



AIEEE - 2007

Full Paper

Mathematics

1. In a geometric progression consisting of positive terms, each term equals the sum of the next two terms. Then the common ratio of this progression equals :

- 1) $(1/2)(1 - \sqrt{5})$
- 2) $(1/2)\sqrt{5}$
- 3) $\sqrt{5}$
- 4) $(1/2)(\sqrt{5} - 1)$

2. If $\sin^{-1}(x/5) + \operatorname{cosec}^{-1}(5/4) = \pi/2$, then a value of x is :

- 1) 1
- 2) 3
- 3) 4
- 4) 5

3. In the binomial expansion of $(a - b)^n$, $n \geq 5$, the sum of 5th and 6th terms is zero, then a / b equals:

- 1) $(5/(n - 4))$
- 2) $(6/(n - 5))$
- 3) $(n - 5)/6$
- 4) $(n - 4)/5$

4. The set $S := \{1, 2, 3, \dots, 12\}$ is to be partitioned into three sets A, B, C of equal size. Thus, $A \cup B \cup C = S$, $A \cap B = B \cap C = A \cap C = \phi$. The number of ways to partition S is:

- 1) $12!/3! (4!)^3$
- 2) $12!/3! (3!)^4$
- 3) $12!/(4!)^3$
- 4) $12!/(3!)^4$

5. The largest interval lying in $(-\pi/2, \pi/2)$ for which the function

$[f(x) = 4 - x^2 + \cos^{-1}((x/2) - 1) + \log(\cos x)]$ is defined, is :

- 1) $[0, \pi]$
- 2) $(-\pi/2, \pi/2)$
- 3) $(-\pi/4, \pi/2)$
- 4) $[0, \pi/2)$

6. A body weighing 13 kg is suspended by two strings 5 m and 12 m long, their other ends being fastened to the extremities of a rod 13 m long. If the rod be so held that the body hangs immediately below the middle point. The tensions in the strings are :

- 1) 12 kg and 13 kg

- 2) 5 kg and 5 kg
- 3) 5 kg and 12 kg
- 4) 5 kg and 13 kg

7. A pair of fair dice is thrown independently three times. The probability of getting a score of exactly 9 twice is :

- 1) $1/729$
- 2) $8/9$
- 3) $8/729$
- 4) $8/243$

8. Consider a family of circles which are passing through the point $(-1, 1)$ and are tangent to x-axis. If (h, k) are the coordinates of the centre of the circles, then the set of values of k is given by the interval :

- 1) $0 < k < 1/2$
- 2) $k \geq 1/2$
- 3) $-1/2 \leq k \leq 1/2$
- 4) $k \leq 1/2$

9. Let L be the line of intersection of the planes $2x + 3y + z = 1$ and $x + 3y + 2z = 2$. If L makes an angle α with the positive x-axis, then $\cos \alpha$ equals :

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

10. The differential equation of all circles passing through the origin and having their centres on the x-axis is :

- 1) $x^2 = y^2 + xy (dy/dx)$
- 2) $x^2 = y^2 + 3xy (dy/dx)$
- 3) $y^2 = x^2 + 2xy (dy/dx)$
- 4) $y^2 = x^2 - 2xy (dy/dx)$

11. If p and q are positive real numbers such that $p^2 + q^2 = 1$, then the maximum value of $(p + q)$ is :

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

12. A tower stands at the centre of a circular park. A and B are two points on the boundary of the park such that $AB (= a)$ subtends an angle of 60° at the foot of the tower and the angle of elevation of the top of the tower from A or B is 30° . The height of the tower is :

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

13. The sum of the series

$${}^{20}C_0 - {}^{20}C_1 + {}^{20}C_2 - {}^{20}C_3 + \dots - \dots + {}^{20}C_{10} \text{ is :}$$

- 1) $- {}^{20}C_{10}$
- 2) $(1/2) {}^{20}C_{10}$
- 3) 0
- 4) ${}^{20}C_{10}$

14. The normal to a curve at P(x, y) meets the x-axis at G. If the distance of G from the origin is twice the abscissa of P, then the curve is a :

- 1) ellipse
- 2) parabola
- 3) circle
- 4) hyperbola

15. If $|z + 4| \leq 3$, then the maximum value of $|z + 1|$ is :

- 1) 4
- 2) 10
- 3) 6
- 4) 0

16. The resultant of two forces P N and 3 N is a force of 7 N. If the direction of the 3 N force were reversed, the resultant would be $\sqrt{19}$ N. The value of P is:

- 1) 5 N
- 2) 6 N
- 3) 3 N
- 4) 4 N

17. Two aeroplanes I and II bomb a target in succession. The probabilities of I and II scoring a hit correctly are 0.3 and 0.2, respectively. The second plane will bomb only if the first misses the target. The probability that the target is hit by the second plane is :

- 1) 0.06
- 2) 0.14
- 3) 0.2
- 4) 0.7

18. $D = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1+x & 1 \\ 1 & 1 & 1+y \end{bmatrix}$ for $x \neq 0, y \neq 0$, then D is :

- 1) divisible by neither x nor y
- 2) divisible by both x and y
- 3) divisible by x but not y
- 4) divisible by y but not x

19. For the Hyperbola $(x^2/(\cos^2 \alpha)) - (y^2/(\sin^2 \alpha)) = 1$, which of the following remains constant when α varies ?

