MATHEMATICS

1. The equation $z^2 = \bar{z}$, where z is a complex number, has

(A) 4 solution (B) 2 solution

(C) no solution (D) infinitely many solutions

2. The coefficient of the term independent of x in the expansion of $\left(\frac{x+1}{x^{2/3}-x^{1/3}+1}-\frac{x-1}{x-x^{1/2}}\right)^{10}$ is :

(A) 35 (B) 70 (C) 105 (D) 210

3. If no two of the real numbers a, b, c are equal and $\begin{vmatrix} a & a^2 & a^3-1 \\ b & b^2 & b^3-1 \\ c & c^2 & c^3-1 \end{vmatrix} = 0$, then :

(A) abc = 1 (B) a + b + c = 1 (C) a + b + c = 0 (D) ab + bc + ca = 0

4. If the slopes of one of the lines represented by $ax^2 - 6xy + y^2 = 0$ is the square of the other for some positive value of a, then a is

(A) 1 (B) 2 (C) 4 (D) 8

5. The number of distinct points common to the curves $x^2 + 4y^2 = 1$ and $4x^2 + y^2 = 4$ is

(A) 0 (B) 1 (C) 2 (D) 4

6. An ellipse has its major axis equal to the diameter of a circle and the area of the ellipse is one-third the area of the circle. The eccentricity of the ellipse is :

(A) $\frac{2}{3}$ (B) $\frac{\sqrt{2}}{3}$ (C) $\frac{2\sqrt{2}}{3}$ (D) $\frac{1}{3}$

7. Two perpendicular chords AB and CD of a circle meet at P. If PA = 2, PB = 18 and PC = 4, then the diameter of the circle is :

(A) $\frac{5\sqrt{17}}{2}$ (B) $5\sqrt{17}$ (C) 20 (D) $10\sqrt{5}$

8. The value of $\cos 5^\circ + \cos 10^\circ + \cos 15^\circ + ...+ \cos 355^\circ$ is

(A) 0 (B) 1 (C) – 1 (D) 71 $\cos 5^{arc}$

9. In a square ABCD, points P on BC and Q on CD are such that AP = 4, PQ = 3 and QA = 5. The area of ABCD is

(A) $\frac{256}{15}$ (B) 16 (C) $\frac{256}{17}$ (D) $\frac{256}{18}$

10. In a triangle ABC, AD bisects $\angle A$. Suppose AC = 2, BD = 2, DC = 1. The value of cos B is

(A) $\frac{6}{7}$ (B) $\frac{7}{8}$ (C) $\frac{8}{9}$ (D) $\frac{9}{10}$

11. The sides of a triangle are 9x + 1, 6x + 2, 3x + 3, where x is a positive integer. If the area is also an integer, the number of admissible values of x in the set {1, 2, 3....., 20} is :

(A) 3 (B) 4 (C) 6 (D) 12

12. Suppose f is a real function defined on R and $\lim_{h\to 0} \frac{f(1+h)}{h}$ exists. Then :

(A) f is not continuous at 1
(B) f is not continuous at 1 but not differentiable at 1
(C) f is differentiable at 1
(D) f is differentiable at 0

13. Consider the following statements :
(I) The derivative of an odd differentiable function is always even.
(II) If $f(x)$ is differentiable at a point x_0 and g(x) is not differentiable at x_0, then $f(x)$ g(x) is not differentiable at x_0.
Which of the following is true ?

(A) I and II are both true (B) I is true and II is false
(C) I is false and II is true (D) I and II are both false

14. If $f(x) = \begin{cases} \frac{\sin[x]}{[x]}, & \text{if } [x] \neq 0 \\ 0, & \text{if } [x] = 0 \end{cases}$. (Here [x] denotes the integer part of x.) Then $\lim_{x\to 0} f(x)$

(A) is –1 (B) is 0 (C) is sin 1 (D) does not exist

15. Let $f : [0, \infty) \to R$ be defined by $f(x) = x - \sqrt{x} + \sqrt[4]{x}$. Then the range of f is

(A) [– 1/2, ∞) (B) [0, ∞) (C) { – 1/4, ∞) (D) R

16. Let $f(x) = \int_0^x e^t(t-1)(t-2)\,dt$ .Then f(x) decreases in the interval

(A) (– ∞, – 2) (B) (– 2, – 1) (C) (1, 2) (D) (2, ∞)

17. The value of $\int_{-1}^{1} x\,|x|^{3/2}\,dx$ is :

(A) $\frac{4}{7}$ (B) $\frac{4}{5}$ (C) $\frac{4}{3}$ (D) 0

18. Let $f_n(x)$ = log log ....log(x), where log is repeated n times. Then

$\int (x f_1(x) f_2(x).....f_{10}(x))^{-1} dx$ is equal to :

(A) $f_{11}(x) + c$ (B) $\frac{f_{11}(x)}{11} + c$ (C) $10f_{10}(x) + c$ (D) $11f_{11}(x) + c$

19. The least value of $x_1^2 + x_2^2 + x_3^2$ where x_1, x_2, x_3 are real numbers satisfying $x_1 + 2x_2 + 3x_3 = 4$ is

(A) $\frac{8}{7}$ (B) 1 (C) 4 (D) 2

20. A coin is tossed until one observes a sequence of exactly three tails. The probability that the experiment comes to an end at 7-th toss is .

