

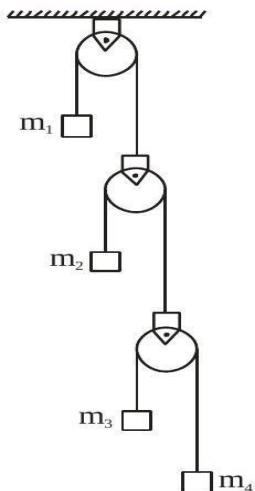
PART-I PHYSICS

SECTION-A

1. The dimension of mutual inductance is :

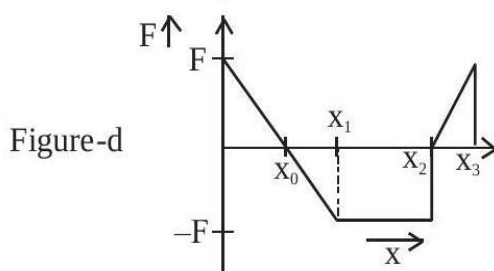
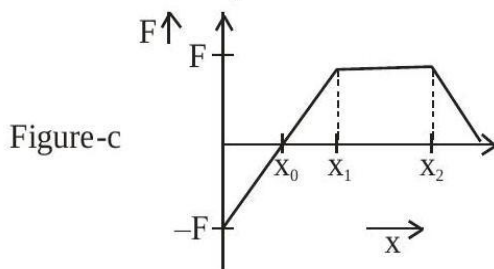
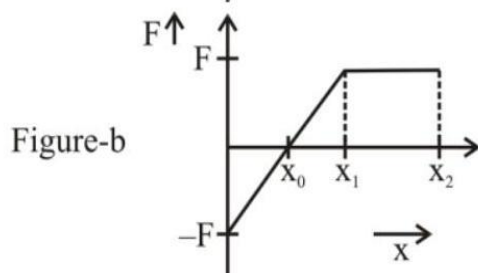
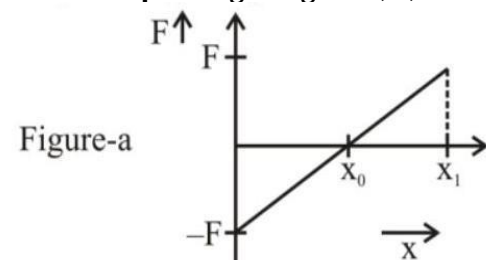
- (a) $[ML^2 T^{-2} A^{-1}]$ (b) $[ML^2 T^{-3} A^{-1}]$
(c) $[ML^2 T^{-2} A^{-2}]$ (d) $[ML^2 T^{-3} A^{-2}]$

2. In the arrangement shown in figure a_1, a_2, a_3 and a_4 are the accelerations of masses m_1, m_2, m_3 and m_4 respectively. Which of the following relation is true for this arrangement?



- (a) $4a_1 + 2a_2 + a_3 + a_4 = 0$
(b) $a_1 + 4a_2 + 3a_3 + a_4 = 0$
(c) $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$
(d) $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

3. Arrange the four graphs in descending order of total work done; where W_1 , W_2 , W_3 and W_4 are the work done corresponding to figure a, b, c and d respectively.



- (a) $W_3 > W_2 > W_1 > W_4$
 (b) $W_3 > W_2 > W_4 > W_1$
 (c) $W_2 > W_3 > W_4 > W_1$
 (d) $W_2 > W_3 > W_1 > W_4$

4. Solid spherical ball is rolling on a frictionless horizontal plane surface about its axis of symmetry. The ratio of rotational kinetic energy of the ball to its total kinetic energy is:-

- (a) $\frac{2}{5}$ (b) $\frac{2}{7}$
 (c) $\frac{1}{5}$ (d) $\frac{7}{10}$

5. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.

Reason R: At equator, the direction of acceleration due to the gravity is towards the center of earth.