- 1) Eccentricity
- 2) Directrix
- 3) Abscissae of vertices

4) Abscissae of foci

20. If a line makes an angle $\alpha/4$ with the positive directions of each of x-axis and y-axis, then the angle that the line makes with the positive direction of the z-axis is :

- 1) $\pi/6$ 2) $\pi/3$ 3) $\pi/4$ 4) $\pi/2$

21. A value of C for which the conclusion of Mean Value Theorem holds for the function $f(x) = \log_e x$ on the interval $[1, 3]$ is :

- 1) $2 \log_3 e$
2) $(1/2) \log_e 3$
3) $\log_3 e$
4) $\log_e 3$

22. The function $f(x) = \tan^{-1}(\sin x + \cos x)$ is an increasing function in :

- 1) $(\pi/4, \pi/2)$
2) $(-\pi/2, \pi/4)$
3) $(0, \pi/2)$
4) $(-\pi/2, \pi/2)$

23. Let $A = \begin{bmatrix} 5 & 5\alpha & \alpha \\ 0 & \alpha & 5\alpha \\ 0 & 0 & 5 \end{bmatrix}$

If $|A^2| = 25$, then $|\alpha|$ equals :

- 1) 5^2
2) 1
3) $1/5$
4) 5

24. The sum of the series $(1/2!) - (1/3!) + (1/4!) - \dots$ upto infinity is :

- 1) e^{-2}
2) e^{-1}
3) $e^{-(1/2)}$
4) $e^{+(1/2)}$

25. If \hat{u} and \hat{v} are unit vectors and θ is the acute angle between them, then $2\hat{u} \times 3\hat{v}$ is a unit vector for :

- 1) exactly two values of θ
2) more than two values of θ
3) no value of θ
4) exactly one value of θ

26. A particle just clears a wall of height b at a distance a and strikes the ground at a distance c from the point of projection. The angle of projection is :

- 1) $\tan^{-1} (b/ac)$
- 2) 45°
- 3) $\tan^{-1} (bc)/(a(c - a))$
- 4) $\tan^{-1} (bc/a)$

27. The average marks of boys in a class is 52 and that of girls is 42. The average marks of boys and girls combined is 50. The percentage of boys in the class is

- 1) 40
- 2) 20
- 3) 80
- 4) 60

28. The equation of a tangent to the parabola $y^2 = 8x$ is $y = x + 2$. The point on this line from which the other tangent to the parabola is perpendicular to the given tangent is :

- 1) (-1, 1)
- 2) (0, 2)
- 3) (2, 4)
- 4) (-2, 0)

29. If (2, 3, 5) is one end of a diameter of the sphere $x^2 + y^2 + z^2 - 6x - 12y - 2z + 20 = 0$, then the coordinates of the other end of the diameter are :

- 1) (4, 9, -3)
- 2) (4, -3, 3)
- 3) (4, 3, 5)
- 4) (4, 3, -3)

30. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + 2\hat{k}$ and $\vec{c} = x\hat{i} + (x - 2)\hat{j} - \hat{k}$. If the vector \vec{c} lies in the plane of \vec{a} and \vec{b} , then x equals :

- 1) 0
- 2) 1
- 3) -4
- 4) -2

31. Let A(h, k), B(1, 1) and C(2, 1) be the vertices of a right angled triangle with AC as its hypotenuse. If the area of the triangle is 1, then the set of values which 'k' can take is given by :

- 1) {1, 3}
- 2) {0, 2}
- 3) {-1, 3}
- 4) {-3, -2}

32. Let P = (-1, 0), Q = (0, 0) and R = (3, $3\sqrt{3}$) be three points. The equation of the bisector of the angle PQR is :

- 1) $\sqrt{3}x + y = 0$
- 2) $x + (\sqrt{3}/2)y = 0$
- 3) $(\sqrt{3}/2)x + y = 0$

4) $x + \sqrt{3}y = 0$

33. If one of the lines of $my^2 + (1 - m^2)xy - mx^2 = 0$ is a bisector of the angle between the lines $xy = 0$, then m is :

- 1) $-(1/2)$ 2) -2 3) ± 1 4) 2

34. Let $F(x) = f(x) + f(1/x)$, where $f(x) = \int_1^x \frac{\log t}{1+t} dt$. Then $F(e)$ equals :

- 1) $1/2$ 2) 0 3) 1 4) 2

35. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a function defined by $f(x) = \min\{x + 1, |x| + 1\}$. Then which of the following is true ?