(A) $\frac{7}{128}$ (B) $\frac{1}{128}$ (C) $\frac{1}{32}$ (D) $\frac{5}{128}$

PHYSICS

21. Super cooled steam suddenly freezes to water. In this process,

(A) entropy of the system (steam) decreases, but entropy of the universe increases

(B) entropy of the system as well as entropy of environment decreases

(C) entropy of the system as well as entropy of the environment increases

(D) entropy of the system increases but entropy of the environment decreases

22. Isothermal compressibility β of a substance is defined as :

$$\beta = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$

where the derivative is taken keeping T constant.

V : Volume

P : Pressure

T : Temperature

For an ideal gas, β equals

(A) R (Gas constant)

(B) P

(C) P^{-1}

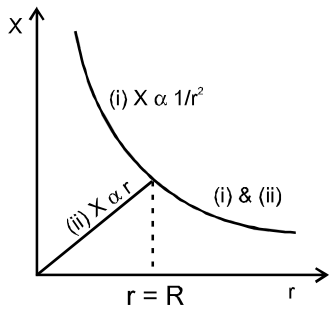
(D) P^{γ} (γ is the ratio of specific heats at constant pressure and constant volume $\gamma = (C_p / C_v)$

23. Consider two cases :

(i) A point charge q at the origin

(ii) A uniformly charged solid sphere of radius R (wth its centre at the origin) and total charge q.

Given below are graphs of a property X versus distance r from the origin for the two cases. The graphs coincide for $r \geq R$.



(A) X is electric potential due to point charge/charged sphere.

(B) X is magnitude of electric field due to point charge/charged sphere

(C) X is electrostatic potential energy of point charge/charged sphere

(D) X is charge density in space.

24. One end of a cylindrical solid rod of length L and radius r is clamped in a fixed positon. The other end is turned by an external torque τ resulting in a twist θ. The sheer modulus is given by η. The twist angle θ is proportional to :

(A) $\tau r^1\eta/\pi L^2$ (B) $\tau r^4/\pi \eta L$ (C) $\tau \eta L/\pi r^4$ (D) $\tau L/\pi \eta r^4$

25. A particle of charge q and mass m moves in a cirular orbit with angular momentum given by $\bar{l}$. The ratio of its magnetic moment μ to orbital angular moment $\bar{l}$ is given by

(A) $\frac{q}{m}$ (B) q (C) $\frac{q}{2m}$ (D) m q

26. Thermal motion of atoms in a gas causes the spectral line emitted by the atoms to be shifted at random towards both the red and blue. This leads to Doppler broadening of the spectral lines. If f is the frequency of the spectral line and Δf is a measure of broadening of the line, the ratio $\frac{\Delta f}{f}$ is proportional to (Proportionality constant is given to be dimensionless)

(A) $\frac{m}{\sqrt{kT}}$ (B) $\sqrt{\frac{kT}{m}}$ (C) $\sqrt{mkT}$ (D) $\frac{1}{c}\sqrt{\frac{kT}{m}}$

27. Consider a sinusoidal traveling wave along a string, with amplitude A and wave velocity v. The power carried by the wave is proportonal to

(A) Av^2 (B) AV (C) A^2v^2 (D) A^2v

(The proportionality constant is not dimensionless)

28. Monochromatic light falls on a pair of slits mounted 24 cm in front of a photographic film. After exposure, the film shows a series of bright bands spaced 0.20 cm apart. The separation between the slits is 6.0×10^{-3} cm. The wavelength of light is :

(A) 600 nm (B) 400 nm (C) 500 nm (D) 560 nm

29. Two clean mercury droplets when pushed into contact spontaneously coalesce to form a single droplet. The single droplet so formed will :

(A) Be slightly warmer than the separate pair of droplets

(B) Be slightly cooler than the separate pair droplets

(C) Have the same temperature as the separate pair of droplets

(D) Be warmer or cooler depending on the size of each initial droplet.

