

SECTION A: PHYSICS

1. Two soap bubbles of radii 4 cm and 3 cm respectively coalesce under isothermal conditions to form a single bubble. What is the radius of the new single bubble?

- (a) 3 cm (b) 4 cm (c) 5 cm (d) 6 cm

2. Kerosene in the wick of lantern rises up because

- (a) Of negligible viscosity (c) Of the surface tension of the oil
(b) The diffusion of the oil through the wick (d) Wick attracts the kerosene

3. A stretched wire has a Young's modulus Y and energy density E . the strain in the stretched wire is

- (a) $\sqrt{\frac{2E}{Y}}$ (b) $\frac{2E}{Y}$ (c) $\frac{4E}{Y}$ (d) $\sqrt{\frac{E}{Y}}$

4. Longitudinal strain is possible in the case of

- (a) Gases (b) Liquid (c) Only solids (d) Only gases & liquids

5. Hooke's law essentially defines

- (a) Stress (b) Strain (c) Yield point (d) Elastic limit

6. The equation of a wave is given by $y = 10 \sin \pi (0.01 x - 2t)$ where y and x are in cm and t is in sec. its frequency is

- (a) 10 sec^{-1} (b) 2 sec^{-1} (c) 1 sec^{-1} (d) 0.01 sec^{-1}

7. Which of the following phenomenon cannot take place with sound wave?

- (a) Reflection (b) Interference (c) Diffraction (d) Polarization

8. A disc of moment of inertia I_1 is rotating with angular velocity ω_1 about an axis perpendicular to its plane and passing through its centre. If another disc of moment of inertia I_2 about the same axis is gently placed over it, then the new angular velocity of the combined disc will be

- (a) $\frac{(I_1 + I_2)\omega_1}{I_1}$ (b) $\frac{I_1\omega_1}{I_1 + I_2}$ (c) ω_1 (d) $\frac{I_2\omega_1}{I_1 + I_2}$

9. The speed of a homogeneous, solid sphere after rolling down in the inclined plane of vertical height h , from rest without sliding is

- (a) $\sqrt{\left(\frac{10}{7} gh\right)}$ (b) \sqrt{gh} (c) $\sqrt{\left(\frac{6}{3} gh\right)}$ (d) $\sqrt{\left(\frac{4}{3} gh\right)}$

10. A bar magnet is equivalent to _____.

- (A) solenoid carrying current (B) circular coil carrying current
(C) toroid carrying current (D) straight conductor carrying current

11. A simple pendulum is suspended from the ceiling of a lift. When the lift is at rest its time period is T. With what acceleration should the lift be accelerated upwards in order to reduce its period to $T/2$? (g is acceleration due to gravity).

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

12. Blue colour of sea water is due to

- (A) interference of sunlight reflected from the water surface (B) scattering of sunlight by the water molecules
(C) image of sky in water (D) refraction of sunlight

13. Dimensional formula for the universal gravitational constant G is

- (A) $M^{-1} L^2 T^{-2}$ (B) $M^0 L^0 T^0$ (C) $M^{-1} L^3 T^{-2}$ (D) $M^{-1} L^3 T^{-1}$

14. How many $6\mu\text{F}$, 200 V condensers are needed to make a condenser of 18 pF, 600 V?

- (A) 9 (B) 18 (C) 3 (D) 27

15. If μ_0 is permeability of free space and ϵ_0 is permittivity of free space, the speed of light in vacuum is given by

- (A) $\sqrt{\mu_0 \epsilon_0}$ (B) $\sqrt{\mu_0 / \epsilon_0}$ (C) $\sqrt{1 / \mu_0 \epsilon_0}$ (D) $\sqrt{\epsilon_0 / \mu_0}$

16. What is the minimum thickness of a thin film required for constructive interference in the reflected light from it? Given, the refractive index of the film = 1.5, wavelength of the light incident on the film = 600 nm.