- 1) $f(x) \geq 1$ for all $x \in \mathbb{R}$
 2) $f(x)$ is not differentiable at $x = 1$
 3) $f(x)$ is differentiable everywhere
 4) $f(x)$ is not differentiable at $x = 0$

36. The function $f : \mathbb{R}/\{0\} \rightarrow \mathbb{R}$ given by $f(x) = (1/x) - (2/e^{2x} - 1)$ can be made continuous at $x = 0$ by defining $f(0)$ as :

- 1) 2 2) -1 3) 0 4) 1

37. The solution for x of the equation $\int_{\sqrt{2}}^x \frac{dt}{t\sqrt{t^2-1}} = \frac{\pi}{2}$ is

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

38. $\int \frac{dx}{\cos x + \sqrt{3} \sin x}$ equals :

- 1) $(1/2) \log \tan ((x/2) + (\pi/12)) + c$
 2) $(1/2) \log \tan ((x/2) - (\pi/12)) + c$
 3) $\log \tan ((x/2) + (\pi/12)) + c$
 4) $\log \tan ((x/2) - (\pi/12)) + c$

39. The area enclosed between the curves $y^2 = x$ and $y = |x|$ is :

- 1) $2/3$ 2) 1 3) $1/6$ 4) $1/3$

40. If the difference between the roots of the equation $x^2 + ax + 1 = 0$ is less than $\sqrt{5}$, then the set of possible values of a is :

- 1) $(-3, 3)$

- 2) $(-3, \infty)$
- 3) $(3, \infty)$
- 4) $(-\infty, -3)$

Physics

41. The displacement of an object attached to a spring and executing simple harmonic motion is given by $x = 2 \times 10^{-2} \cos \pi t$ metre. The time at which the maximum speed first occurs is :

- 1) 0.5 s
- 2) 0.75 s
- 3) 0.125 s
- 4) 0.25 s

42. In an AC circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin (\omega t - (\pi/2))$. The Power consumption in the circuit is given by :

- 1) $P = (E_0 I_0 / \sqrt{2})$
- 2) $P = \text{Zero}$
- 3) $P = (E_0 I_0 / 2)$
- 4) $P = \sqrt{2} E_0 I_0$

43. An electric charge $10^{-3} \mu\text{C}$ is placed at the origin $(0, 0)$ of X-Y coordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and $(2, 0)$ respectively. The potential difference between the points A and B will be :

- 1) 9 V
- 2) Zero
- 3) 2 V
- 4) 4.5 V

44. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done the battery will be :

- 1) 1
- 2) 2
- 3) 1/4
- 4) 1/2

45. An ideal coil of 10 H is connected in series with a resistance of 5Ω and a battery of 5 V. 2 s after the connection is made, the current flowing (in ampere) in the circuit is :

- 1) $(1 - e)$
- 2) e
- 3) e^{-1}
- 4) $(1 - e^{-1})$

46. A long straight wire of radius a carries a steady current i . The current is uniformly distributed across its cross-section. The ratio of the magnetic field at $a/2$ and $2a$ is :

- 1) 1/4
- 2) 4
- 3) 1
- 4) 1/2

47. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then :

- 1) the magnetic field is zero only on the axis of the pipe
- 2) the magnetic field is different at different points inside the pipe
- 3) the magnetic field at any point inside the pipe is zero
- 4) the magnetic field at all points inside the pipe is the same, but not zero

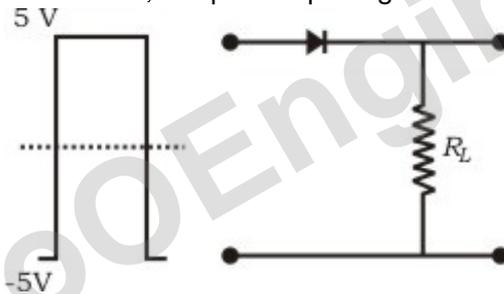
48. If M_o is the mass of an oxygen isotope ${}_8O^{17}$, M_p and M_n are the masses of a proton and a neutron, respectively, the nuclear binding energy of the isotope is :

- 1) $(M_o - 8M_p)c^2$
- 2) $(M_o - 8M_p - 9M_n)c^2$
- 3) $M_o c^2$
- 4) $(M_o - 17M_n)c^2$

49. In gamma ray emission from a nucleus :

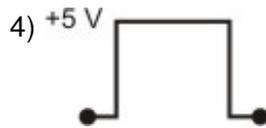
- 1) both the neutron number and the proton number change
- 2) there is no change in the proton number and the neutron number
- 3) only the neutron number changes
- 4) only the proton number changes

50. If in a $p-n$ junction diode, a square input signal of 10 V is applied as shown :



Then the output signal across R_L will be :

- 1)
- 2)
- 3)



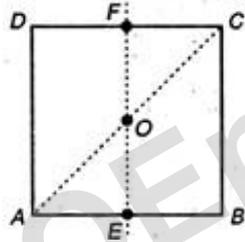
51. Photon of frequency ν has a momentum associated with it. If c is the velocity of light, the momentum is