30. The speed of a comet at perihelion (chosest to the sun) is 5.6×10^4 ms^{-1}, while its distance from the sun is 9.0×10^{10}m. At aphelion (farthest from the sun) its distance is 5.6×10^{12}m. The comet's aphelion speed is :

(A) 1.0 km s^{-1} (B) 900 ms^{-1} (C) 504 ms^{-1} (D) 5.6×10^4 ms^{-1}

31. Consider two wave forms

$y_1 = A \cos(k x - \omega t)$ and $y_2 = A \cos(k x + \omega t)$

whose superposition forms a standing wave. Here x is in metres and t is in seconds. A node is found at x = 10 m. The longest wavelength possible for this situation is

(A) 1 m (B) 40 m (C) 20 m (D) 10 cm

32. The displacement x of a damped oscillator in one dimension is given by

$$x(t) = A e^{-\alpha t} \sin(\omega t + \beta)$$

where x is in metres. The SI units of the constants A, α, ω, β are respectively

(A) m, s^{-1}, s^{-1}, dimensionless (B) m, s, s^{-1}, m

(C) m, s^{-1}, s, dimensionless (D) dimensionless, s^{-1}, s^{-1}, dimensionless

33. In the following reaction, a proton bombards a lithium nucleus at rest producing two α-particles :

$$_3Li^7 + _1H^1 \rightarrow 2\ _2He^4$$

The total rest mass of the products is less than the total rest mass of the reactants by 0.01864 atomic mass unit (amu). By mass-energy conversion formula, 1 amu = 931 MeV approximately. This means that

(A) The kinetic energy of the proton 17.4 MeV

(B) The total kinetic energy of two α- particles is more than the kinetic energy of the proton by 17.4 Mev

(C) Each α-particle has a kinetic energy of 8.7 MeV.

(D) The proton's kinetic energy is 8.7 MeV more than that of each α-article

34. The radius of the first (n = 1) orbit in Bohr's model of hydrogen atom is 0.53×10^{10} m. (Planck's constant h = 6.63×10^{-34} Js, mass of electorn = 9.11×10^{-3t} kg). The speed of the electron in this orbit is approximately

(A) 3.0×10^{10} m s^{-1} (B) 1.4×10^{7} m s^{-1} (C) 3.5×10^{7} m s^{-1} (D) 2.2×10^{7} m s^{-1}

35. In an electric motor, two parallel wires 60 cm long are separated by a distance of 1.5 cm. The wires have non-magnetic insulation between them. A short circuit in the motor results suddenly in a large current of 4000 A. The currents flow in opposite directions in the two wires. Then

(A) There will be a repulsive force of 128 N on each wire

(B) There will be an attractive force of 128 N on each wire

(C) There will be no force experienced by any wire, since they are insulated.

(D) There will be a force along the length of each wire, of magnitude128 N.

36. Let λ be the typical de Broglie wavelength associated with an He atom in helium gas at room temperature T (20ºC) and pressure P(1 atomosphere).Let d be the mean separation between helium atoms under these conditions.Then

(A) λ is greater than d under the given T and P.

(B) λ is less than d under the given T and P.

(C) λ is equal to d under the given T and P

(D) The ratio of λ to d has no relation to T or P.

37. In a plane electromagnetic wave of frequency f traveling in free space with speed c, the elctric field magnitude E and magnetic field amplitude B are related (In S.I. units) by

(A) B = fE (B) B = cE (C) $B = \frac{E}{c}$ (D) E = fB

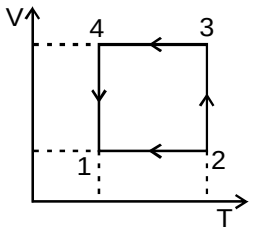
38. A resistor R and a capacitor C are connected in series to a 220 V, 50 Hz a.c. source. Let V_R and V_c be the r.m.s. voltages across R and C respectively. Then

(A) $V_R = V_c = 220$ V (B) $V_R - V_c = 220$ V (C) $V_c - V_R = 220$ V (D) $\sqrt{V_R^2 + V_C^2} = 220$ V

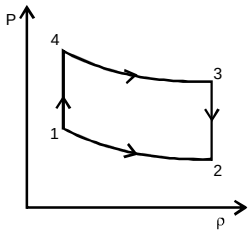
39. Two identical point sources P and Q vibrating in phase with the same amplitude generate sinusoidal waves on a water surface.The sources are 6.5 cm apart. Two nearest points (from P) of destructive interference along PQ are found to be at 0.7 cm and 2.4 cm from P. The total number of points of destructive interference on the line segment PQ is

(A) 4 (B) 3 (C) 2 (D) 5

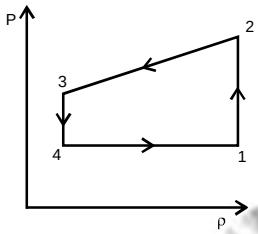
40. An ideal gas is subjected to an isothermal -isochoric cycle 1 – 2 – 3 – 4 – 1 as shown.