In the light of above statements, choose the correct answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
 (b) Both A and R are true but R is NOT the correct explanation of A.
 (c) A is true but R is false
 (d) A is false but R is true

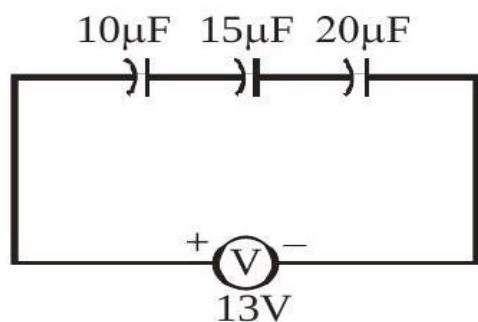
6. If ρ is the density and η is coefficient of viscosity of fluid which flows with a speed v in the pipe of diameter d , the correct formula for Reynolds number R_e is :

- (a) $R_e = \frac{\eta d}{\rho v}$ (b) $R_e = \frac{\rho v}{\eta d}$
 (c) $R_e = \frac{\rho v d}{\eta}$ (d) $R_e = \frac{\eta}{\rho v d}$

7. A flask contains argon and oxygen in the ratio of 3: 2 in mass and the mixture is kept at 27°C . The ratio of their average kinetic energy per molecule respectively will be:

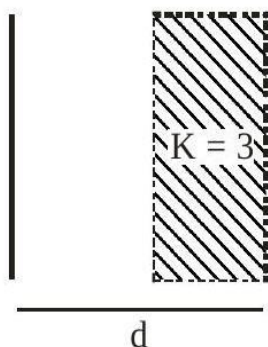
- (a) 3: 2 (b) 9: 4
 (c) 2: 3 (d) 1: 1

8. The charge on capacitor of capacitance $15\mu\text{F}$ in the figure given below is:



- (a) $60\mu\text{C}$ (b) $130\mu\text{C}$
 (c) $260\mu\text{C}$ (d) $585\mu\text{C}$

9. A parallel plate capacitor with plate area A and plate separation $d = 2\text{ m}$ has a capacitance of $4\mu\text{F}$. The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant $K = 3$ (as shown in figure) will be:

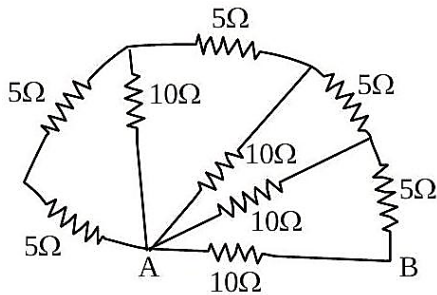


- (a) $2\mu\text{F}$ (b) $32\mu\text{F}$
 (c) $6\mu\text{F}$ (d) $8\mu\text{F}$

10. Sixty- four conducting drops each of radius 0.02 m and each carrying a charge of $5\mu\text{C}$ are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be:

- (a) 1: 4 (b) 4: 1
 (c) 1: 8 (d) 8: 1

11. The equivalent resistance between points A and B in the given network is :

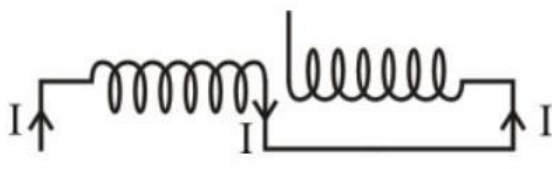


- (a) 65Ω (b) 20Ω
(c) 5Ω (d) 2Ω

12. A bar magnet having a magnetic moment of $2.0 \times 10^5 \text{ JT}^{-1}$, is placed along the direction of uniform magnetic field of magnitude $B = 14 \times 10^{-5} \text{ T}$. The work done in rotating the magnet slowly through 60° from the direction of field is:

- (a) 14 J (b) 8.4 J
(c) 4 J (d) 1.4 J

13. Two coils of self-inductance L_1 and L_2 are connected in series combination having mutual inductance of the coils as M . The equivalent self inductance of the combination will be:



- (a) $\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{M}$ (b) $L_1 + L_2 + M$
(c) $L_1 + L_2 + 2M$ (d) $L_1 + L_2 - 2M$

14. A metallic conductor of length 1 m rotates in a vertical plane parallel to east-west direction about one of its end with angular velocity 5 rad/s . If the horizontal component of earth's magnetic field is $0.2 \times 10^{-4} \text{ T}$, then emf induced between the two ends of the conductor is:

- (a) $5\mu\text{V}$ (b) $50\mu\text{V}$
(c) 5mV (d) 50mV

15. Which is the correct ascending order of wavelengths?

- (a) $\lambda_{\text{visible}} < \lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{microwave}}$
(b) $\lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$
(c) $\lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$
(d) $\lambda_{\text{microwave}} < \lambda_{\text{visible}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}}$

16. For a specific wavelength 670 nm of light coming from a galaxy moving with velocity v , the observed wavelength is 670.7 nm.