- 1) ν/c
- 2) $h\nu c$
- 3) $h\nu/c^2$
- 4) $h\nu/c$

52. The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is $x = 0$ at $t = 0$, then its displacement after unit time ($t = 1$) is :

- 1) $v_0 + 2g + 3f$
- 2) $v_0 + g/2 + f/3$
- 3) $v_0 + g + f$
- 4) $v_0 + g/2 + f$

53. For the given uniform square lamina ABCD, whose centre is O :

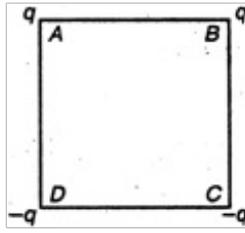


- 1) $\sqrt{2} I_{AC} = I_{EF}$
- 2) $I_{AD} = 3I_{EF}$
- 3) $I_{AC} = I_{EF}$
- 4) $I_{AC} = \sqrt{2} I_{EF}$

54. A point mass oscillates along the x-axis according to the law $x = x_0 \cos(\omega t - \pi/4)$. If the acceleration of the particle is written as : $a = A \cos(\omega t + \delta)$, then :

- 1) $A = x_0, \delta = -\pi/4$
- 2) $A = x_0\omega^2, \delta = \pi/4$
- 3) $A = x_0\omega^2, \delta = -\pi/4$
- 4) $A = x_0\omega^2, \delta = -3\pi/4$

55. Charges are placed on the vertices of a square as shown. Let \vec{E} be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then :



- 1) \vec{E} remains unchanged, V changes
- 2) both \vec{E} and V change
- 3) \vec{E} and V remain unchanged
- 4) \vec{E} changes, V remains unchanged

56. The half-life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially they have the same number of atoms. Then :

- 1) X will decay faster than Y
- 2) Y will decay faster than X
- 3) Y and X have same decay rate initially
- 4) X and Y decay at same rate always

57. A Carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is :

- 1) 99 J
- 2) 90 J
- 3) 1 J
- 4) 100 J

58. Carbon, silicon and germanium have four valence electrons each. At room temperature which one of the following statements is most appropriate ?

- 1) The number of free conduction electrons is significant in C but small in Si and Ge
- 2) The number of free conduction electrons is negligibly small in all the three
- 3) The number of free electrons for conduction is significant in all the three
- 4) The number of free electrons for conduction is significant only in Si and Ge but small in C

59. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields \vec{E} and \vec{B} with a velocity \vec{v} perpendicular to both \vec{E} and \vec{B} , and comes out without any change in magnitude or direction of \vec{v} . Then :

- 1) $\vec{v} = \vec{E} \times \vec{B}/B^2$
- 2) $\vec{v} = \vec{B} \times \vec{E}/B^2$
- 3) $\vec{v} = \vec{E} \times \vec{B}/E^2$
- 4) $\vec{v} = \vec{B} \times \vec{E}/E^2$

60. The potential at a point x (measured in μm) due to some charges situated on the x -axis is given by : $V(x) = 20/(x^2 - 4)$ volt

The electric field E at $x = 4\mu\text{m}$ is given by :

- 1) $(5/3) \text{ V}/\mu\text{m}$ and in the -ve x direction
- 2) $(5/3) \text{ V}/\mu\text{m}$ and in the +ve x direction
- 3) $(10/9) \text{ V}/\mu\text{m}$ and in the -ve x direction
- 4) $(10/9) \text{ V}/\mu\text{m}$ and in the +ve x direction

61. Which of the following transitions in hydrogen atoms emit photons of highest frequency ?

- 1) $n = 2$ to $n = 6$
- 2) $n = 6$ to $n = 2$
- 3) $n = 2$ to $n = 1$
- 4) $n = 1$ to $n = 2$

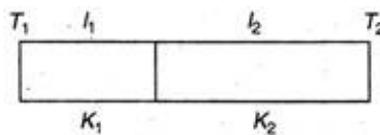
62. A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k . The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force F starts acting on the block of mass M to pull it. Find the force on the block of mass m .

- 1) mF/M
- 2) $((M + m)F/m)$
- 3) $(mF/(m + M))$
- 4) $(MF/(m + M))$

63. Two lenses of power -15D and $+5\text{D}$ are in contact with each other. The focal length of the combination is :

- 1) -20 cm
- 2) -10 cm
- 3) $+20 \text{ cm}$
- 4) $+10 \text{ cm}$

64. One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2 . The rod is composed of two sections of lengths l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two sections is



- 1) $(K_2 l_2 T_1 + K_1 l_1 T_2)/(K_1 l_1 + K_2 l_2)$
- 2) $(K_2 l_1 T_1 + K_1 l_2 T_2)/(K_2 l_1 + K_1 l_2)$
- 3) $(K_1 l_2 T_1 + K_2 l_1 T_2)/(K_1 l_2 + K_2 l_1)$
- 4) $(K_1 l_1 T_1 + K_2 l_2 T_2)/(K_1 l_1 + K_2 l_2)$