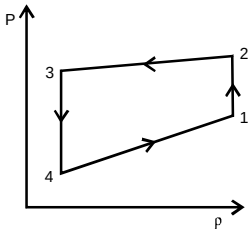
On the pressure - density (P-ρ) graph, this cycle is represented by



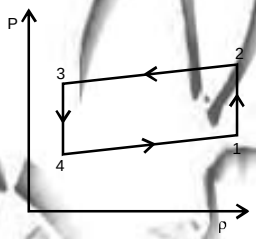
(A)



(B)



(C)



(D)

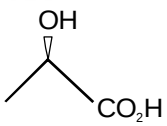
(A) Graph (A) (B) Graph (C) (C) Graph (B) (D) Graph (D)

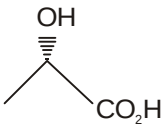
CHEMISTRY

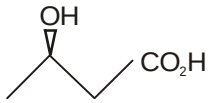
41. Li metal is a better reducing agent than Na metal because -
(A) The ionization enthalpy of Li is lower than that of Na
(B) The hydration enthalpy of Li is lower than that of Na
(C) The ionization enthalpy of Li is higher than that of Na
(D) The hydration enthalpy of Li is higher than that of Na

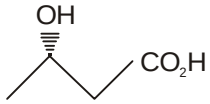
42. One mole each of the two gases X and Y are stored separately in two cylinders at 25ºC at pressures 1 atm. and 2 atm, respectively. The difference in the compressibilities of the two gases. ($k_x - k_y$) is
(A) 0.1 atm^{-1} (B) 0.5 atm^{-1} (C) 1.0 atm^{-1} (D) 2.0 atm^{-1}

43. (S)-lactic acid is

(A) 

(B) 

(C) 

(D) 

44. The reaction between p-methylbenzaldehyde and NaOH is an example of -

(A) Aldol condensation reaction (B) Cannizzarro reaction

(C) Disproportionation reaction (D) Hydrolysis reaction

45. A saturated solution of $BaSO_4$ is heated from 25ºC to 35ºC and the conductance of the solution and the solubility of $BaSO_4$ are measured. It is found that :

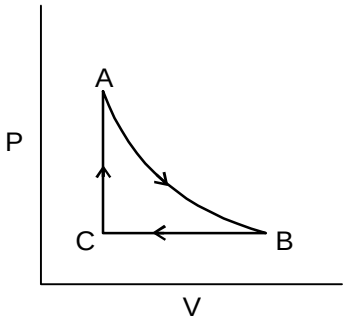
(A) both conductance and solubility increase

(B) both conductance and solubility decrease

(C) conductance increases but solubility decreases

(D) conductance decreases but solubility increases.

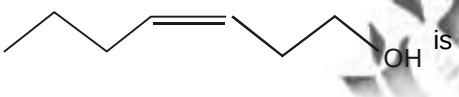
46. An ideal gas is subjected to a cyclic change as shown in the P-V diagram below :



The step in which the gas will cool down is along

(A) AB (B) BC (C) both AB and CA (D) both BC and CA

47. The IUPAC name of



is

(A) (3Z)-hept-3-en-1-ol (B) (3E)-hept-3-en-1-ol (C) (3Z)-hept-4-en-7-ol (D) (3E)-hept-4-en-7-ol

48. The Lewis acid strength of BF_3, BCl_3 and BBr_3 follows the order.

(A) $BBr_3 > BCl_3 > BF_3$ (B) $BF_3 > BCl_3 > BBr_3$ (C) $BCl_3 > BBr_3 > BF_3$ (D) $BCl_3 > BF_3 > BBr_3$

49. The total number of possible geometrical and optical isomers for $[CoCl_2(en)_2]^+$ (en = 1, 2-diaminoethane) is -

(A) 1 (B) 2 (C) 3 (D) 4

50. In balancing the reaction.

$xH_2S + 2NaNO_3 + 2HCl = y\,S + zNO + kNaCl + 4H_2O$

one would get x,y, z and k, respectively, as

(A) 3,3,2 and 2 (B) 2,2,3 and 3 (C) 3,3,4 and 4 (D) 4,4,3 and 3

51. The overall order of a reaction involving two reactants, X and Y, which follows the rate expression Rate $= k\,[X]^{1/3}\,[Y]^{2/3}$. Where k is the specific rate and [ ] represents concentration, is -

(A) 2/3 (B) 0 (C) 1/3 (D) 1

52. In a Daniel cell in operation :

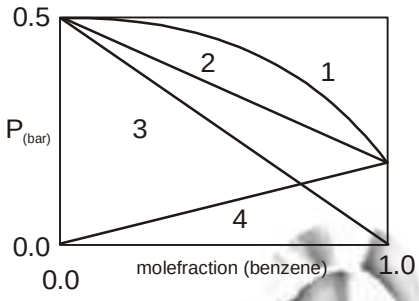
(A) Electrons flow externally from copper to zinc while anions flow from zinc to copper in solution.

(B) Electrons flow externally from zinc to copper while anions flow from zinc to copper in solution.

(C) Electrons flow externally from zinc to copper while anions flow from copper to zinc in solution.

(D) Electrons flow externally from coppper to zinc while anions flow from copper to zinc in solution.

53. In the pressure vs. molefraction of benzene curves/lines shown below, the total vapour pressure of an ideal mixture of benzene and toluene will follow the curve/line.