- (A) 50 nm (B) 200 nm (C) 100 nm (D) 300 nm

17. Water is in streamline flow along a horizontal pipe with nonuniform cross-section. At a point in the pipe where the area of cross-section is 10 cm^2 , the velocity of water is 1 ms^{-1} and the pressure is 2000 Pa. The pressure at another point where the cross-sectional area is 5 cm^2 is _____.

- (A) 1000 Pa (B) 500 Pa (C) 4000 Pa (D) 2000 Pa

18. A single slit Fraunhofer diffraction pattern is formed with white light. For what wavelength of light the third secondary maximum in the diffraction pattern coincides with the second secondary maximum in the pattern for red light of wavelength 6500 \AA ?

- (A) 9100 \AA (B) 4642.8 \AA (C) 4100 \AA (D) 4400 \AA

19. An inductance of $\frac{200}{\pi}$ mH, a capacitance of $\frac{10^{-3}}{\pi}$ F and a resistance of 10Ω are connected in series with an a.c. source 220 V, 50Hz. The phase angle of the circuit is

- (A) $\frac{\pi}{3}$ (B) $\frac{\pi}{2}$ (C) $\frac{\pi}{4}$ (D) $\frac{\pi}{6}$

20. In an ac circuit an alternating voltage $e = 200\sqrt{2}\sin 100t$ volts is connected to capacitor of capacity $1\mu\text{F}$. The r.m.s. value of the current in the circuit is

- (A) 20 mA (B) 10 mA (C) 100 mA (D) 200 mA

21. Solar spectrum is an example for

- (A) line emission spectrum (B) continuous emission spectrum
(C) band absorption spectrum (D) line absorption spectrum

22. The dimensions of 'resistance' are same as those of _____ where h is the Planck's constant, e is the charge.

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

23. The maximum kinetic energy of emitted electrons in a photoelectric effect does not depend upon

- (A) wavelength (B) frequency (C) intensity (D) work function

24. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will
(A) Be doubled (B) Increase four times (C) Be reduced to half (D) Remain the same

25. A body is projected vertically upwards. The times corresponding to height h while ascending and while descending are t_1 and t_2 respectively. Then the velocity of projection is (g is acceleration due to gravity)

- (A) $g\sqrt{t_1 t_2}$ (B) $\frac{gt_1 t_2}{t_1 + t_2}$ (C) $\frac{g\sqrt{t_1 t_2}}{2}$ (D) $\frac{g(t_1 + t_2)}{2}$

26. A body of mass 4 kg is accelerated upon by a constant force, travels a distance of 5 m in the first second and a distance of 2 m in the third second. The force acting on the body is

- (A) 2 N (B) 4 N (C) 6N (D) 8N

27. A body weighs 50 grams in air and 40 grams in water. How much would it weigh in a liquid of specific gravity 1.5?

- (A) 30 grams (B) 35 grams (C) 65 grams (D) 45 grams

28. Two equal forces (P each) act at a point inclined to each other at an angle of 120° . The magnitude of their resultant is _____.

- (A) P (B) 2P (C) $\frac{P}{2}$ (D) $\frac{P}{4}$

29. A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10$

m/s^2 , the range of the missile is

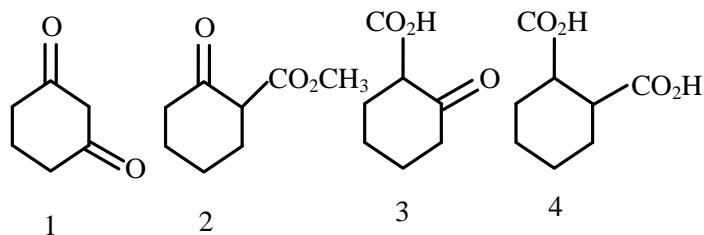
- (A) 20 m (B) 40 m (C) 50 m (D) 60 m

30. A 1250 W heater operates at 115 V. What is the resistance of the heating coil?

- (A) 1.6Ω (B) 13.5Ω (C) 1250Ω (D) 10.6Ω

SECTION B: CHEMISTRY

31. Which of the following compounds will undergo decarboxylation on heating?



- (A) 2 and 3 (B) 3 and 4 (C) 3 only (D) 1 and 4

32. 1 mol of $N_2O_4(g)$ at 300 K is kept in a closed container under 1 atm. It is heated to 600K, upon which 20% by mass of $N_2O_4(g)$ decomposes to $NO_2(g)$. The resultant pressure is