The value of v is :

- (a) $3 \times 10^8 \text{ ms}^{-1}$ (b) $3 \times 10^{10} \text{ ms}^{-1}$
(c) $3.13 \times 10^5 \text{ ms}^{-1}$ (d) $4.48 \times 10^5 \text{ ms}^{-1}$

17. A metal surface is illuminated by a radiation of wavelength $4500\text{\AA}$. The ejected photo-electron enters a constant magnetic field of 2mT making an angle of 90° with the magnetic field. If it starts revolving in a circular path of radius 2 mm, the work function of the metal is approximately:

- (a) 1.36eV (b) 1.69eV
(c) 2.78eV (d) 2.23eV

18. A radioactive nucleus can decay by two different processes. Half-life for the first process is 3.0 hours while it is 4.5 hours for the second process.

The effective half- life of the nucleus will be:

- (a) 3.75 hours (b) 0.56 hours
(c) 0.26 hours (d) 1.80 hours

19. The positive feedback is required by an amplifier to act an oscillator. The feedback here means:

- (a) External input is necessary to sustain ac signal in output.
(b) A portion of the output power is returned back to the input.
(c) Feedback can be achieved by LR network.
(d) The base-collector junction must be forward biased.

20. A sinusoidal wave $y(t) = 40\sin(10 \times 10^6\pi t)$ is amplitude modulated by another sinusoidal wave $x(t) = 20\sin(1000\pi t)$. The amplitude of minimum frequency component of modulated signal is:

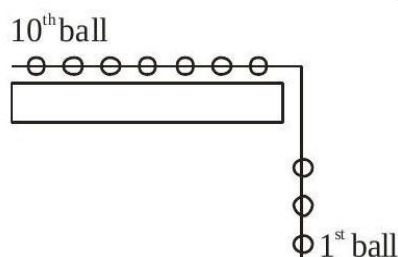
- (a) 0.5 (b) 0.25
(c) 20 (d) 10

SECTION-B

21. A ball is projected vertically upward with an initial velocity of 50 ms^{-1} at $t = 0 \text{ s}$. At $t = 2 \text{ s}$, another ball is projected vertically upward with same velocity. At $t = s$, second ball will meet the first ball ($g = 10 \text{ ms}^{-2}$).

22. A batsman hits back a ball of mass 0.4 kg straight in the direction of the bowler without changing its initial speed of 15 ms^{-1} . The impulse imparted to the ball is Ns .

23. A system to 10 balls each of mass 2 kg are connected via massless and unstretchable string. The system is allowed to slip over the edge of a smooth table as shown in figure. Tension on the string between the 7th and 8th ball is N when 6th ball just leaves the table



24. A geyser heats water flowing at a rate of $2.0 \text{ kg per minute}$ from 30°C to 70°C . If geyser operates on a gas burner, the rate of combustion of fuel will be gmin^{-1} [Heat of combustion = $8 \times 10^3 \text{ Jg}^{-1}$ Specific heat of water = $4.2 \text{ Jg}^{-1} \text{ }^\circ\text{C}^{-1}$]

25. A heat engine operates with the cold reservoir at temperature 324 K .

The minimum temperature of the hot reservoir, if the heat engine takes 300 J heat from the hot reservoir and delivers 180 J heat to the cold reservoir per cycle, is K .

26. A set of 20 tuning forks is arranged in a series of increasing frequencies. If each fork gives 4 beats with respect to the preceding fork and the frequency of the last fork is twice the frequency of the first, then the frequency of last fork is Hz .

