2+x+1\right)\left(x^2+x+2\right)+(a-4)\left(x^2+x+1\right)^2=0$ has at least one root, then the complete set of values of a is

1) $(-\infty,5)$ 2) $(3,6)$

3) $\left(5,\frac{19}{2}\right)$ 4) $\left(5,\frac{19}{3}\right]$

16. If the equations $ax^2+bx+c=0$, $a,b,c\in R$ and $x^3+3x^2+3x+2=0$ have two common roots, then $2a+3b-5$ is

1) -1 2) 0

3) 1 4) 2

17. If α,β are the roots $4x^2-16x+\lambda=0,\lambda\in R,$ such that $1<\alpha<2$ and $2<\beta<3$, then the number of integral solutions of λ is

1) 6 2) 5

3) 3 4) 2

18. The product of real values of x such that $\left(\log_x 2\right)^2-\left(\log_2 x\right)^2=\log_{2x}\left(\frac{2}{x}\right)$ is

1) $\sqrt{2}$ 2) $\frac{1}{\sqrt{2}}$

3) $2^{\sqrt{2}}$ 4) $\frac{1}{2^{\sqrt{2}}}$

19. The solution set of $\left|\left|x-1\right|-1\right|+x\le 2$ is

1) $(-\infty,2]$ 2) $[0,1)$

3) $[0,2)$ 4) $[1,2)$

20. If $\alpha_1,\alpha_2,...,\alpha_n$ are roots of the equation $x^n+ax+b=0$, then $(\alpha_1-\alpha_2)(\alpha_1-\alpha_3)(\alpha_1-\alpha_4).....(\alpha_1-\alpha_n)$ is equal to

1) n 2) $n\alpha_1^{n-1}$

3) $n\alpha_1+b$ 4) $n\alpha_1^{n-1}+a$

21. Let $S\equiv\{a\in N,a\le 100\}$. If the equation $\left[\tan^2 x\right]-\tan x-a=0$ has real roots then number of elements in S is, [where [.] greatest integer function]

1) 10 2) 8

3) 9 4) 0

22. Number of real roots of the equation $x^{10}-3x^8+5x^6-5x^4+3x^2-1=0$ is

1)2 2)4

3)8 4) 10

23. The remainder obtained by dividing the polynomial x^{49} by x^2-4x+3 is

1) $\frac{1}{2}(3^{49}-1)x-\frac{1}{2}(3^{49}-3)$

2) $\frac{1}{2}(3^{49}-1)x+\frac{1}{2}(3^{49}-3)$

3) $\frac{1}{2}(3^{49}-3)x+\frac{1}{2}(3^{49}-1)$

4) $\frac{1}{2}(3^{49}-3)x-\frac{1}{2}(3^{49}-1)$

24. The number of solutions of $|[x]-2x|=4$ where $[x]$ is the greatest integer $\le x$ is

1) 2 2) 4

3) 1 4) Infinite

25. If $x^2+4y^2-8x+12=0$ is satisfied by real values of x and y then $'y'\in$

1) $[2,6]$ 2) $[2,5]$

3) $[-1,1]$ 4) $[-2,-1]$

26. Let $f(x)=x^2+5x+6$, then the number of real roots of $(f(x))^2+5f(x)+6-x=0$ is

1) 1 2) 2

3) 3 4) 0

27. If $f(x)=x^2+2bx+2c^2$ and $g(x)=-x^2-2cx+b^2$ are such that $\min f(x)>\max g(x)$, then relation between b and c, is

1) no relation 2) $0<c<b/2$

3) $|c|<\frac{|b|}{\sqrt{2}}$ 4) $|c|>\sqrt{2}|b|$

28. Sum of all the values of x satisfying the equation $\log_{17}\log_{11}\left(\sqrt{x+11}+\sqrt{x}\right)=0$ is

1) 25 2) 36

3) 171 4) 0

29. The number of ordered pairs of integers (x, y) satisfying the equation $x^2+6x+y^2=4$

1) 2 2) 8

3) 6 4) 10

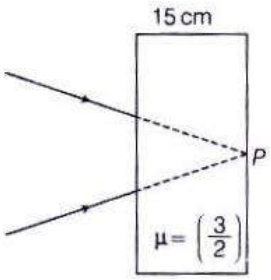
30. The values of 'a' for which the quadratic expression $ax^2+(a-2)x-2$ is negative for exactly two integral values of x, belongs to

1) $[-1,1]$ 2) $[1,2)$

3) $[3,4]$ 4) $[-2,-1)$

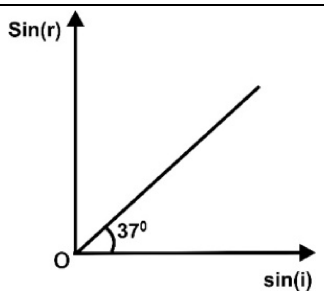
PHYSICS

31. A paraxial beam of light incident on a slab of refractive index $\frac{3}{2}$ and thickness 15 cm. The slab is placed in air as shown in the figure. The converging point of the beam after refraction through slab is



1) at 5 cm rightward from point P
2) at 5 cm leftward from point P
3) at point P
4) None of these

32. A ray of light, travelling in medium A, is incident on plane interface of two media A and B and gets refracted into medium B. The angle of incidence is *i* and that of refraction is *r*. Graph between sin (*i*) and sin (*r*) is as shown in figure.

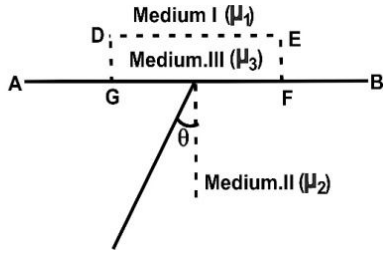


Which of the following statement is correct?

1) Speed of light in medium B is three-fourth of that in medium A.
2) Total internal reflection can take place.
3) Refractive index of medium A is greater than that of medium B.
4) None

33. Monochromatic light is incident on plane interface AB between two media of refractive indices μ_1 and μ_2 ($\mu_2 > \mu_1$) at angle θ shown in figure. The angle θ is infinitesimally greater than the critical angle for two media so that total internal reflection takes place. Now, if a transparent slab DEFG of uniform thickness and having refractive index μ_3 is introduced on the interface as shown in

the figure, which of the following statement is incorrect?



1) If $\mu_3 < \mu_1$, total internal reflection will take place at face GF.

2) If $\mu_3 > \mu_1$, light will refract into the slab.

3) If $\mu_3 > \mu_1$, total internal reflection will take place at face DE.

4) Light can notbe transmitted to medium I.

34. The refracting angle of prism is A and refractive index of material of prism is cot (A/2). The angle of minimum deviation will be:

1) $(180^0 - 2A)$

2) $(180^0 + 2A)$

3) $90^0 - A$

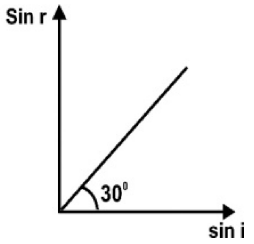
4) $(180^0 - A)$

35. An air bubble in a glass slab ($\mu = 1.5$) appears 6 cm deep when viewed from one face and 4 cm deep when viewed from the other face. The thickness of the glass slab is:

1) 10 cm 2) 6.67 cm

3) 15 cm 4) None of these.