- (A) 1.2 atm (B) 2.4 atm (C) 2.0 atm (D) 1.0 atm

33. At constant pressure, the addition of argon

- (A) reduces the formation of ammonia from nitrogen and hydrogen
(B) increases the formation of ammonia from nitrogen and hydrogen
(C) does not affect the equilibrium of the reaction in which ammonia is formed from nitrogen and hydrogen
(D) reduces the dissociation of ammonia

34. Calculate the pH of a solution prepared by mixing 2.0 mL of a strong acid (HCl) solution of pH 3.0 and 3.0 mL of a strong base (NaOH) of pH 10.0.

- (A) 2.5 (B) 3.5 (C) 4.5 (D) 6.5

35. Roasting of Cinnabar produces

- (A) HgO (B) ZnO (C) Hg (D) HgS

36. Gypsum is

- (A) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (B) $(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$ (C) CaOCl_2 (D) $\text{CaCl}_2 \cdot \text{H}_2\text{O}$

37. Formalin is a solution of

- (A) HCHO (B) HCOOH (C) CH_3OH (D) CH_3CHO

38. The reaction of sunflower oil with NaOH can be called

- (A) Cracking (B) Saponification (C) Polymerization (D) Esterification

39. This is involved in rusting of Fe :

- (A) O_2 (B) H_2 (C) N_2 (D) Cl_2

40. What will be the K_b value of a weak base (BOH) of which a 0.1 M solution has a pH of 8, when it is half neutralized with 0.1 M HNO_3 ?

- (A) 10^{-8} (B) 10^{-4} (C) 10^{-6} (D) 10^{-7}

41. The pH of an aqueous solution of $\text{Ba}(\text{OH})_2$ is 10.0. If the K_{sp} of $\text{Ba}(\text{OH})_2$ is 1×10^{-9} then the concentration of Ba^{2+} ions in the solution is

- (A) $1 \times 10^{-4} M$ (B) $1 \times 10^{-6} M$ (C) $1 \times 10^{-2} M$ (D) $1 \times 10^{-1} M$

42. When a 0.20 M solution of acetic acid is neutralized with 0.20 M NaOH in 0.50 L of water, the pH of the resulting solution will be (given that pK_a for $\text{CH}_3\text{COOH} = 4.74$)

- (A) 12.67 (B) 7.87 (C) 8.87 (D) 7.00

43. Calculate the pH at which an acid indicator with $K_{acid}(\text{indicator}) = 1.0 \times 10^{-5}$ changes colour when the concentration of the indicator is $1 \times 10^{-3} M$.

- (A) 5 (B) 11 (C) 3 (D) 8

44. Calculate the pH of a 0.01 M NaHCO_3 solution $\left[K_1(\text{H}_2\text{CO}_3) = 4 \times 10^{-7} K_2(\text{HCO}_3^-) = 4.8 \times 10^{-11} \right]$.