27. Two 10 cm long, straight wires, each carrying a current of 5 A are kept parallel to each other. If each wire experienced a force of 10^{-5} N, then separation between the wires is cm.
28. A small bulb is placed at the bottom of a tank containing water to a depth of $\sqrt{7}$ m. The refractive index of water is $\frac{4}{3}$. The area of the surface of water through which light from the bulb can emerge out is $x\pi\text{m}^2$. The value of x is
29. A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is $\times 10^{-6}$ m.
30. The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength $6630\text{\AA}$ is 0.42 V. If the threshold frequency is $x \times 10^{13}/\text{s}$, where x is (nearest integer). (Given, speed light = 3×10^8 m/s, Planck's constant = $6.63 \times 10^{-34}\text{Js}$)

PART-II CHEMISTRY

SECTION-A

31. The number of radial and angular nodes in 4 d orbital are. respectively
 (a) 1 and 2 (b) 3 and 2
 (c) 1 and 0 (d) 2 and 1
32. Match List I with List II.

List I	List II
Enzyme	Conversion of
A. Invertase	I. Starch into maltose
B. Zymase	II. Maltose into glucose
C. Diastase	III. Glucose into ethanol
D. Maltase	IV. Cane sugar into glucose

Choose the most appropriate answer from the options given below:

- (a) A-III, B-IV. C-II. D-I (b) A-III. B-II. C-I. D-IV
 (c) A-IV, B-III. C-I. D-II (d) A-IV, B-II. C-III. D-I

33. Which of the following elements is considered as a metalloid?

- (a) Sc (b) Pb
 (c) Bi (d) Te

34. The role of depressants in Froth Flotation method* is to

- (a) selectively prevent one component of the ore from coming to the froth.
 (b) reduce the consumption of oil for froth formation.
 (c) stabilize the froth.
 (d) enhance non-wettability of the mineral particles.

35. Boiling of hard water is helpful in removing the temporary hardness by converting calcium hydrogen carbonate and magnesium hydrogen carbonate to

- (a) CaCO_3 and Mg(OH)_2 (b) CaCO_3 and M_2CO_3
(c) Ca(OH)_2 and MgCO_3 (d) Ca(OH)_2 and Mg(OH)_2

36. s-block element which cannot be qualitatively confirmed by the flame test is

- (a) Li (b) Na
(c) Rb (d) Be

37. The oxide which contains an odd electron at the nitrogen atom is

- (a) N_2O (b) NO_2
(c) N_2O_3 (d) N_2O_5

38. Which one of the following is an example of disproportionation reaction?

- (a) $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$
(b) $\text{MnO}_4^{2-} + 4\text{H}^+ + 4\text{e}^- \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$
(c) $10\text{I}^- + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{I}_2$
(d) $8\text{MnO}_4^- + 3\text{S}_2\text{O}_3^{2-} + \text{H}_2\text{O} \rightarrow 8\text{MnO}_2 + 6\text{SO}_4^{2-} + 2\text{OH}^-$

39. The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?

- (a) Ce (At. No. 58) (b) La (At. No. 57)
(c) Lu (At. No. 71) (d) Gd (At. No. 64)

40. The measured BOD values for four different water samples (A-D) are as follows:

A = 3ppm: B = 18ppm: C = 21ppm: D = 4ppm. The water samples which can be called as highly polluted with organic wastes, are

- (a) A and B (b) A and D
(c) B and C (d) B and D

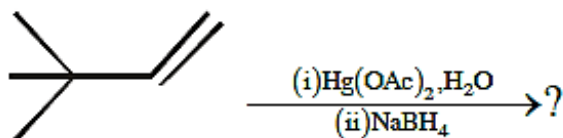
41. The correct order of nucleophilicity is

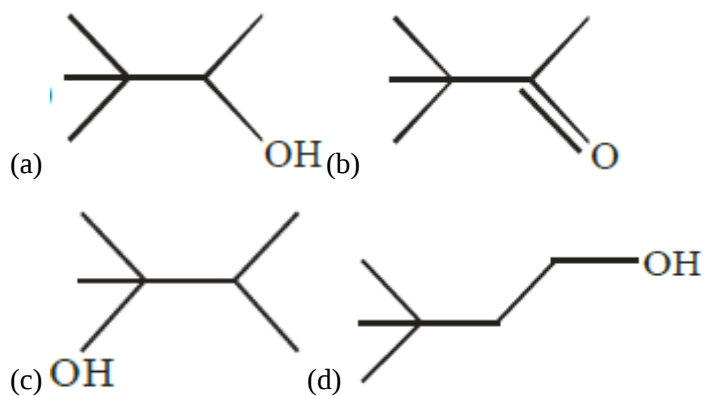
- (a) $\text{F}^- > \text{OH}^-$ (b) $\text{H}_2\ddot{\text{O}} > \text{OH}^-$
(c) $\text{ROH} > \text{RO}^-$ (d) $\text{NH}_2^- > \text{NH}_3$