36. When light is incident on a medium at angle *i* and refracted into a second medium at an angle r, the graph of sin *i*vs sin *r* is as shown in the graph. From this, one can conclude that:



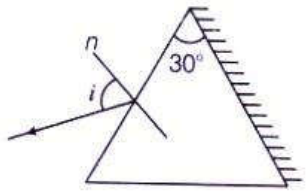
1) Velocity of light in first medium is 1.73 times the velocity of light in the second medium

2) The critical angle for the two media is given by $\sin C = \frac{\sqrt{3}}{2}$

3) $\sin C = \frac{1}{2}$

4) None of these

37. A prism of refractive index $\sqrt{2}$ has a angle of prism 30^0 . One of the refracting surface of prism is silvered . Find the angle of incidence i for which the ray retraces its path



1) 30^0 2) 60^0

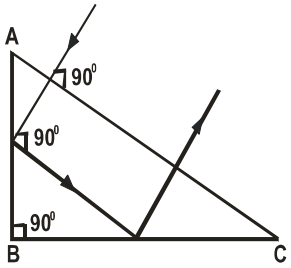
3) 45^0 4) 90^0

38. A beam of width t is incident at 45^0 on an air-water boundary. The width of the beam in water is:

1) $(\mu-1)t$ 2) μt

2) $\frac{\sqrt{2\mu^2-1}}{\mu}t$ 4) $\frac{\sqrt{\mu^2-1}}{\mu}t$

39. A ray of light falls on a prism ABC (AB = BC) and travels as shown in figure. The refractive index of the prism material should be at least:



1) 4/3 2) $\sqrt{2}$

3) 1.5 4) $\sqrt{3}$

40. A bulb is placed at a depth of $2\sqrt{7}$ m in water and a floating opaque disc is placed over the bulb so that the bulb is not visible from the surface. The radius of the disc should be atleast:

1) 42 m. 2) 6 m.

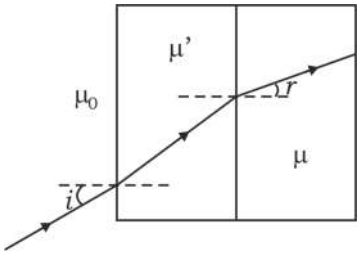
3) $2\sqrt{7}$ m. 4) 12 m.

41. A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence of 45^0. The ray undergoes total internal reflection. If n is the refractive index of the medium with respect to air, select the possible value of n from the following:

1) 1.3 2) 1.4

3) 1.2 4) 1.6

42. In the adjacent figure, sin*i*/sin*r*:



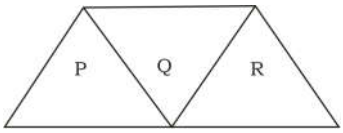
1) is equal to $\frac{(\mu')^2}{\mu.\mu_0}$

2) is equal to $\frac{\mu}{\mu_0}$

3) is equal to $\frac{\mu.\mu_0}{(\mu')^2}$

4) cannot be calculated

43. A given ray of light suffers minimum deviation in an equilateral prism P. Additional prisms Q and R of identical shape and of the same material as P are now added as shown in Fig. The ray will now suffer



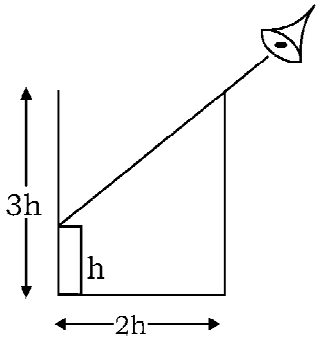
1) greater deviation

2) no deviation

3) same deviation as before

4) total internal reflection.

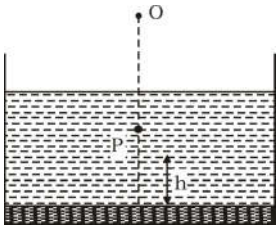
44. An observer can see through a pin hole, the top end of a thin rod of height h placed as shown in Fig. The beaker height is 3*h* and its radius is h. When the beaker is filled with a liquid upto a height 2*h*, he can see the lower end of the rod. Then the refractive index of the liquid is



1) 5/2 2) $\sqrt{5/2}$

3) 3/2 4) $\sqrt{3/2}$

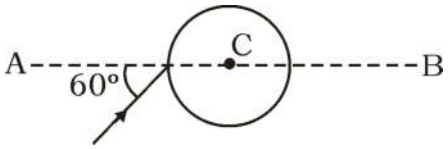
45. A plane mirror is placed at the bottom of a tank containing a liquid of refractive index μ. P is a small object at a height h above the mirror. An observer O- vertically above P outside the liquid sees P and its image in the mirror. The apparent distance between these two will be



1) $2\ \mu h$ 2) $\frac{2h}{\mu}$

3) $\frac{2h}{\mu - 1}$ 4) $h\left(1+\frac{1}{\mu}\right)$

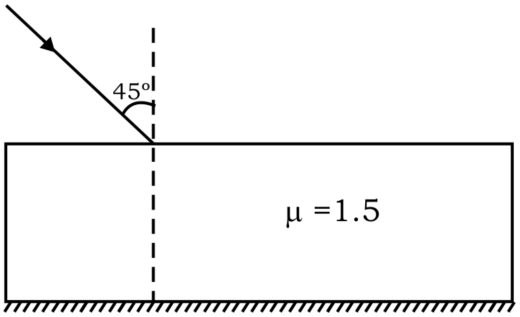
46. A ray of light falls on a transparent sphere with centre at C as shown in Fig. The ray emerges from the sphere parallel to line AB. The refractive index of the sphere is



1) 3/2 2) $\sqrt{2}$

3) 1/2 4) $\sqrt{3}$

47. One side of a glass slab is silvered as shown in Fig. A ray of light is incident on the other side at angle of incidence I = 45°. Refractive index of glass is 1.5. The deviation of the ray of light from its initial path when it comes out of the slab is



1) 180° 2) 120°

3) 45° 4) 90°

48. A point source is placed at a distance d in a liquid of refractive index μ below the air-liquid interface, d_A is apparent depth of this when seen from air. Now this point source is placed in air at same distance d from interface. When it is observed from within the liquid, it is at an apparent distance d_A'. The product of d_A' and d_A is given by

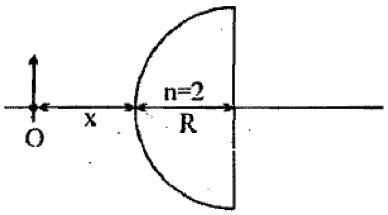
1) d^2 2) $\frac{d^2}{\mu^2}$

3) $d^2\mu^2$ 4) $\frac{d^2}{\mu(1-1/\mu)}$

Paragraph for question no. 49 to 51

Consider a transparent hemisphere (n=2) in front of which a small object is placed.

space for rough work



49. For which value of x of the following will final image of an object at O be virtual

1) 2R 2) 3R

3) R/2 4) 1.5 R

50. What is the nature of final image of object O for x = 2R.

1) erect and magnified

2) inverted and magnified

3) erect and same size

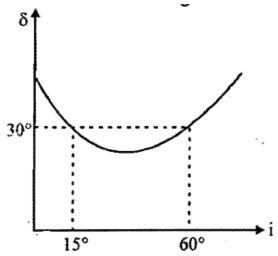
4) inverted and same size

51. Consider a ray starting from O which strikes the spherical surface at grazing incidence (i =90). Taking x = R, what will be the angle (from the normal) at which the ray emerges from the plane surface.