65. A sound absorber attenuates the sound level by 20 dB . The intensity decreases by a factor of:

- 1) 1000
- 2) 10000
- 3) 10
- 4) 100

66. If C_P and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then :

- 1) $C_P - C_V = R/28$
- 2) $C_P - C_V = R/14$
- 3) $C_P - C_V = R$
- 4) $C_P - C_V = 28R$

67. A charged particle moves through a magnetic field perpendicular to its direction. Then :

- 1) the momentum changes but the kinetic energy is constant
- 2) both momentum and kinetic energy of the particle are not constant
- 3) both momentum and kinetic energy of the particle are constant
- 4) kinetic energy changes but the momentum is constant

68. Two identical conducting wires AOB and COD are placed at right angles to each other. The wire AOB carries an electric current I_1 and COD carries a current I_2 . The magnetic field on a point lying at a distance d from O, in a direction perpendicular to the plane of the wires AOB and COD, will be given by :

- 1) $\mu_0/2\pi ((I_1 + I_2)/d)^{1/2}$
- 2) $\mu_0/2\pi d (I_1^2 + I_2^2)^{1/2}$
- 3) $\mu_0/2\pi d (I_1 + I_2)$
- 4) $\mu_0/2\pi d (I_1^2 + I_2^2)$

69. The resistance of a wire is $5\ \Omega$ at 50°C and $6\ \Omega$ at 100°C . The resistance of the wire at 0°C will be :

- 1) $2\ \Omega$
- 2) $1\ \Omega$
- 3) $4\ \Omega$
- 4) $3\ \Omega$

70. A parallel plate condenser with a dielectric of dielectric constant K between the plates has a capacity C and is charged to a potential V volts. The dielectric slab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is :

- 1) $1/2 (K - 1) CV^2$
- 2) $CV^2 (K - 1)/K$
- 3) $(K - 1) CV^2$
- 4) zero

71. If g_E and g_M are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two faces one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be.

- 1) 1

- 2) zero
- 3) g_E/g_M
- 4) g_M/g_E

72. A circular disc of radius R is removed from a bigger circular disc of radius $2R$, such that the circumference of the discs coincide. The centre of mass of the new disc is αR from the centre of the bigger disc. The value of α is :

- 1) $1/3$
- 2) $1/2$
- 3) $1/6$
- 4) $1/4$

73. A round uniform body of radius R , mass M and moment of inertia I , rolls down (without slipping) an inclined plane making an angle θ with the horizontal. Then its acceleration is :

- 1) $(g \sin \theta)/(1 + I/MR^2)$
- 2) $(g \sin \theta)/(1 + MR^2/I)$
- 3) $(g \sin \theta)/(1 - I/MR^2)$
- 4) $(g \sin \theta)/(1 - MR^2/I)$

74. Angular momentum of the particle rotating with a central force is constant due to :

- 1) constant force
- 2) constant linear momentum
- 3) zero torque
- 4) constant torque

75. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10,000 W/m. The spring compresses by :

- 1) 5.5 cm
- 2) 2.5 cm
- 3) 11.0 cm
- 4) 8.5 cm

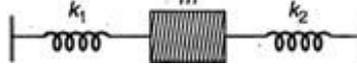
76. A particle is projected at 60° to the horizontal with a kinetic energy K . The kinetic energy at the highest point is :

- 1) K
- 2) zero
- 3) $K/4$
- 4) $K/2$

77. In a Young's double slit experiment the intensity at a point where the path difference is $\lambda/6$ (λ being the wavelength of the light used) is I . If I_0 denotes the maximum intensity, I/I_0 is equal to :

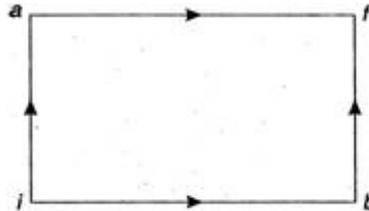
- 1) $1/\sqrt{2}$
- 2) $\sqrt{3}/2$
- 3) $1/2$
- 4) $3/4$

78. Two springs, of force constants k_1 and k_2 , are connected to a mass m as shown. The frequency of oscillation of the mass is f . If both k_1 and k_2 are made four times their original values, the frequency of oscillation becomes :



- 1) $f/2$ 2) $f/4$ 3) $4f$ 4) $2f$

79. When a system is taken from state i to state f along the path iaf , it is found that $Q = 50$ cal and $W = 20$ cal. Along the path ibf $Q = 36$ cal. W along the path ibf is :



- 1) 6 cal
2) 16 cal
3) 66 cal
4) 14 cal

80. A particle of mass m executes simple harmonic motion with amplitude a and frequency ν . The average kinetic energy during its motion from the position of equilibrium to the end is :

- 1) $\pi^2 ma^2 \nu^2$
2) $(1/4) ma^2 \nu^2$
3) $4\pi^2 ma^2 \nu^2$
4) $2\pi^2 ma^2 \nu^2$