42. Oxidation of toluene to Benzaldehyde can be easily carried out with which of the following reagents?

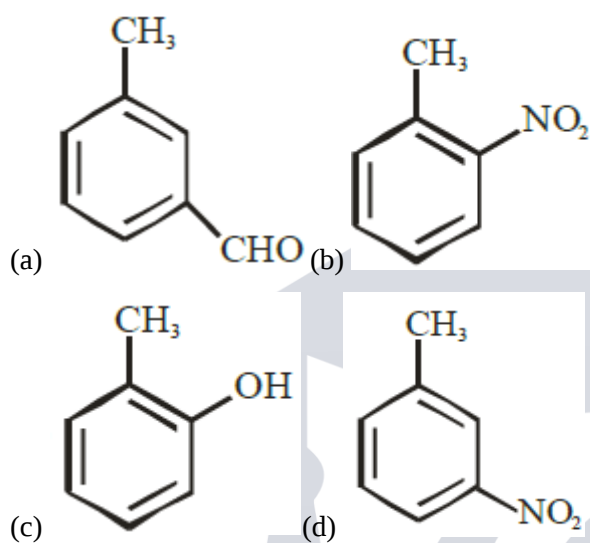
- (a) CrO_3 /acetic acid, H_3O^+
(b) CrO_3 /acetic anhydride, H_3O^+
(c) KMnO_4/HCl , H_3O^+
(d) CO/HCl , anhydrous AlCl_3

43. The major product in the following reaction

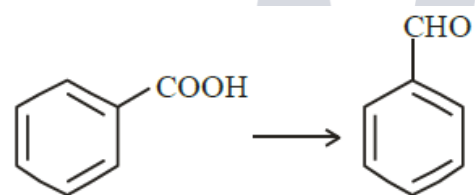




44. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?

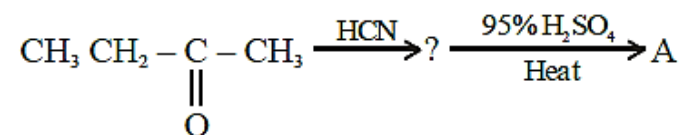


45. The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is



- (a) LiAlH_4 (b) KMnO_4
(c) MnO (d) NaBH_4

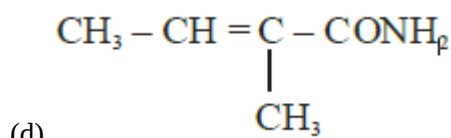
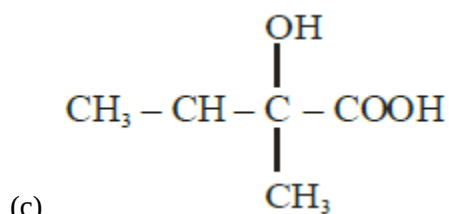
46. The final product 'A' in the following reaction sequence



- (a)
$$\text{CH}_3 - \text{CH} = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{COOH}$$

$$\text{CH}_3 - \text{CH} = \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{CN}$$

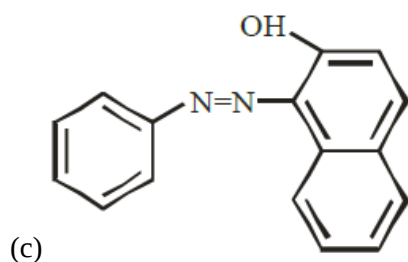
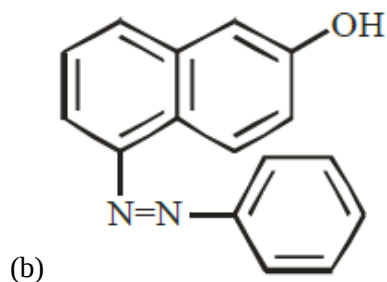
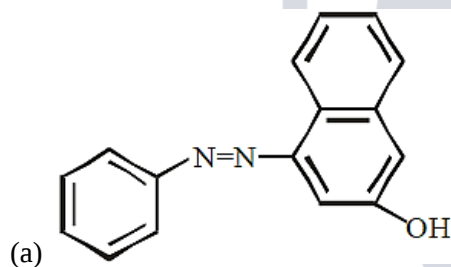
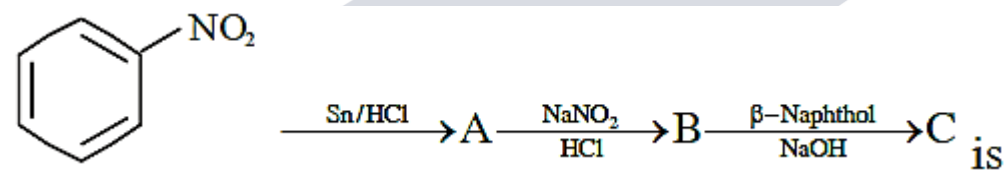
(b)