1) 90^0 2) 0^0

3) 30^0 4) 60^0

52. Figure shows the graph of angle of deviation δ versus angle of incidence i for a light ray striking a prism. The prism angle is



1) 30^0 2) 45^0

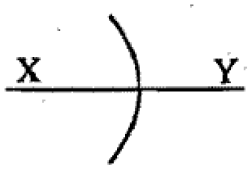
3) 60^0 4) 75^0

53. A certain prism is found to produce minimum deviation of 38^0. It produces a deviation of 44^0 when the angle of incidence is either 42^0 or 62^0. What is the angle of incidence when it is undergoing minimum deviation

1) 45^0 2) 49^0

3) 40^0 4) 55^0

54. A concave spherical surface of radius ofcurvature10cm separates two medium x& y of refractive index *4/3* & 3/2 respectively. If the object is placed along principal axis in medium X then



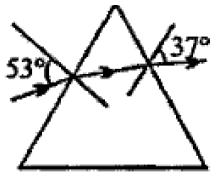
1) image is always real .

2) image is real if the object distance is greater than 90 cm .

3) image is always virtual

4) image is virtual if the object distance is less than 90 cm

55. A ray incident at an angle 53° on a prism emerges at an angle at 37^0 as shown.

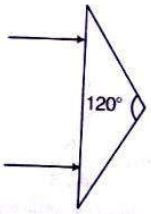


If the angle of incidence is made 50°, which of the following is a possible value of the angle of emergence.

1) 35^0 2) 42^0

3) 40^0 4) 38^0

56. An isosceles prism of angle 120^0 has a refractive index 1.44. Two parallel rays of monochromatic light enter the prism parallel to each other in air as shown in the figure. The rays emerging from the opposite face



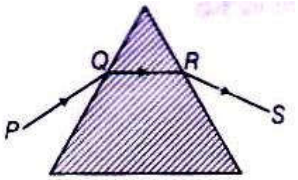
1) are parallel to each other

2) are diverging

3) make an angle $2\left[\sin^{-1}(0.72)-30^0\right]$ with each other

4) make an angle $2\sin^{-1}(0.72)$ with each other

57. A ray of light is incident on an equilateral glass prism placed on a horizontal table .For minimum deviation which of the following is correct?



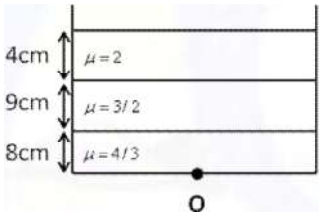
1) PQ is horizontal

2) QR is horizontal

3) RS is horizontal

4) Either PQ or RS is horizontal

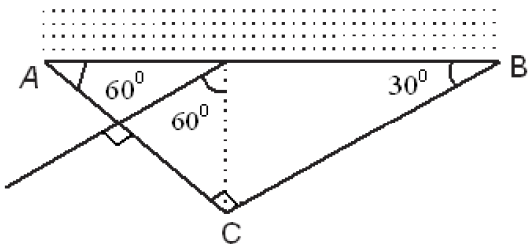
58. A tank contains three layers of immiscible liquids.The first layer is of water with refractive index 4/3 and thickness 8 cm.The second layer is of oil with refractive index 3/2 and thickness 9 cm while the third layer of glycerin with refractive index 2 and thickness 4cm.Find the apparent depth of the bottom of the container.



1)14 cm 2)21 cm

3)7 cm 4)13 cm

59. ACB is right angle prism with other angles as60° and30°.Refractive index of the prism is 1.5.AB has the layer of liquid on it as shown in figure. Light falls normally on the face AC. For total internal reflections, maximum refractive index of the liquid is.



1)1.4 2)1.3

3)1.2 4)1.6

60. A ray of light passes from vacuum into a medium of refractive index n. If the angle of incidence is twice the angle of refraction, then the angle of incidence is

1) $\cos^{-1}(n/2)$ 2) $\sin^{-1}(n/2)$

3) $2\cos^{-1}(n/2)$ 4) $2\sin^{-1}(n/2)$

CHEMISTRY

61. According to Bohr's theory the angular momentum of electron in 5th orbit is:

1) $1.0\frac{h}{\pi}$ 2) $10\frac{h}{\pi}$

3) $2.5\frac{h}{\pi}$ 4) $25\frac{h}{\pi}$

62. The wave length of the first spectral line in Balmer series of spectrum of H-atom is:

1) $\frac{36}{5R}$cm 2) $\frac{5R}{36}$cm

3) $\frac{6}{R}$cm 4) none of these

63. Ionization energy of He^+ is $19.6\times10^{-18} J\ atom^{-1}$. The energy of the first stationary state ($n=1$) of Li^{2+} is:

1) $8.82\times10^{-17} J\ atom^{-1}$

2) $4.41\times10^{-16} J\ atom^{-1}$

3) $-4.41\times10^{-17} J\ atom^{-1}$

4) $-2.2\times10^{-15} J\ atom^{-1}$

64. The uncertainties in the velocities of two particles, A and B are 0.05 and 0.02 ms^{-1} respectively. The mass of B is five times that of the mass of A. What is the ratio of uncertainties $(\Delta x_A / \Delta x_B)$ of their positions?

1) 2 2) 0.25

3) 4 4) 1

65. How many revolutions an electron will make in 2nd shell of He^+ in one second?

1) 6.66×10^{15} 2) 3.33×10^{15}

3) 2.22×10^{15} 4) 1.11×10^{15}

66. If H-atom is supplied with 12.1 eV energy and electron returns to the ground state after excitation the number of spectral lines in Balmer series would be: (use energy of ground state of H-atom = $-13.6eV$)

1) 1 2) 2

3) 3 4) 4

67. The correct set of four quantum numbers for the valence electrons of rubidium atom(Z = 37) is:

1) 5, 1, 0, $+\frac{1}{2}$ 2) 5, 1, 1, $+\frac{1}{2}$

3) 5, 0, 1, $+\frac{1}{2}$ 4) 5, 0, 0, $+\frac{1}{2}$

68. Considering the wavelength of electron and proton to be equal, the ratio of their velocities would be:
(mass of $e^- = 9.1\times10^{-31} kg$, mass of proton = $1.67\times10^{-27} kg$)