(A) 1 (B) 2 (C) 3 (D) 4

54. sp^3d^2 hybridization explains the bonding in

(A) $[FeCl_4]^-$ (B) $[Fe(CN)_6]^{3-}$ (C) $[FeCl_4]^{2-}$ (D) $[Fe(H_2O)_6]^{2+}$

55. The gas formed when conc. H_2SO_4 is added to a mixture of NaCl and MnO_2, is -

(A) Cl_2 (B) SO_2 (C) SO_3 (D) O_2

56. The interatomic distance in O_2^+, O_2^-, and O_2^{2-} follow the order

(A) $O_2^+ > O_2^- > O_2^{2-}$ (B) $O_2^{2-} > O_2^- > O_2^+$ (C) $O_2^- > O_2^{2-} > O_2^+$ (D) $O_2^+ > O_2^{2-} > O_2^-$

57. A naturally occuring polymer is

(A) Amylose (B) Polyvinylchloride (C) Teflon (D) Bakelite

58 The half-life of ammonia adsorbed on a Ni surface if the rate of desorption is $6.93 \times 10^{-3}\ s^{-1}$, is -

(A) 0.01 s (B) 200 s (C) 0.05 s (D) 100 s

59. The number of facial atoms in a fcc unit shell is -

(A) 2 (B) 3 (C) 6 (D) 8

60. The maximum amount of work produced by a heat engine operating between 200 K and 800 K if 100 J of heat is absorbed from the hot reservoir, is -

(A) 100 J (B) 75 J (C) 50 J (D) 25 J

BIOLOGY

61. Embryonic stem cells are derived from,
(A) Inner cell mass of the blastocyst (B) Outer cell mass of the blastocyst
(C) Cells from morula (D) Cells from the placenta

62. The phase in which meiotic recombination occurs
(A) Diplotene (B) Zygotene (C) Pachytene (D) Diakinesis

63. SCID (Severe Combined Immuno Defficiency Syndrome) patients do not have
(A) T-lymphocytes (B) Platelets
(C) Monocytes (D) Erythrocytes

64. What is the maximum number of hydrogen bonds possible involving a water molecule ?
(A) 0 (B) 1 (C) 2 (D) 3

65. A strand of a nucleic acid having 60% of base A and 30% of base G is
(A) B-DNA (B) A-DNA (C) Should be an RNA (D) Single stranded

66. Tetracycline, cyclohexamide, and streptomycin inhibit :
(A) Transcription (B) Translation
(C) Splicing (D) mRNA editing

67. In the genetic code, a nonsense codon codes for
(A) An antisense amino acid (B) A sensible amino acid
(C) Does not code for any amino acid (D) Methionine

68. The dinosaurs became extinct at the end of the following period :
(A) Cambrian (B) Cretaceous (C) Ordovician (D) Silurian

69. The anticoagulant most commonly used in blood banks is :
(A) EDTA (B) Heparin (C) Sodium Citrate (D) Hirudin

70. Totipotent cell is
(A) A cell which can be differentiated into most of the cell types.
(B) A cell which can be differentiated to all cell types to form a complete organism
(C) A cell which can be differentiated into only a specific cell type
(D) A cell which does not differentiated at all

71. You have an infection of pneumococcus (a bacteria). Which part of the bacteria may be toxic to your body and causes immunological reaction ?
(A) The outer cell wall lipoplysaccharide (B) The plasma membrane of the bacteria
(C) bacterial nucleus (D) Polysomes

72. Three nucleotides form a codon, which can code for a single amino acid. However, the same amino acid can be coded by three different codons. These three codons are collectively called
(A) Puncture codons (B) Degenerat codons
(C) Nonsense codons (D) Termination codons

73. The reason for doctor's advice for vaccination of newborns is :
(A) To increase the innate immunity of the baby
(B) To increase the acquired immunity of the baby
(C) To increase both, the innate and acquired immunity of the baby
(D) To protect the baby only against bacterial diseases

74. If you start a bacterial culture with 100 E. coli cells and allow the culture to grow for 2 hours, approximately what would be the total number of E. coli in the culture considering E.coli has a doubling time of 20 minutes.
(A) 10^2 (B) 10^3 (C) 10^5 (D) 10^7

75. Bacterial Flagellar movement requires
(A) Energy through ATP hydrolysis
(B) Nutrient gradient
(C) Proton gradient coupled to transport
(D) Energy through GTP hydeolysis

76. Which of the following bio-molecules is responsible for the "prion" infectious diseases
(A) DNA (B) Protein (C) RNA (D) Lipid

77. Charles Darwin's Theory of natural selection was heavily influenced by :
(A) Thomas Malthus "An Essay on the Principle of Population"
(B) Jean-Bapiste Lamark "Philosophie Zoologique"
(C) Issac Newton "Principia"
(D) Gregor Mendel "Experiments on Plant Hybridization"

78. Which one of the following chemical groups is not present in the nascent polypeptide chain of a protein ?
(A) Methine (B) Methylene (C) Amide (D) Phosphate

79. Identify the evolutionarily related proteins :
(A) Pepsin & Papain (B) Collagen & Collagenase
(C) Myoglobin & Hemoglobin (D) Lysozyme & Ribozyme