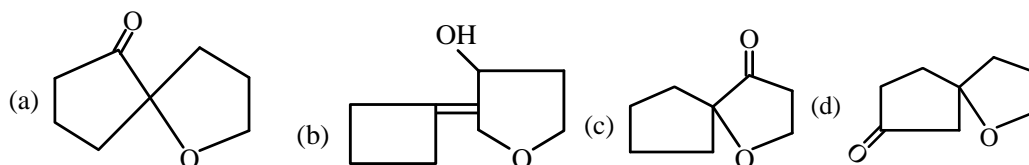
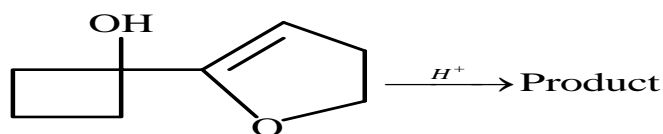
- (A) 9.38 (B) 6.38 (C) 8.38 (D) 7.38

45. The IUPAC name of lactic acid is

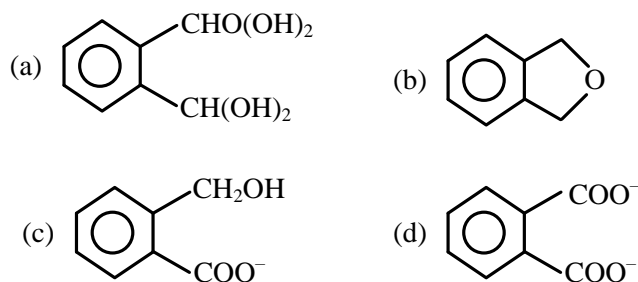
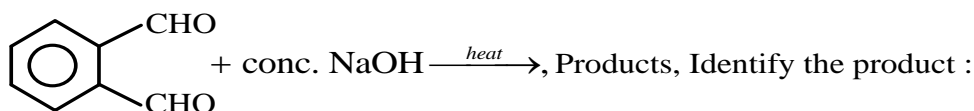
- (A) 2-hydroxyethanoic acid (B) 2-hydroxypropanoic acid
(C) 3-hydroxybutanoic acid (D) 2-hydroxybutanoic acid

46. The number of optical isomers of $\text{HOOC} - (\text{CHOH})_2 - \text{COOH}$ is
 (A) 2 (B) 3 (C) 4 (D) 0
47. CH_3 free radical contains C with following hybridization:
 (A) sp^2 (B) sp (C) sp^3 (D) None of these
48. Electrolysis of CH_3COOK forms following on anode:
 (A) $\text{H}_2 + \text{CH}_4$ (B) $\text{CH}_4 + \text{CO}_2$
 (C) $\text{C}_2\text{H}_6 + \text{H}_2$ (D) $\text{C}_2\text{H}_6 + \text{CO}_2$
49. This causes explosions in coal mines:
 (A) $\text{H}_2 + \text{air}$ (B) $\text{CO} + \text{air}$ (C) $\text{C}_2\text{H}_6 + \text{air}$ (D) $\text{CH}_4 + \text{air}$
50. Esterification is involved in the formation of
 (A) Decron (B) Nylon (C) Cellulose (D) Wool
51. The ratio of $\text{CH}_2 = \text{CHCH} = \text{CH}_2$ to styrene in Buna-S is
 (A) 1 : 1 (B) 2 : 1 (C) 3 : 1 (D) 1 : 2
52. Williamson's synthesis produces
 (A) Alkane (B) Amide (C) Ester (D) Ether
53. Which is produced by contact process ?
 (A) H_2SO_4 (B) Steel (C) S (D) NaOH
54. How many out of TiF_6^{2-} , CoF_6^{3-} , Cu_2Cl_2 and NiCl_4^{2-} (Ti = 22, Co = 27, Cu = 29, Ni = 28) are colourless?
 (A) 0 (B) 2 (C) 3 (D) 1
55. Which of the following is not concentrated by Froth floatation process ?
 (A) Argentite (B) Galena (C) Copper pyrite (D) Bauxite
56. In which molecule all bonds are not identical ?
 (A) CF_3 (B) BF_3
 (C) AlF_3 (D) NF_3
57. Which compound behaves as electron deficient ?
 (A) B_2H_6 (B) C_2H_6
 (C) PH_3 (D) SiH_4
58. Which one is a major impurity in pig iron ?
 (A) Si (B) O (C) S (D) C