1) 1.6 2) 91

3) 15.20 4) 1835

69. The maximum number of electrons that can have principal quantum number $n = 3$ and spin quantum number $m_s = -\frac{1}{2}$ is:

1) 1 2) 3

3) 5 4) 9

70. The orbital angular momentum of an electron revolving in an orbit is given by $\sqrt{\ell(\ell+1)}\frac{h}{2\pi}$. This momentum for an s-electron will be given by:

1) $+\frac{1}{2}\cdot\frac{h}{2\pi}$ 2) zero

3) $\frac{h}{2\pi}$ 4) $\sqrt{2}\cdot\frac{h}{2\pi}$

71. The wavelength of a photon that is associated with 1 eV energy is:
($h = 6.6\times10^{-34} Js, 1eV = 1.6\times10^{-19} J$, $c = 3\times10^{8} ms^{-1}$)

1) $1.2375\,A^0$ 2) $12.375\,A^0$

3) $123.75\,A^0$ 4) $12375\,A^0$

72. Bohr radius of a shell in H-atom is $8.46A^0$. The number of electrons in this shell are:

1) 2 2) 8

3) 18 4) 32

73. Consider the ground state of Cr atom (Z = 24), the number of electrons, with azimuthal quantum numbers $\ell = 1$ and $\ell = 2$ respectively

1) 12 and 4 2) 16 and 5

3) 16 and 4 4) 12 and 5

74. Which of the following sets of quantum numbers represents the highest energy in an atom?

	n	***l***	***m***	***s***
1)	4	0	0	$+\frac{1}{2}$
2)	3	0	0	$+\frac{1}{2}$
3)	3	1	1	$+\frac{1}{2}$
4)	3	2	1	$+\frac{1}{2}$

75. Which one of the following grouping represents a collection of isoelectronic species? (At.no of $Cs = 55$, $Br = 35$)

1) Na^+, Ca^{2+}, Mg^{2+}

2) N^{3-}, F^-, Na^+

3) Be, Al^{3+}, Cl^-

4) Ca^{2+}, Cs^+, Br

76. The radius of which of the following orbits is the same as that of the first Bohr's orbit of hydrogen atom?

1) $He^+(n = 2)$ 2) $Li^{2+}(n = 2)$

3) $Li^{2+}(n = 3)$ 4) $Be^{3+}(n = 2)$

77. What is the ratio of specific charge of α-particle to that of proton?

1) 1 : 1 2) 4 : 1

3) 1/2 : 1 4) 1 : 1/2

78. Which of the following does not have spherical as well as angular node?

1) $1s$ 2) $2s$

3) $2p$ 4) $3d$

79. The number of radial nodes of $3s$ and $2p$ orbitals are respectively:

1) 2, 0 2) 0, 2

3) 1, 2 4) 2, 1

80. If an electron, a proton and an α-particle have same de-Broglie wavelengths, their kinetic energies are related to one another as:

1) electron > proton > α-particle

2) proton > electron > α-particle

3) α-particle > proton > electron

4) electron = proton = α-particle

81. The wavelength of limiting line (i.e., of shortest wavelength) in Balmer series of H-atom is

1) $4758\,A^0$ 2) $3644\,A^0$

3) $2435\,A^0$ 4) $4634\,A^0$

82. The electrons identified by quantum numbers n and ℓ

(a) $n = 4, \ell = 1$ (b) $n = 4, \ell = 0$

(c) $n = 3, \ell = 2$ (d) $n = 3, \ell = 1$

can be placed in order of increasing energy as:

1) d < b < c < a

2) b < d < a < c

3) a < c < b < d

4) c < d < b < a

83. Energies of subshells in H-atom depend upon

1) n value

2) $(n+\ell)$ value

3) ℓ value only

4) n, ℓ and m values

84. If the uncertainties of position and momentum of a particle of mass m are equal, the uncertainty of velocity would be:

1) $\sqrt{\hbar}$ 2) $\frac{1}{m}\sqrt{\frac{\hbar}{2}}$

3) $\sqrt{2\hbar}$ 4) $m\sqrt{\frac{\hbar}{2}}$

85. The number of spherical nodes, angular nodes and nodal plane for $3p_z$ in proper order are:

1) 3, 1, 0 2) 1, 1, 1

3) 2, 0, 1 4) 2, 1, 1

86. Uncertainty in the position of an electron (mass = $9.1\times10^{-31}kg$) moving with a velocity of $300\,ms^{-1}$ accurate upto 0.001% will be:

1) $5.76\times10^{-3}m$ 2) $1.92\times10^{-3}m$

3) $3.84\times10^{-3}m$ 4) $1.52\times10^{-4}m$

87. The dimensions of Planck's constant are the same as that of:

1) energy

2) angular momentum

3) work

4) power

88. The energy of second Bohr's orbit in hydrogen atom is $-328\,kJ\,mol^{-1}$. The energy of the third Bohr's orbit of He^+ is:

1) $-583.11kJ\,mol^{-1}$ 2) $-853.11kJ\,mol^{-1}$

3) $-145.78kJ\,mol^{-1}$ 4) $-511.83\,kJ\,mol^{-1}$

89. Under certain conditions the velocity of H-atom is $10^3 ms^{-1}$. Its wavelength is:

1) $3.98\,A^0$ 2) $10^3\,A^0$

3) $103\,A^0$ 4) $398\,A^0$

90. The number of radial nodes for 4p orbital is

1) 4 2) 3

3) 2 4) 1

Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MANIS PAPER-2

Max. Marks: 360

KEY SHEET

MATHS

1	2	**2**	1	**3**	1	**4**	2	**5**	4	**6**	3
7	1	**8**	2	**9**	3	**10**	3	**11**	4	**12**	3
13	2	**14**	4	**15**	4	**16**	2	**17**	3	**18**	4
19	1	**20**	4	**21**	3	**22**	1	**23**	1	**24**	2
25	3	**26**	4	**27**	4	**28**	1	**29**	2	**30**	2

PHYSICS

31	2	**32**	1	**33**	4	**34**	1	**35**	3	**36**	1
37	3	**38**	3	**39**	2	**40**	2	**41**	4	**42**	2
43	3	**44**	2	**45**	2	**46**	4	**47**	4	**48**	1
49	3	**50**	4	**51**	1	**52**	2	**53**	2	**54**	3
55	4	**56**	3	**57**	2	**58**	1	**59**	2	**60**	3

CHEMISTRY

61	3	**62**	1	63	3	**64**	1	**65**	2	**66**	1
67	4	**68**	4	69	4	**70**	2	**71**	4	**72**	4
73	4	**74**	4	75	2	**76**	4	**77**	3	**78**	1
79	1	**80**	1	81	2	**82**	1	**83**	1	**84**	2
85	2	**86**	2	87	2	**88**	3	**89**	1	**90**	3

SOLUTIONS:

MATHS

1. $\dfrac{\left(b^2-4ac\right)^2}{16a^2} < \dfrac{4}{1+4a^2}$

   Now, max $\left(ax^2+bx+c\right) = -\dfrac{b^2-4ac}{4a}$

   $\dfrac{-2}{\sqrt{1+4a^2}} < -\dfrac{b^2-4ac}{4a} < \dfrac{2}{\sqrt{1+4a^2}}$

   So, max value always less than 2 (when $a \to 0$).