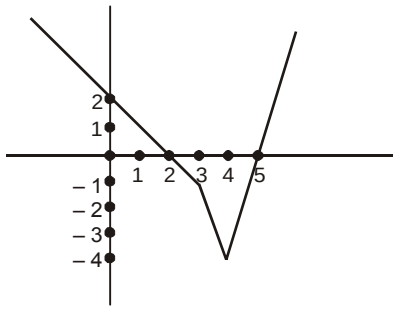
80. How many peptide linkages are present in a protein with 176 residues ?
(A) 174 (B) 175 (C) 176 (D) 177

MATHEMATICS

81. Suppose a, b, c are in arithmetic progression and a^2, b^2, c^2 are in geometric progression. If $a < b < c$ and $a + b + c = 3/2$, the value of a is :

(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2} - \frac{1}{\sqrt{2}}$ (C) $\frac{1}{\sqrt{3}}$ (D) $\frac{1}{3} - \frac{1}{\sqrt{3}}$

82. Let y = g(x) be a function whose derivative g'(x) has the following graph. Which of the following values of g is the largest ?



(A) g(2) (B) g(3) (C) g(4) (D) g(5)

83. Let ABCDEFGHI be a regular nanogon (9-sided polygon). If AB = x, AC = y, AD = z, then x, y, z are related by

(A) $z^2 = x^2 + xy + y^2$ (B) $z = x + y$ (C) $y^2 = xz$ (D) $2y = x + z$

84. If A is a 10 × 10 matrix with entries from the set {0, 1, 2, 3} and if AA^T is of the form :

$$\begin{pmatrix} 0 & * & * & \cdots & * \\ * & 0 & * & \cdots & * \\ * & * & 0 & \cdots & * \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ * & * & * & \cdots & 0 \end{pmatrix}$$

the number of such matrices A is :

(A) $(4^3)^{10}$ (B) $(4^2)^{10}$ (C) 4^{10} (D) 1

85. In an ellipse, O is the centre, AB is the major axis and CD is the minor axis. Suppose the focus between A and O is the ortho-centre of the triangle ACD. The eccentricity of the ellipes is

(A) $\frac{-1+\sqrt{5}}{2}$ (B) $\frac{2-\sqrt{3}}{2}$

(C) $\frac{\sqrt{5}-2}{2}$ (D) not uniquely determinable

86. The integral $\int_0^\infty [x]e^{-x}dx$ equals :

(A) $\frac{e}{e-1}$ (B) $\frac{e^2}{e^2-1}$ (C) $1 - \frac{1}{e}$ (D) $\frac{1}{e-1}$

87. What is the value of $\left(\int_0^{\pi/2} \cos^{1003} x dx\right)\left(\int_0^{\pi/2} \cos^{1004} x dx\right)$?

(A) $\frac{\pi}{2006}$ (B) $\frac{\pi}{2007}$ (C) $\frac{\pi}{2008}$ (D) $\frac{\pi}{2009}$

88. Let f(x) and g(x) be real polynomials of degree 4 and 3 respectively with leading coefficients 4 and 3 respectively. Then

$\lim_{x\to\infty} g(x)\int_0^x e^{f(t)-f(x)}dt$ is

(A) 0 (B) ∞ (C) $\frac{3}{16}$ (D) $\frac{4}{13}$

89. The equation of the curve through the origin satisfying the differential equation $\frac{dy}{dx} = \sin(x + y) + \cos(x + y)$

(A) $\log\left|1+\tan\frac{(x+y)}{2}\right| = y$ (B) $\log|1 + \tan(x + y)| = x$

(C) $\log\left|1+\tan\frac{(x+y)}{2}\right| = x$ (D) $\log|1 + \tan(x + y)| = y$

90. Let A = {1, 2, 3, 4, 5, 6} and f : A $\to$ A be a bijection. What is the probability that f o f = id, i.e., f is its own inverse ?

(A) $\frac{19}{180}$ (B) $\frac{13}{48}$ (C) $\frac{1}{720}$ (D) $\frac{5}{16}$

PHYSICS

91. Two stars of masses M_1 and M_2 form a binary system. The distance between the centres of the stars is d. The orbital period is given by

(A) $\frac{2\pi d^3}{\sqrt{G(M_1+M_2)}}$

(B) $\frac{2\pi d^{3/2}}{\sqrt{G(M_1+M_2)}}$

(C) $\frac{2\pi d^{3/2}}{\sqrt{G\mu}}$, where μ is the 'reduced' mass $\mu = \frac{M_1M_2}{M_1+M_2}$

(D) $\frac{2\pi d^3}{\sqrt{G\mu}}$

92. A particle is stuck on the rim of a wheel of radius 50 cm. The wheel is rotating with an angular acceleration of 20 rad s^{-2}. If at an instant the angular speed of the wheel is 10 rad s^{-1}, the total linear acceleration of the particle is :