Chemistry

81. The energies of activation for forward and reverse reactions for $A_2 + B_2 \rightleftharpoons 2AB$ are 180 kJ mol^{-1} and 200 kJ mol^{-1} respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by 100 kJ mol^{-1} . The enthalpy change of the reaction ($A_2 + B_2 \rightarrow 2AB$) in the presence of catalyst will be (in kJ mol^{-1}) :

- 1) 300 2) 120 3) 280 4) 20

82. The cell, $\text{Zn} | \text{Zn}^{2+} (1\text{M}) || \text{Cu}^{2+} (1\text{M}) | \text{Cu}$ ($E^\circ_{\text{cell}} = 1.10 \text{ V}$), was allowed to be completely discharged at 298 K . The relative concentration of Zn^{2+} to Cu^{2+} ($[\text{Zn}^{2+}]/[\text{Cu}^{2+}]$) is :

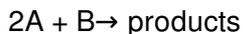
- 1) antilog (24.08)
2) 37.3
3) $10^{37.3}$
4) 9.65×10^4

83. The pK_a of a weak acid (H A) is 4.5. The pOH of an aqueous buffered solution of HA in

which 50% of the acid ionised is :

- 1) 4.5 2) 2.5 3) 9.5 4) 7.0

84. Consider the reaction,



When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is :

- 1) $\text{L mol}^{-1} \text{s}^{-1}$
2) no unit
3) $\text{mol L}^{-1} \text{s}^{-1}$
4) s^{-1}

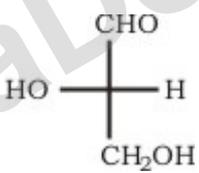
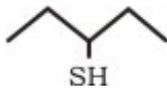
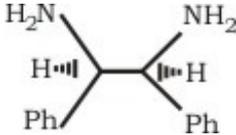
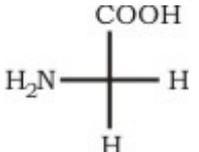
85. Identify the incorrect statement among the following

- 1) d-block elements show irregular and erratic chemical properties among themselves
2) La and Lu have partially filled d orbitals and no other partially filled orbitals
3) The chemistry of various lanthanoids is very similar
4) 4f and 5f orbitals are equally shielded

86. Which one of the following has a square planar geometry ?

- 1) $[\text{CoCl}_4]^{2-}$
2) $[\text{FeCl}_4]^{2-}$
3) $[\text{NiCl}_4]^{2-}$
4) $[\text{PtCl}_4]^{2-}$

87. Which of the following molecules is expected to rotate the plane of plane-polarised light ?

- 1) 
- 2) 
- 3) 
- 4) 

88. The secondary structure of a protein refers to :

- 1) α -helical backbone

- 2) hydrophobic interactions
- 3) sequence of α -amino acids
- 4) fixed configuration of the polypeptide backbone

89. Which of the following reactions will yield, 2, 2-dibromopropane ?

- 1) $\text{CH}_3 - \text{C} \equiv \text{CH} + 2\text{HBr} \rightarrow$
- 2) $\text{CH}_3\text{CH} = \text{CHBr} + \text{HBr} \rightarrow$
- 3) $\text{CH} \equiv \text{CH} + 2\text{HBr} \rightarrow$
- 4) $\text{CH}_3 - \text{CH} = \text{CH}_2 + \text{HBr} \rightarrow$

90. In the chemical reaction, $\text{CH}_3\text{CH}_2\text{NH}_2 + \text{CHCl}_3 + 3\text{KOH} \rightarrow (\text{A}) + (\text{B}) + 3\text{H}_2\text{O}$, the compounds (A) and (B) are respectively :

- 1) $\text{C}_2\text{H}_5\text{CN}$ and 3KCl
- 2) $\text{CH}_3\text{CH}_2\text{CONH}_2$ and 3KCl
- 3) $\text{C}_2\text{H}_5\text{NC}$ and K_2CO_3
- 4) $\text{C}_2\text{H}_5\text{NC}$ and 3KCl

91. The reaction of toluene with Cl_2 in presence of FeCl_3 gives predominantly :

- 1) benzoyl chloride
- 2) benzyl chloride
- 3) o-and p-chlorotoluene
- 4) m-chlorotoluene

92. Presence of a nitro group in a benzene ring :

- 1) activates the ring towards electrophilic substitution
- 2) renders the ring basic
- 3) deactivates the ring towards nucleophilic substitution
- 4) deactivates the ring towards electrophilic substitution

93. In which of the following ionisation processes, the bond order has increased and the magnetic behaviour has changed ?