2. $b^2 > (a+c)^2 \Rightarrow (a-b+c)(a+b+c) < 0 \Rightarrow f(-1)\, f(1) < 0.$

3. α, β are roots of $x^n\left(x^2+12x-9\right)=0$

   $\Rightarrow \begin{cases} 12\alpha^{n+1} = 9\alpha^n - \alpha^{n+2} \\ 12\beta^{n+1} = 9\beta^n - \beta^{n+2} \end{cases}$

   Adding $9a_n - a_{n+2} = 12a_{n+1}$

   $\Rightarrow \left(\dfrac{9a_n - a_{n+2}}{2a_{n+1}}\right) = 6$

4. $P(x) = Q(x)(x-a)(x-b)(x-c) + Ax^2 + Bx + C$

   $P(a) = a \Rightarrow Aa^2 + Ba + d = a$

   $P(b) = b \Rightarrow Ab^2 + Bb + d = b$

   $p(c) = c \Rightarrow Ac^2 + Bc + d = c$

   Solving we get $A=0; B=1; C=0$

   $\therefore$ reminder is x

5. $x^2 + 2x + a = \pm 2$

   $x^2 + 2x \pm 2 = -a$

   $x^2 + 2x + 2 + a = 0$ or $x^2 + 2x + a - 2 = 0$

   $D_1 > 0 \quad \& \quad D_2 > 0$

   $4 - 8 - 4a > 0 \quad \& \quad 4 - 4a + 8 > 0$

   $a + 1 < 0 \quad \& \quad a < 3$

   $a < -1 \quad \& \quad a < 3$

   $\therefore a < -1$

6. $a\, f(x) + bf(-x) = px^2 + qx + r$

   $bf(x) + af(-x) = px^2 - qx + r$

   $\Rightarrow \left(a^2 - b^2\right) f(x) = (a-b)\, px^2 + (a+b)qx + (a-b)r$

   $f(x) = 0$

   will have real roots is

   $(a+b)^2 q^2 - 4p(a-b)(a-b)r \geq 0$

   $\Rightarrow \left(\dfrac{a+b}{a-b}\right)^2 \geq \dfrac{4pr}{q^2}$

7. Divide the numerator & Denominator by x and take $y = x + \dfrac{15}{x}$

8. If $x, y, z \in R; x + y + z = 4$

   $x + y = 4 - z; x^2 + y^2 = 6 - z^2$

Now $2xy = (x+y)^2 - x^2 - y^2$

$= (4-z)^2 - (6-z^2) = 2z^2 - 8z + 10$

The quadratic equation whose roots are x,y can be

$t^2 - (x+y)t + xy = 0$

$\Rightarrow t^2 - (4-z)t + (z^2 - 4z + 5) = 0$

Since $x, y \in R$

$\therefore (4-z)^2 - 4(z^2 - 4z + 5) \geq 0$

$\Rightarrow 3z^2 - 8z + 4 \leq 0 \Rightarrow \frac{2}{3} \leq z \leq 2$

9. $f(x) = (x-a_1)(x-a_2)(x-a_3) + (a_1 - x) + (a_2 - x) + (a_3 - x)$

Now $f(x) \to -\infty$ as $x \to -\infty$ and $f(x) \to \infty$ as $x \to \infty$

Again, $f(a_1) = (a_2 - a_1) + (a_3 - a_1) > 0 (\because a_1 < a_2 < a_3)$

$\Rightarrow$ one root belongs to $(-\infty, a_1)$

Also, $f(a_3) = (a_1 - a_3) + (a_2 - a_3) < 0$

$\Rightarrow$ one root belongs to (a_1, a_3)

So $f(x) = 0$ has three distinct real roots.

10. Let α, β be roots of $x^2 - bx + c = 0$

Then $\alpha + \beta = b$

$\Rightarrow$ one of the roots is '2' (since α, β are primes and b is odd positive integer)

$\therefore f(2) = 0 \Rightarrow 2b - c = 4$ and $b + c = 35$

$\therefore \ b = 13, c = 22$

Minimum value $= f\left(\frac{13}{2}\right) = -\frac{81}{4}$

11. The given equation reduces to $(2a+b)x^2 - (a-b)x - (a+2b) = 0$

The sum of the coefficients = 0

$\therefore x = 1$ is a root

The other root $= -\left(\frac{a+2b}{2a+b}\right)$

12. $x^{15} - x^{13} + x^{11} - x^9 + x^7 - x^5 + x^3 - x = x(x^8+1)(x^4+1)(x^2-1)$

$x^{16} - 1 = (x^8+1)(x^4+1)(x^2+1)(x^2-1)$

$\frac{7}{x}(x^2+1) = 7\left[\left(\sqrt{x} - \frac{1}{\sqrt{x}}\right)^2 + 2\right] > 14 \ \therefore x^{16} > 15$

13.

14. $x^2 + (\log_3 2 + \log_2 3)x + \log_2\left(\sqrt{6}.\sqrt{\frac{2}{3}}\right) < 0$

$\Rightarrow x^2 + (\log_3 2 + \log_2 3)x + 1 < 0$

$\Rightarrow (x + \log_3 2)(x + \log_2 3) < 0$

$\Rightarrow -\log_2 3 < x < -\log_3 2, [\because \log_3 2 < 1 \ \& \ \log_2 3 > 1]$

$\therefore x \in (-\log_2 3, -\log_3 2)$ or $x \in \left(\log_2 \frac{1}{3}, \log_3 \frac{1}{2}\right)$

Or $x \in \left(\log_{1/2} 3, \log_{1/3} 2\right)$

$\Rightarrow$ all options are correct.

15. Let $x^2 + x + 1 = t \Rightarrow t \in \left[\frac{3}{4}, \infty\right)$

$\Rightarrow t = \frac{1}{a-5} \Rightarrow \frac{1}{a-5} \geq \frac{3}{4}$

16. $x^3 + 3x^2 + 3x + 2 = 0$

$\Rightarrow \left(x^3 - 1\right) + 3\left(x^2 + x + 1\right) = 0 \Rightarrow \left(x^2 + x + 1\right)\left(x + 2\right) = 0$

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

Common roots ω, ω^2, $\therefore \omega, \omega^2$ are common roots of two equations $\therefore a = b = c = 1$

17.