59. Identify the major product,



60. The reaction



SECTION C: MATHEMATICS

61. If $u = \cot^{-1} \sqrt{\cos \alpha} - \tan^{-1} \sqrt{\cos \alpha}$, then $\sin u$ is equal to

- (A) $\tan^2 \alpha$ (B) $\tan^2 \frac{\alpha}{2}$ (C) $\cot^2 \alpha$ (D) $\cot^2 \frac{\alpha}{2}$

62. If four distinct points (2, 3), (0, 2), (4, 5) and (0, t) are concyclic, then $(t^3 + 17)$ is equal to

- (A) 4913 (B) 4930 (C) 4947 (D) 4964

63. The maximum and minimum values of $x^2 + 2x + 3$ are (x is real)

- (A) 4, -5 (B) 3, 1 (C) 0, 1 (D) 2, -3

64. If $n(U) = 700$, $n(A) = 200$, $n(B) = 300$ and $n(A \cap B) = 100$, then $n(A' \cap B')$ is

- (A) 600 (B) 400 (C) 300 (D) 200

65. If $f : A \rightarrow B$ is a bijection and $g : B \rightarrow A$ is the inverse of f , then $f \circ g$ is equal to

- (A) I_A (B) I_B
(C) f (D) g

66. The number of ways in which 15 objects can be distributed identical among 6 people, is

- (A) ${}^{15}C_6$ (B) ${}^{16}C_5$ (C) ${}^{20}C_5$ (D) ${}^{21}C_6$

67. If 20% of the bolts produced by a machine are defective, then determine the probability that out of 4 bolts chosen at random less than 2 bolts will be defective

- (A) 0.2048 (B) 0.4096 (C) 0.6144 (D) 0.8192

68. If in a triangle ABC, $\cos A + 2 \cos B + \cos C = 2$, then a, b, c are in

- (A) arithmetic progression (B) geometric progression
(C) harmonic progression (D) none of the above progression

69. The area of the closed figure bounded by the curves $y = x$, $y = 4 - 3x$ and $y = 0$

- (A) $\frac{4}{9}$ (B) $\frac{8}{9}$ (C) $\frac{16}{9}$ (D) $\frac{32}{9}$

70. A bullet of mass 0.006 kg travelling at 120 m/s penetrates deeply into a fixed target and is brought to rest in 0.01 s. The distance through which it penetrates the target is

- (A) 3 cm (B) 6 cm
(C) 30 cm (D) 60 cm

71. If \vec{a} and \vec{b} are non zero, non collinear, and the linear combination $(2x - y)\vec{a} + 4\vec{b} = 5\vec{a} + (x - 2y)\vec{b}$ holds for real x and y then x + y has the value equal to

- (A) -3 (B) 1 (C) 17 (D) 3

72. In the isosceles triangle ABC, $\overline{AB} = \overline{BC} = 8$, a point E divides AB internally in the ratio 1 : 3, then the cosine of the angle between \overline{CE} & \overline{CA} is (where $|\overline{CA}| = 12$)

- (A) $\frac{3\sqrt{7}}{8}$ (B) $\frac{3\sqrt{8}}{17}$ (C) $\frac{3\sqrt{7}}{8}$ (D) $\frac{-3\sqrt{8}}{17}$

73. The value of $\lim_{x \rightarrow 0} (\cos x + a \sin bx)^{\frac{1}{x}}$ is

- (A) e^{ab} (B) e^a (C) e^{-a} (D) e^{ab}

74. The number of points (x, y) having integral coordinates satisfying the condition $x^2 + y^2 < 25$ is

- (A) 69 (B) 80 (C) 81 (D) 77

75. For two particular vectors \vec{A} and \vec{B} it is known that $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$. What must be true about the two vectors?

- (A) At least one of the two vectors must be the zero Vector.
(B) $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$ is true for any two vectors.
(C) One of the two vectors is a scalar multiple of the other vector.
(D) The two vectors must be perpendicular to each other.