- 1) $\text{C}_2 \rightarrow \text{C}_2^+$
- 2) $\text{NO} \rightarrow \text{NO}^+$
- 3) $\text{O}_2 \rightarrow \text{O}_2^+$
- 4) $\text{N}_2 \rightarrow \text{N}_2^+$

94. The actinoids exhibit more number of oxidation states in general than the lanthanoids. This is because :

- 1) the 5f orbitals are more buried than the 4f orbitals
- 2) there is a similarity between 4f and 5f orbitals in their angular part of the wave function

- 3) the actinoids are more reactive than the lanthanoids
4) the 5f orbitals extend further from the nucleus than the 4f orbitals
95. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by oxygen is :
- 1) 2/3
 - 2) $(1/3) \times (273/298)$
 - 3) 1/3
 - 4) 1/2
96. A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60 g mol⁻¹) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0 g cm⁻³, molar mass of the substance will be :
- 1) 90.0 g mol⁻¹
 - 2) 115.0 g mol⁻¹
 - 3) 105.0 g mol⁻¹
 - 4) 210.0 g mol⁻¹
97. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mole of water is vapourised at 1 bar pressure and 100°C, (Given : molar enthalpy of vaporisation of water at 1 bar and 373 K = 41 kJ mol⁻¹ and R = 8.3 J mol⁻¹ K⁻¹) will be :
- 1) 4.100 kJ mol⁻¹
 - 2) 3.7904 kJ mol⁻¹
 - 3) 37.904 kJ mol⁻¹
 - 4) 41.00 kJ mol⁻¹
98. In a saturated solution of the sparingly soluble strong electrolyte AgIO₃ (Molecular mass = 283) the equilibrium which sets in is
 $\text{AgIO}_3(\text{s}) \rightleftharpoons \text{Ag}^+(\text{aq}) + \text{IO}_3^-(\text{aq})$
if the solubility product constant K_{sp} of AgIO₃ at a given temperature is 1.0×10^{-8} , what is the mass of AgIO₃ contained in 100 mL of its saturated solution ?
- 1) 28.3×10^{-2} g
 - 2) 2.83×10^{-3} g
 - 3) 1.0×10^{-7} g
 - 4) 1.0×10^{-4} g
99. A radioactive element gets spilled over the floor of a room. Its half-life period is 30 days. If the initial activity is ten times the permissible value, after how many days will it be safe to enter the room
- 1) 1000 days
 - 2) 300 days

- 3) 10 days
- 4) 100 days

100. Which one of the following conformations of cyclohexane is chiral ?

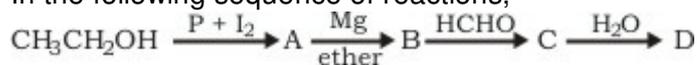
- 1) Twist boat
- 2) Rigid
- 3) Chair
- 4) Boat

101. Which of the following is the correct order of decreasing S_N2 reactivity ?

(X = a halogen)

- 1) $RCH_2X > R_3CX > R_2CHX$
- 2) $RCH_2X > R_2CHX > R_3CX$
- 3) $R_3CX > R_2CHX > RCH_2X$
- 4) $R_2CHX > R_3CX > RCH_2X$

102. In the following sequence of reactions,



the compound 'D' is :

- 1) butanal
- 2) n-butyl alcohol
- 3) n-propyl alcohol
- 4) propanal

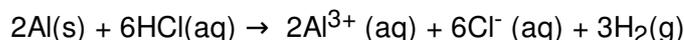
103. Which of the following sets of quantum numbers represents the highest energy of an atom ?

- 1) $n = 3, l = 1, m = 1, s = + 1/2$
- 2) $n = 3, l = 2, m = 1, s = + 1/2$
- 3) $n = 4, l = 0, m = 0, s = + 1/2$
- 4) $n = 3, l = 0, m = 0, s = + 1/2$

104. Which of the following hydrogen bonds is the strongest.?

- 1) $O - H \cdots N$
- 2) $F - H \cdots F$
- 3) $O - H \cdots O$
- 4) $O - H \cdots F$

105. In the reaction,



- 1) 6 L HCl(aq) is consumed for every 3L H_2 (g) produced
- 2) 33.6 L H_2 (g) is produced regardless of temperature and pressure for every mole Al

- that reacts
- 3) 67.2 L H₂ (g) at STP is produced for every mole Al that reacts
 - 4) 11.2 L H₂ (g) at STP is produced for every mole HCl(aq) consumed
106. Regular use of which of the following fertilisers increases the acidity of soil ?
- 1) Potassium nitrate
 - 2) Urea
 - 3) Superphosphate of lime
 - 4) Ammonium sulphate
107. Identify the correct statement regarding a spontaneous process :
- 1) For a spontaneous process in an isolated system, the change in entropy is positive
 - 2) Endothermic processes are never spontaneous
 - 3) Exothermic processes are always spontaneous
 - 4) Lowering of energy in the reaction process is the only criterion for spontaneity
108. Which of the following nuclear reactions will generate an isotope ?
- 1) Neutron particle emission
 - 2) Positron emission
 - 3) α -particle emission
 - 4) β -particle emission
109. The equivalent conductances of two strong electrolytes at infinite dilution in H₂O (where ions move freely through a solution) at 25°C are given below :
- $\Lambda^\circ_{\text{CH}_3\text{COONa}} = 91.0 \text{ S cm}^2/\text{equiv}$
 $\Lambda^\circ_{\text{HCl}} = 426.2 \text{ S cm}^2/\text{equiv}$
- What additional information/quantity one needs to calculate Λ° of an aqueous solution of acetic acid ?
- 1) Λ° of NaCl
 - 2) Λ° of CH₃COOK
 - 3) The limiting equivalent conductance of H⁺ ($\lambda^\circ_{\text{H}^+}$)
 - 4) Λ° of chloroacetic acid (ClCH₂COOH)
110. Which one of the following is the strongest base in aqueous solution ?
- 1) Trimethylamine
 - 2) Aniline
 - 3) Dimethylamine
 - 4) Methylamine
111. The compound formed as a result of oxidation of ethyl benzene by KMnO₄ is
- 1) benzophenone