18. if $t = \log_2 x$, the given relation becomes

$\frac{1}{t^2} - t^2 = \frac{1-t}{1+t} \Rightarrow \left(t-1\right)\left(t^4 + 2t^3 + t^2 + 2t + 1\right) = 0$

$\Rightarrow t = 1, t^2 + 2t + 1 + \frac{2}{t} + \frac{1}{t^2} = 0$

or $\left(t + \frac{1}{t}\right)^2 + 2\left(t + \frac{1}{t}\right) - 1 = 0$

$\therefore t + \frac{1}{t} = -\left(\sqrt{2} + 1\right) \in R - (-2, 2)$

The sum of its roots is $t_1 + t_2 = -\left(\sqrt{2} + 1\right)$

The product of the value of x is $2^{t + t_1 + t_2} = 2^{-\sqrt{2}}$

19. (i) if x<0, then $|1 - x - 1| + x \leq 2$

$\Rightarrow |x| + x \leq 2 \Rightarrow -x + x \leq 2 \Rightarrow 0 \leq 2 (\text{true})$

$\therefore$ x<0

(ii) if $0 \leq x < 1$, then $|1 - x - 1| + x \leq 2$

$|x| + x \leq 2 \Rightarrow 2x \leq 2 \Rightarrow x \leq 1 \therefore 0 \leq x < 1$

(iii) If $1 \leq x < 2$, then $|x - 1 - 1| + x \leq 2$

$\Rightarrow |x - 2| + x \leq 2 \Rightarrow 2 - x + x \leq 2 \Rightarrow 2 \leq 2 (\text{true})$

$\therefore 1 \leq x < 2$

(iv) if $x \geq 2$, then $|x - 1 - 1| + x \leq 2$

$\Rightarrow |x - 2| + x \leq 2 \Rightarrow x \leq 2 \quad \therefore x = 2 [\because x \geq 2]$

$\therefore$ Required solution set is $(-\infty, 2]$

20. $x^n + ax + b\left(x - \alpha_1\right)\left(x - \alpha_2\right)....\left(x - \alpha_n\right)$

Differentiate both sides w.r.t.x

$nx^{n-1} + a = \left(x - \alpha_2\right)....\left(x - \alpha_n\right) + \left(x - \alpha_1\right)\left(\frac{d}{dx}\left(x - \alpha_2\right).....\left(x - \alpha_n\right)\right)$

Put $x = \alpha_1, n\alpha_1^{n-1}, n\alpha_1^{n-1} + a = \left(\alpha_1 - \alpha_2\right)\left(\alpha_1 - \alpha_3\right)....\left(\alpha_1 - \alpha_n\right)$

21. The equation $\left[\tan^2 x\right] - \tan x - a = 0$ is true only if tanx is an integer. Since $\left[\tan^2 x\right]$ and a both are integers.

$\Rightarrow \tan x = \frac{1 \pm \sqrt{4a+1}}{2} =$ both value are integers

$\Rightarrow 4a + 1 = (2k - 1)^2 \Rightarrow k^2 - k = a$ and $a \leq 100$

$\Rightarrow$ there are 9 values of a satisfied

22. it is reciprocal equation, 1 and -1 are real roots.

23. Write $x^{49} = (x-1)(x-3)Q(x) + Ax + B$

24. If $x = n \in Z$, $|n-2n| = 4 \Rightarrow n = \pm 4$

If $x = n + K$ where $0 < K < 1$ then $|n-2(n+k)| = 4$, it is possible if $K = \frac{1}{2}$

$\Rightarrow |-n-1| = 4$

$\therefore n = 3, -5$

25. $x^2 - 8x + (4y^2 + 12) = 0$ is a quadratic in 'x', 'x' is real then discriminate ≥ 0

26. Use "f(x) = x has non real roots $\Rightarrow$ f(f(x)) = x also has non-real roots"

27. $f(x) = (x+b)^2 + 2c^2 - b^2$

$\Rightarrow \min f(x) = 2c^2 - b^2$

Also $g(x) = -x^2 - 2cx + b^2 = b^2 + c^2 - (x+c)^2$

$\Rightarrow \max g(x) = b^2 + c^2$

As $\min f(x) > \max g(x)$, we get $2c^2 - b^2 > b^2 + c^2$

$\Rightarrow c^2 > 2b^2 \Rightarrow |c| > \sqrt{2}|b|$

28. $\log_{17} \log_{11} \left(\sqrt{x+1} + \sqrt{x}\right) = 0$ ..... (1)

Equation (1) is defined if $x \geq 0$.

We can rewrite (1) as $\log_{11} \left(\sqrt{x+11} + \sqrt{x}\right) = 17^0 = 1$

$\Rightarrow \sqrt{x+11} + \sqrt{x} = 11^1 = 11$

$\Rightarrow \sqrt{x+11} = 11 - \sqrt{x}$

Squaring both sides we get $x + 11 = 121 - 22\sqrt{x} + x$

$\Rightarrow 22\sqrt{x} = 110 \Rightarrow \sqrt{x} = 5$ or $x = 25$

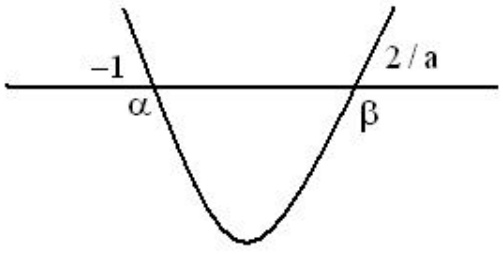
This clearly satisfies (1). Thus, sum of all the values satisfying (1) is 25.

29. $(x+3)^2 + y^2 = 13$

$x + 3 = \pm 2, y = \pm 3 \; or \; x + 3 = \pm 3, y = \pm 2$

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

$f(x)$ is negative for two integral values of x, so graph should be vertically upward parabola i.e., $a > 0$



Let two roots of $f(x) = 0$ are α and β then $\alpha, \beta = \frac{-(a-2) \pm (a+2)}{2a}$

$\Rightarrow \alpha = -1, \beta = \frac{2}{a} \Rightarrow 1 < \beta \leq 2 \Rightarrow 1 < \frac{2}{a} \leq 2 \Rightarrow a \in [1,2]$

31. $x = \left(1 - \frac{1}{\mu}\right)t$

32. Refractive index of second medium relative to first is,

$$\mu = \frac{\sin i}{\sin r} = \frac{1}{\tan\ 37^0} = \frac{4}{3}.$$

But the refractive index of second medium B, relative to medium A, is equal to $\frac{\mu_2}{\mu_1}$.

Hence, $\frac{\mu_2}{\mu_1} = \frac{4}{3}$. But $\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$,

where v_1 is velocity of light in first medium &v_2 is velocity of light in second medium. Hence, speed of light in medium B is ¾ of that in medium A. Therefore, (A) is correct.

Since $\frac{\mu_2}{\mu_1} > 1$, it means, second medium is denser than the first medium. Hence, total internal reflection can not take place. Therefore, (B) is incorrect.

Since $\frac{\mu_2}{\mu_1} = \frac{4}{3}$, therefore, $\mu_2 = \frac{4}{3}\mu_1$.

Hence (C) is wrong.

33. Critical angle C_1 for interface AB of two media of refractive indices μ_1 and μ_2 is given by $\sin C_1 = \frac{\mu_1}{\mu_2}$.

Since θ is infinitesimally greater than C_1, therefore, sin θ is infinitesimally greater than $\frac{\mu_1}{\mu_2}$.

If $\mu_3 < \mu_1$, critical angle C_2 for interface GF will be given by $\sin C_2 = \frac{\mu_3}{\mu_2}$. Since $\mu_3 < \mu_1$, therefore, $\frac{\mu_3}{\mu_2} < \frac{\mu_1}{\mu_2}$.