76. Cosine of an angle between the vectors $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ if $|\vec{a}| = 2$, $|\vec{b}| = 1$ and $\vec{a} \wedge \vec{b} = 60^\circ$ is

- (A) $5/\sqrt{7}$ (B) $9/\sqrt{2}$ (C) $3/\sqrt{7}$ (D) none

77. If $y = e^{\tan x}$, then $\cos^2 x \frac{d^2 y}{dx^2} =$

- (A) $(1 - \sin 2x) \frac{dy}{dx}$ (B) $-(1 + \sin 2x) \frac{dy}{dx}$
 (C) $(1 + \sin 2x) \frac{dy}{dx}$ (D) None of these

78. The smallest distance between the circle $(x-5)^2 + (y+3)^2 = 1$ and the line $5x + 12y - 4 = 0$, is

- (A) 1/13 (B) 2/13
 (C) 3/15 (D) 4/15

79. Given $f(x) = |x| + |x - 1|$, then

- (A) $f(x)$ is continuous at $x = 0$ only
 (B) $f(x)$ is continuous at $x = 1$ only
 (C) $f(x)$ is continuous at both $x = 0$ and $x = 1$
 (D) $f(x)$ is discontinuous

80. If $\log x^2 - \log 2x = 3 \log 3 - \log 6$, then x is equal to

- (A) 3 (B) 4 (C) 6 (D) 9

81. The order of the differential equation of all tangent lines to the parabola $y = x^2$ is

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

82. If in a triangle ABC, $a = 5$, $b = 4$ and $\cos(A - B) = 31/32$, then third side C is equal to

- (A) 3 (B) 6 (C) 7 (D) 9

83. If $ad - bc \neq 0$ and $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ and $A^2 + xA + yI = 0$ then

- (A) $x = -(a+b)$ (B) $x = -(a+d)$
 (C) $y = ad+bc$ (D) $y = bd+ac$

84. If from point P (4, 4) perpendiculars to the straight lines $3x + 4y + 5 = 0$ and $Y = mx + 7$ meet at Q and R and area of triangle PQR is maximum, then m is equal to

- (A) $\frac{4}{3}$ (B) $-\frac{4}{3}$ (C) -1 (D) 1

85. In a $\triangle ABC$, co-ordinates of orthocenter, centroid and vertex A are (3, 2), (4, 1) and (1, 2) respectively. The x-coordinate of vertex B is

- (A) 2 (B) 3/2 (C) 7/2 (D) 11/2

86. The equation of circle touching the parabola $y^2 = 4x$ at the point (1, -2) and passing through origin is

- (A) $x^2 + y^2 + 6x + 9y = 0$ (B) $x^2 + y^2 - 3x - 4y = 0$
 (C) $x^2 + y^2 - 7x - y = 0$ (D) $x^2 + y^2 - 9x - 2y = 0$

87. The curve described parametrically by $x = t^2 + t + 1$, $y = t^2 - t + 1$ represents

- (A) a pair of straight lines (B) an ellipse
 (C) a parabola (D) a hyperbola

88. If $f : \mathbb{R} \rightarrow \mathbb{R}$ be a mapping defined by $f(x) = x^3 + 5$, then $f^{-1}(x)$ is equal to

- (A) $\frac{1}{x^3+5}$ (B) $(x + 5)^{\frac{1}{3}}$ (C) $(5 - x)^{\frac{1}{3}}$ (D) $(x - 5)^{\frac{1}{3}}$

89. A class has 175 students. The following data shows the number of students opting one or more subjects : Mathematics 100, Physics 70, Chemistry 40 Mathematics and Physics 30 Mathematics and Chemistry 28 Physics and Chemistry 23 Mathematics, Physics and Chemistry 18 How many students have opted Mathematics alone ?

- (A) 24 (B) 48 (C) 60 (D) 100

90. If three positive real numbers a, b, c are in arithmetic progression such that $abc = 4$, then the minimum possible value of b is

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