(A) 10 m s^2 (B) 50 m s^2 (C) 51 m s^2 (D) 60 m s^2

93. A beam of 30 keV electrons strikes different targets in different experiments. The lowest wave length cut -off of the continuous spectrem of X-rays generated by beam for any target is

(A) 1.0×10^{-10} m (B) 3.0×10^{-10} m

(C) 4.14×10^{-11} m (D) dependent on the nature of the target

94. A bat flying towards a wall with a speed 9.0 m s^{-1} emits ultrasound of frequency 90 kHz. (Speed of ultrasonic waves is 340 ms^{-1}) The frequency of ultrasound received by the bat after reflection from the wall is :

(A) 90 kHz (B) 94.9 kHz (C) 85.4 kHz (D) 99 kHz

95. A cylindrical glass vessel of height 18 cm and diameter 8 cm is 4 mm thick. It is covered with a1 mm thick copper lid (Thermal conductivity of copper is 400 W $K^{-1}m^{-1}$) In a cold environment the water in the vessel has got frozen into 0ºC ice. It is then immersed into a tank of 15ºC water. (Density of ice is 0.92×10^3 kgm^{-3} and latent heat of fusion of water is 333×10^3 J kg^{-1}) The time taken for the ice to melt completely is

(A) 9.2 s (B) 46 s (C) 18.4 s (D) 136 s

96. An upright cylinder of large base area is filled with water up to height H. Water is flowing out through holes (1, 2 and 3) of equal diameter on the side of the cylinder at heights H/4, H/2 and 3H/4 respectively. Let x_1, x_2 and x_3 be the respective horizonatal distance covered by the water flowing out of the holes before hitting the ground. Then

(A) $x_3 > x_2 > x_1$ (B) $x_3 < x_2 < x_1$ (C) $x_2 > x_1 = x_3$ (D) $x_2 > x_1 > x_3$

97. Ocean tides on the Earth are caused by the gravitational effects of the Moon (for lunar tides) as well as the Sun (for solar tides). If the diameter of the earth were to increase by 20%, then

(A) Lunar tides would be strengthened but soalr tides would be weakened

(B) Lunar tides would be weakened but solar tides would be strengthened

(C) Both lunar and solar tides would be strengthened with lunar tides strengthening more than solar tides

(D) Both lunar and solar tides would be weakened with lunar tides weakening more than solar tides.

98. The wavelength of radiation emitted by a hydrogen atom when it de-excites from its first excited state to ground state (n = 2 to n = 1) is 121.7 nm. For the analogous transition in a positronium atom (bound state of electron and its antiparticle called positron) the wave length of radiation will be approximately
(A) 243.4 (B) 121.7 (C) 60.85 (D) 0.53

99. The objective lens of a telescope has a diameter of 12.2 cm. The angular resolution of the telescope at the wavelength of 500 nm is
(A) 2×10^{-x} rad (B) 1.22×10^{-7} rad (C) 4×10^{-5} rad (D) 5×10^{-6} rad

100. A conducting rod of length 80 cm rotates with its one end fixed at the centre of a circular metallic ring and the other end in contact with the ring. The angular frequency of the rod is 300 s^{-1}. There is a uniform and constant magnetic field of 1.0T parallel to the axis of rotation. The emf developed between the centre and the ring is :
(A) 48 V (B) 192 V (C) 36 V (D) 96 V

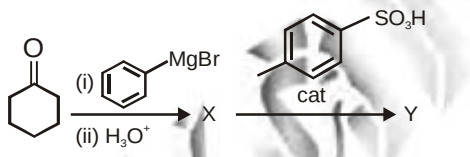
CHEMISTRY

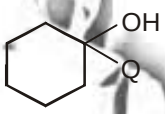
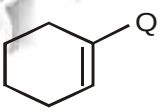
101. The numbers of lone pairs of electrons in XeF_2 and XeF_4 respectively, are -
(A) 3 and 3 (B) 2 and 3 (C) 2 and 2 (D) 3 and 2

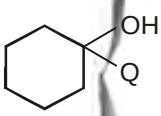
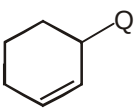
102. When 4 moles of N_2 gas reacts with 16 moles of H_2 gas in 10 lit vessel, 4 moles of ammonia gas is produced in the equilibrium mixture.
The equilibrium constant K_c for this reaction in mol^{-2} lit^2 is -
(A) 0.4 (B) 0.2 (C) 0.8 (D) 1.6

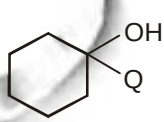
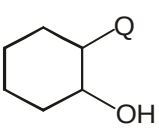
103. The freezing point of pure benzene is 5.5º C. When 2.9 g of butane is dissolved in 200g of benzene, the freezing point of benzene decreases to 4ºC. To lower the freezing point of benzene by another 1.5ºC, the amount of butane that has to be added to mixture is -
(A) 5.8 g (B) 2.9 g (C) 1.5 g (D) 8.7 g