Hence $C_2 < C_1$. It means, θ is greater than C_2. Hence, total internal reflection will take place at interface GF. Therefore, (A) is correct.

If $\mu_3 > \mu_1, \frac{\mu_3}{\mu_2} > \frac{\mu_1}{\mu_3}$.

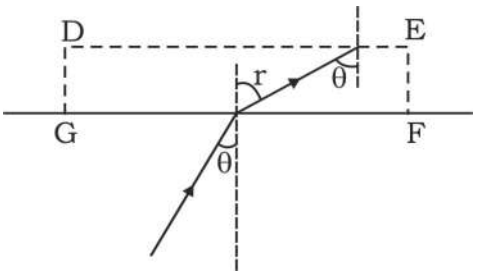
Hence, $\sin C_2 > \sin C_1$.

Since $C_2 > C_1$ and θ is infinitesimally greater than C_1, therefore, $C_2 > \theta$. Hence, light ray will get refracted into the slab. Therefore, (B) is correct.

Angle of refraction (r) will be given by $\frac{\sin\theta}{\sin r} = \frac{\mu_3}{\mu_2}$ or $\sin r = \frac{\mu_2}{\mu_3}\sin\theta$.

Critical angle C_3 for face DE is given by $\sin C_3 = \frac{\mu_1}{\mu_3}$.

But $\sin r = \frac{\mu_2}{\mu_3}\sin\theta$, where sin θ is infinitesimally greater than $\frac{\mu_1}{\mu_2}$. Hence, sin r is infinitesimally greater than $\frac{\mu_1}{\mu_3}$. It means sin r is infinitesimally greater than sin C_3.



Since angle of incidence for interface DE is equal to r, as shown in figure, therefore, total internal reflection will now take place at face DE. Hence (C) is correct. Since (A) and (C) are correct, therefore, (D) is incorrect.

34. $\mu = \frac{\sin\left(A+\delta_m\right)/2}{\sin A/2} = \cot A/2 = \frac{\cos A/2}{\sin A/2}$

$\therefore \sin\frac{\left(A+\delta_m\right)}{2} = \cos\frac{A}{2} = \sin\left(90^0 - A/2\right)$

$\therefore \frac{A+\delta_m}{2} = 90^0 - \frac{A}{2}$

$\delta_m = 180^0 - 2A.$

35. Total apparent depth $y = y_1 + y_2 = 5 + 2 = 7$ cm

If x is real depth = thickness of slab, then as

$\mu = \frac{x}{y}$, $x = \mu y = 1.5 \times 7 = 10.5$ cm.

37. $\mu = \frac{\sin i}{\sin r}$

42. Snell's Law can be applied at two point also, but the essential condition for this is that the refracting surfaces must be parallel to each other.

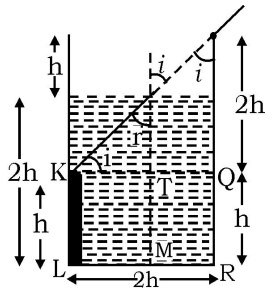
In that case, $\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$

where μ_1 is refractive index of that medium in which angle of incidence is measured and μ_2 is refractive index of that medium in which angle r is measured.

$\therefore \quad \dfrac{\sin i}{\sin r} = \dfrac{\mu}{\mu_0}.$ Hence (B) is correct.

43. When the ray suffers minimum deviation, it becomes parallel to base of prism P. As prisms Q and R are of identical shape and of the same material, therefore, the ray continues to be parallel to the base of prism Q and R. Hence, the deviation remains same as before.

44. As is clear from Fig.



PQ = QK = 2h $\quad \therefore \angle i = 45^\circ$

Also, LM = MR = h

KT = TQ = h

$\therefore \quad LS = \sqrt{h^2 + (2h)^2} = h\sqrt{5}$

$\therefore \quad \sin r = \dfrac{LM}{LS} = \dfrac{h}{h\sqrt{5}} = \dfrac{1}{\sqrt{5}}$

$\mu = \dfrac{\sin i}{\sin r} = \dfrac{\sin 45^0}{1/\sqrt{5}} = \dfrac{\sqrt{5}}{\sqrt{2}}.$

45. Note that image formation by a mirror does not depend on the medium. As P is at a height h above the mirror, image of P will be at a depth h below the mirror.

If d is depth of liquid in the tank, apparent depth of P, $x_1 = \dfrac{d-h}{\mu}$.

$\therefore$ apparent distance between P and its image

$= x_2 - x_1 = \dfrac{d+h}{\mu} - \dfrac{d-h}{\mu} = \dfrac{2h}{\mu}.$

46. Here, $i = 60^\circ$.

As the ray emerges from the sphere parallel to line AB, therefore, net deviation of the ray, $\delta = 60^\circ$. But, deviation on two refractions through a sphere $\delta = 2(i - r)$.

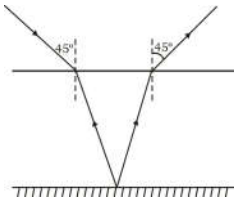
$\therefore \quad 2(i - r) = 60^\circ$

$i - r = 30^\circ$

$60^\circ - r = 30^\circ$ or $r = 30^\circ$

$$\mu = \frac{\sin\ i}{\sin\ r} = \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}.$$

47. As is clear from fig., the ray incident at 45º will emerge at 45º after reflection at the silvered surface. Therefore, angle between incident ray and emergent ray is 90º, i.e. deviation of the ray from its initial path is 90°.



56. $\mu = \frac{\sin i}{\sin r} \& d = i - r$

57. Conceptual

58. Net shift

$$S = d_1\left(1 - \frac{1}{\mu_1}\right) + d_2\left(1 - \frac{1}{\mu_2}\right) + d_3\left(1 - \frac{1}{\mu_3}\right)$$

$$= 8\left(1 - \frac{1}{4/3}\right) + 9\left(1 - \frac{1}{2/3}\right) + 4\left(1 - \frac{1}{2}\right)$$

=7 cm

The shifting will be in the direction of ray travelling i.e upward

Apparent depth =21-7=14 cm.