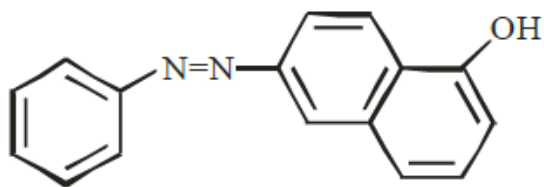
47. Which statement is NOT correct for p-toluenesulphonyl chloride?

- (a) It is known as Hinsberg's reagent.
- (b) It is used to distinguish primary and secondary amines.
- (c) On treatment with secondary amine, it leads to a product, that is soluble in alkali.
- (d) It doesn't react with tertiary amines.

48. The final product 'C' is the following series series of reactions

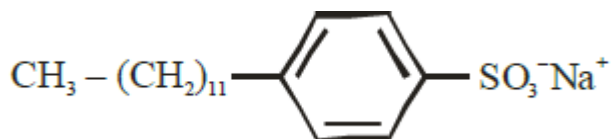


(d)

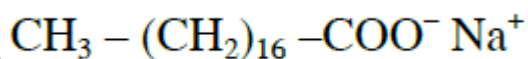


49. Which of the following is NOT an example of synthetic detergent?

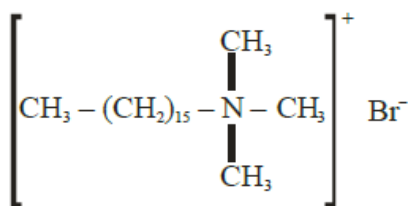
(a)



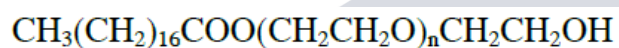
(b)



(c)



(d)



50. Which one of the following is a water-soluble vitamin, that is not excreted easily?

(a) Vitamin B₂

(b) Vitamin B₁

(c) Vitamin B₆

(d) Vitamin B₁₂

SECTION-B

51. CNG is an important transportation fuel. When 100 g CNG is mixed with 208 oxygen in vehicles, it leads to the formation of CO₂ and H₂O and produces large quantity of heat during this combustion, then the amount of carbon dioxide, produced in grams is [nearest integer] [Assume CNG to be methane]

52. In a solid AB. A atoms are in ccp arrangement and B atoms occupy all the octahedral sites. If two atoms from the opposite faces are removed, then the resultant stoichiometry of the compound is A_xB_y. The value of x is [nearest integer]

53. Amongst SF₄, XeF₄, CF₄ and H₂O, the number of species with two lone pairs of electrons

54. A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36 g. When it is subjected to cooking at 100°C, then the internal energy for vaporization in kJmol⁻¹ is [nearest integer]

[Assume steam to be an ideal gas. Given A_{vap}H[⊖] for water at 373 K and 1 bar is 41.1 kJ mol⁻¹; R = 8.31 JK⁻¹ mol⁻¹]

55. The osmotic pressure exerted by a solution prepared by dissolving 2.0 g of protein of molar mass 60 kg mol⁻¹ in 200 mL of water at 27°C is Pa. [integer value] (use R = 0.083 Lbarmol⁻¹ K⁻¹)

56. 40° of HI undergoes decomposition to H₂ and I₂ at 300 K. ΔG[⊖] for this decomposition reaction at one atmosphere pressure is Jmol⁻¹. [nearest integer] (Use R = 8.31 J K⁻¹ mol⁻¹; log 2 = 0.3010. ln 10 = 2.3, log 3 = 0.477)