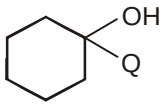
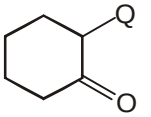
104. X and Y in the following reactions, respectively are



(A) X =  Y = 

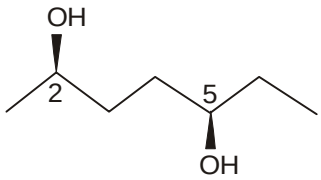
(B) X =  Y = 

(C) X =  Y = 

(D) X =  Y = 

Q = Phenyl group

105. The configuration at C-2 and C-5 in the following compound, respectively, are



(A) 2R and 5R (B) 2S and 5S (C) 2R and 5S (D) 2S and 5R

106. The cell potential of an electrochemical cell with the cell reaction
$Zn + 2Ag^{+}$ (0.0001M) $\longrightarrow$ Zn^{2+} (0.1 M) + 2Ag, is
(A) 1.25 V (B) 1.35 V (C) 1.45 V (D) 1.55 V
Given that the standard cell potential is 1.56 V

107. Methyl chloride reacts with X at high temperature in the presence of a catalyst Y to give Me_2SiCl_2 as one of the products. The compound can also be formed by reaction of silicon tetrachloride with an organometallic reagent, Z.
X, Y, and Z respectively,are
(A) Si, Cu, MeMgBr (B) SiO_2, Cu, Me_2Zn (C) Si, Ni, MeMgBr (D) SiO_2, Fe, Me_2Zn

108. A chemical reaction takes place at 625 K with an activation energy barrier, E/R = 500 K. A catalyst when used in the reaction reduces the activation energy barrier to 400 K. The temperature at which the rate constant with and without the catalyst will be same is -
(A) 300 K (B) 400 K (C) 500 K (D) 600 K

109. A divalent transition metal ion with valence electron configuration $3d^8$ forms a complex with cyanide ion. The correct identity of the metal ion, the complex and its geometry, respectively, are
(A) Fe^{2+}, $[Fe(CN)_6]^{4-}$, and octahedral
(B) Ni^{2+}, $[Ni\ (CN)_4]^{2-}$ and tetrahedral
(C) Fe^{2+}, $[Fe(CN)_6]^{3-}$ and octahedral
(D) Ni^{2+}, $[Ni(CN)_4]^{2-}$ and square planar

110. The number of α and β particles to be emitted by $^{238}U_{92}$ to give $^{206}Pb_{82}$, respectively, are -
(A) 8 and 6 (B) 4 and 3 (C) 6 and 8 (D) 3 and 4

BIOLOGY

111. In a double-stranded DNA coding for a protein, in principle, how many codon reading frames are possible?
(A) 1 (B) 2 (C) 3 (D) 6

112. Which of the following is advantage of meiotic recombination in diploids ?
(A) Helps in maintaining chromosome length
(B) Ensures chromosome segregation
(C) Helps chromosomes to attach to the spindle microtubules
(D) Ensures new combinations of genetic traits

113. Plants obtain their nitrogen supply through bacteria of the soil because :
(A) Nitrogen is absent in the air and present in the soil
(B) Plants do not have a mechanism to absorb gaseous Nitrogen
(C) Bacteria are Nitrogen rich
(D) Getting nitrogen is a side-effect of a bacterial infection

114. The number of genes in man (Homo sapiens) is X-fold more than in a fly (Drosophila melanogaster). The value of X is
(A) 2 (B) 10 (C) 250 (D) 10000

115. You are supposed to mix a 3000 bp DNA fragment and a 600 bp DNA fragment in 1 : 5 molar ratio. If you take 100 ng of the 3000 bp fragment how much of the 600 bp fragment do you require to get desired ratio
(A) 10 ng (B) 100 ng (C) 500 ng (D) 2500 ng

116. An enzyme that cleaves DNA recognizes an 8 base-pair unique DNA sequence. The probable number of times this enzyme will cleave a 70 kilobase pair random DNA sequence is
(A) 1 (B) 2 (C) 3 (D) 4

117. Mendel's law of independent assortment when interpreted in a modern context indicates :
(A) Alleles are present on the same chromosome, but they assort independently due to recombination
(B) Alleles are present on independent chromosomes and these separate and assort independently
(C) Alleles are present on independent chromosomes and they can be sorted during meiosis.
(D) Alleles are present on the same chromosome and their combination is dependen

118. Fat absorption in the microvilli is by :
(A) Endocytosis
(B) Simple diffusion through the plasma membrane
(C) Facilitated diffusion
(D) Active transport

119. During the process of photosynthesis
(A) Glucose is synthesized during the dark reaction and ATP during the light reaction
(B) Glucose and ATP are produced during light and dark reaction
(C) Glucose and ATP are produced during the dark reaction
(D) Glucose is synthesized during the light reaction and ATP during the dark reaction

120. Identify the protein with more than one polypeptide chain.
(A) Myoglobin (B) Trypsin (C) Immunoglobulin (D) Lysozyme