Clearly $i_c \le 60^0$

59. *so,* $\max$ *imum possible value of* i_c *is* 60^0

$$\frac{\mu_g}{\mu_1} = \frac{1}{\sin i_c}$$

60. Conceptual

CHEMISTRY

61. (3)

$m\upsilon r = \frac{nh}{2\pi}$

For 5th shell, $m\upsilon r = \frac{5h}{2\pi} = 2.5\frac{h}{\pi}$

62. (1)

$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$, for first spectral line,

$= R\left(\frac{1}{4} - \frac{1}{9}\right) = R \times \frac{5}{36} cm^{-1}$

$\lambda = \frac{36}{5R}$ cm

63. (3)

$\frac{E_{Li^{2+}}}{E_{He^{+}}} = \frac{Z^2_{Li^{2+}}}{Z^2_{He}}$ (for equal n values, 1 in each case)

$E_{Li^{2+}} = \frac{9}{4} \times (-19.6 \times 10^{-18}) = -4.41 \times 10^{-17} J\, atom^{-1}$

Energy of Ist shell of Li^{2+} is $-4.41 \times 10^{-17} J\, atom^{-1}$

64. (1)

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

$\frac{\Delta x_A}{\Delta x_B} = \frac{m_B}{m_A} \times \frac{\Delta v_B}{\Delta v_A} = 5 \times \frac{0.02}{0.05} = 2$

65. (2)

No. of revolutions of electron in nth shell in 1 second

$= \frac{6.66 \times 10^{15} \times Z^2}{n^3} = \frac{6.66 \times 10^{15} \times 4}{8} = 3.33 \times 10^{15}$

6. (1)

New energy = $-13.6 + 12.1 = -1.5 eV$

$E_n = \frac{-13.6}{n^2} \Rightarrow n^2 = \frac{-13.6}{-1.5} = 9 \Rightarrow n = 3$

Number of spectral lines in Balmer series for $3 \to 2$ transitions would be one only.

67. (4)

Rb(Z = 37) has V.S. electronic configuration $5s^1$.

$\Rightarrow n = 5,\ \ell = 0,\ m_\ell = 0,\ m_s = +\frac{1}{2}$

68. (4)

$\lambda_e = \lambda_p \Rightarrow \left(\frac{h}{mv}\right)_e = \left(\frac{h}{mv}\right)_p$

$\Rightarrow\ m_e v_e = m_p v_p\ \Rightarrow\ \dfrac{v_e}{v_p} = \dfrac{m_p}{m_e} = \dfrac{1.67\times10^{-27}}{9.1\times10^{-31}} = \dfrac{1.67}{9.1}\times10^4 = 1835.16$

69. (4)

3^{rd} shell has 18 electrons, 9 have +1/2 and other 9 have – 1/2 spin.

70. (2)

For s-electron, $\ell = 0$

Hence, $\sqrt{\ell(\ell+1)}\cdot\dfrac{h}{2\pi} = 0$

71. (4)

$E = 1eV = 1.6\times10^{-19}J$

$E = h\nu = \dfrac{hc}{\lambda}\ \Rightarrow\ \lambda = \dfrac{hc}{E}$

$\lambda = \dfrac{6.6\times10^{-34}Js\times3\times10^{8}ms^{-1}}{1.6\times10^{-19}J} = 12.375\times10^{-7}m = 12375\,A^0$

72. (4)

$r_n = \dfrac{0529n^2}{Z}$

$n^2 = \dfrac{8.46\times1}{0.529}$

Electrons in nth shell = $2n^2 = 2\times\dfrac{8.46}{0.529} = 32$

73. (4)

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

Total electrons in $Cr(Z=24): 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$, i.e., p-subshell = 6 + 6 =12

Total electrons in $\ell = 2$, i.e., d-subshell = 5

74. (4)

As per the $(n+\ell)$ rule, the choice (4) has highest value = 3 + 2 = 5

75. (2)

N^{3-}, F^- and Na^+ have 10 electrons each.

76. (4)

$r = \dfrac{0.529n^2}{Z}A^0$

For radius equal to Bohr's 1^{st} orbit of H-atom,

$n^2 = Z\cdot Be^{3+}(n=2)$ has Z = 4 and $n^2 = 4$

77. (3)

$\dfrac{\text{sp.charge of }\alpha\text{-particle}}{\text{sp.charge of proton}} = \dfrac{(e/m)\alpha\text{-particle}}{(e/m)\text{ proton}} = \dfrac{(2/4)}{(1/1)} = \dfrac{(1/2)}{1} = \dfrac{1}{2}:1$ or 1 : 2

78. (1)

Spherical or radial nodes for $1s = n-\ell-1 = 1-0-1 = 0$

Non-spherical or angular nodes for $1s, \ell = 0$

79. (1)

$(n-\ell-1)$ for 3s = 2 and for 2p = 0

80. (1)

$\lambda = \frac{h}{mv}$; KE = $\frac{1}{2}mv^2 \Rightarrow$ KE = $\frac{h^2}{2m\lambda^2}$

For h and λ being constant, KE $\propto \frac{1}{m}$

81. (2)

$\bar{v} = \frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \frac{R}{4}$

$\lambda = \frac{4}{R} = 4 \times 9.11 \times 10^{-8} m = 4 \times 9.11 \times 100 \times 10^{-10} m = 3644\, A^0$

82. (1)

(a) is 4p, (b) is 4s, (c) is 3d, (d) is 3p

83. (1)

$n + \ell$ rule is not applicable to H-atom. Energy system is

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

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

84. (2)

$\Delta x = \Delta p = a$

$\Delta x \cdot \Delta p \geq \frac{h}{4\pi} \Rightarrow a^2 \approx \frac{h}{4\pi} \Rightarrow a = \sqrt{\frac{h}{4\pi}}$

$\Delta x \cdot \Delta p = \Delta x \cdot m\Delta v \approx \frac{h}{4\pi}$

$\Delta v = \frac{h}{4\pi} \times \frac{1}{m\Delta x} \approx \frac{(h/4\pi)}{m\sqrt{(h/4\pi)}} \approx \frac{1}{m}\sqrt{\frac{h}{4\pi}} \approx \frac{1}{m}\sqrt{\frac{h}{2}}$ [Here, $\hbar = h/2\pi$]

85. (2)

Spherical nodes for $3p_z = n - \ell - 1 = 3 - 1 - 1 = 1$

Angular nodes for $3p_z = \ell = 1$

Nodal planes for $3p_z = \ell = 1$

86. (2)

$\Delta v = \frac{0.001}{100} \times 300 = 3 \times 10^{-3} ms^{-1}$

$\Delta x = \frac{h}{4\pi m\Delta v} = \frac{6.6 \times 10^{-34} kgm^2 s^{-1}}{4 \times 3.14 \times (9.1 \times 10^{-31} kg) \times (3 \times 10^{-3} ms^{-1})}$

$= \frac{6.6}{4 \times 3.14 \times 9.1 \times 3} m = 0.01925\, m = 1.925 \times 10^{-2} m$

87. (2)

h and mvr has same units $kgm^2 s^{-1}$

88. (3)

$E_n = \frac{E_1}{n^2} \Rightarrow E_1 = 2^2 \times (-328) = -4 \times 328\, kJ\, mol^{-1}$

Energy of 3rd shell, $E_3 = \frac{E_1}{9} = -\frac{4 \times 328}{9} = -145.78\, kJ\, mol^{-1}$

89. (1)

$$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}\, kgm^2 s^{-1}}{1.66 \times 10^{-24} \times 10^{-3} \times 10^{3}} = \frac{6.6}{1.66} \times 10^{-10}\, m = 3.976 \times 10^{-10}\, m = 3.976\, A^0$$

(Mass of 1 H-atom = $\frac{1}{6.02 \times 10^{23}} = 1.66 \times 10^{-24}\, g$)

90. (3)
Conceptual