- 2) acetophenone
- 3) benzoic acid
- 4) benzyl alcohol

112. The IUPAC name of  is :

- 1) 1, 1-diethyl-2, 2-dimethylpentane
- 2) 4, 4-dimethyl-5, 5-diethylpentane
- 3) 5, 5-diethyl-4, 4-dimethylpentane
- 4) 3-ethyl-4, 4-dimethylheptane

113. Which of the following species exhibits the diamagnetic behaviour ?

- 1) O_2^{2-}
- 2) O_2^+
- 3) O_2
- 4) NO

114. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence :

- 1) $GeX_2 < SiX_2 < SnX_2 < PbX_2$
- 2) $SiX_2 < GeX_2 < PbX_2 < SnX_2$
- 3) $SiX_2 < GeX_2 < SnX_2 < PbX_2$
- 4) $PbX_2 < SnX_2 < GeX_2 < SiX_2$

115. Identify the incorrect statement among the following :

- 1) Ozone reacts with SO_2 to give SO_3
- 2) Silicon reacts with $NaOH(aq)$ in the presence of air to give Na_2SiO_3 and H_2O
- 3) Cl_2 reacts with excess of NH_3 to give N_2 and HCl
- 4) Br_2 reacts with hot and strong $NaOH$ solution to give $NaBr$, $NaBrO_4$ and H_2O

116. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+ , Ca^{2+} , Mg^{2+} , Be^{2+} ?

- 1) $Mg^{2+} < Be^{2+} < K^+ < Ca^{2+}$
- 2) $Be^{2+} < K^+ < Ca^{2+} < Mg^{2+}$
- 3) $K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$
- 4) $Ca^{2+} < Mg^{2+} < Be^{2+} < K^+$

117. The density (in $g\ mL^{-1}$) of a 3.60 M sulphuric acid solution that is 29% H_2SO_4 (molar mass $98\ g\ mol^{-1}$) by mass will be :

1) 1.64

2) 1.88

3) 1.22

4) 1.45

118. The first and second dissociation constants of an acid H_2A are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acid will be:

1) 5.0×10^{-5}

2) 5.0×10^{15}

3) 5.0×10^{-15}

4) 0.2×10^5

119. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be :

1) 350

2) 300

3) 700

4) 360

120. In conversion of limestone to lime,



the value of ΔH° and ΔS° are $+179.1 \text{ kJ mol}^{-1}$ and 160.2 J/K respectively at 298 K and 1 bar. Assuming that ΔH° and ΔS° do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is :

1) 1008 K

2) 1200 K

3) 845 K

4) 1118 K

Answer Key

1) 4	2) 2	3) 4	4) 3	5) 4	6) 3	7) 4	8) 2	9) 1	10) 3
11) 4	12) 3	13) 2	14) 3	15) 3	16) 1	17) 2	18) 2	19) 4	20) 4
21) 1	22) 2	23) 3	24) 2	25) 4	26) 3	27) 3	28) 4	29) 1	30) 4
31) 3	32) 1	33) 3	34) 1	35) 1	36) 4	37) 1	38) 1	39) 3	40) 1
41) 1	42) 2	43) 2	44) 4	45) 4	46) 3	47) 3	48) 2	49) 2	50) 4
51) 4	52) 2	53) 3	54) 4	55) 4	56) 2	57) 2	58) 4	59) 1	60) 4
61) 3	62) 3	63) 2	64) 3	65) 4	66) 1	67) 1	68) 2	69) 3	70) 4
71) 1	72) 1	73) 1	74) 3	75) 1	76) 3	77) 4	78) 4	79) 1	80) 1
81) 4	82) 3	83) 3	84) 1	85) 4	86) 4	87) 1	88) 1	89) 1	90) 4
91) 3	92) 4	93) 2	94) 4	95) 3	96) 4	97) 3	98) 2	99) 4	100) 3
101) 2	102) 3	103) 2	104) 2	105) 4	106) 4	107) 1	108) 1	109) 1	110) 3
111) 3	112) 4	113) 1	114) 3	115) 4	116) 3	117) 3	118) 3	119) 1	120) 4