57. Cu(s) + Sn²⁺(0.001M) → Cu²⁺(0.01M) + Sn(s)

The Gibbs free energy change for the above reaction at 298 K is $\times \times 10^{-1} \text{ kJ mol}^{-1}$;

The value of x is . [nearest integer]

[Given: $E_{\text{Cu}^{2+}/\text{Cu}}^{\ominus} = 0.34 \text{ V}$; $E_{\text{Sn}^{2+}/\text{Sn}}^{\ominus} = -0.14 \text{ V}$; $F = 96500 \text{ Cmol}^{-1}$]

58. Catalyst A reduces the activation energy for a reaction by 10 kJ mol^{-1} at 300 K. The ratio of rate

constants, $\frac{k_{\text{T, Catalysed}}}{k_{\text{T, Uncatalysed}}}$ is e^x . The value of x is

[nearest integer]

[Assume that the pre-exponential factor is same in both the cases.

Given $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$]

59. Reaction of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in t_{2g} -orbitals of the product is

60. The moles of methane required to produce 81 g of water after complete combustion is $\times 10^{-2} \text{ mol}$. [nearest integer]

PART-III MATHEMATICS

SECTION-A

61. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be defined as $f(x) = x - 1$ and $g: \mathbb{R} - \{1, -1\} \rightarrow \mathbb{R}$ be defined as $g(x) = \frac{x^2}{x^2 - 1}$.

Then the function fg is:

- (a) one-one but not onto function
- (b) onto but not one-one function
- (c) both one-one and onto function
- (d) neither one-one nor onto function

62. If the system of equations $\alpha x + y + z = 5$, $x + 2y + 3z = 4$, $x + 3y + 5z = \beta$, has infinitely many solutions, then the ordered pair (α, β) is equal to:

- (a) $(1, -3)$
- (b) $(-1, 3)$
- (c) $(1, 3)$
- (d) $(-1, -3)$

63. If $A = \sum_{n=1}^{\infty} \frac{1}{(3+(-1)^n)^n}$ and $B = \sum_{n=1}^{\infty} \frac{(-1)^n}{(3+(-1)^n)^n}$, then $\frac{A}{B}$ is equal to :

- (a) $\frac{11}{9}$
- (b) 1
- (c) $-\frac{11}{9}$
- (d) $-\frac{11}{3}$

64. $\lim_{x \rightarrow 0} \frac{\cos(\sin x) - \cos x}{x^4}$ is equal to:

- (a) $\frac{1}{3}$ (b) $\frac{1}{4}$
(c) $\frac{1}{6}$ (d) $\frac{1}{12}$

65. Let $f(x) = \min\{1, 1 + x \sin x\}$, $0 \leq x \leq 2\pi$. If m is the number of points, where f is not differentiable and n is the number of points, where f is not continuous, then the ordered pair (m, n) is equal to

- (a) (2, 0) (b) (1, 0)
(c) (1, 1) (d) (2, 1)

66. Consider a cuboid of sides $2x$, $4x$ and $5x$ and a closed hemisphere of radius r . If the sum of their surface areas is a constant k , then the ratio $x : r$, for which the sum of their volumes is maximum, is:

- (a) 2 : 5 (b) 19 : 45
(c) 3 : 8 (d) 19 : 15

67. The area of the region bounded by $y^2 = 8x$ and $y^2 = 16(3 - x)$ is equal to:-

- (a) $\frac{32}{3}$ (b) $\frac{40}{3}$
(c) 16 (d) 19

68. If $\int \frac{1}{x} \sqrt{\frac{1-x}{1+x}} dx = g(x) + c$, $g(1) = 0$, then $g\left(\frac{1}{2}\right)$ is equal to :

- (a) $\log_e \left(\frac{\sqrt{3}-1}{\sqrt{3}+1} \right) + \frac{\pi}{3}$ (b) $\log_e \left(\frac{\sqrt{3}+1}{\sqrt{3}-1} \right) + \frac{\pi}{3}$
(c) $\log_e \left(\frac{\sqrt{3}+1}{\sqrt{3}-1} \right) - \frac{\pi}{3}$ (d) $\frac{1}{2} \log_e \left(\frac{\sqrt{3}-1}{\sqrt{3}+1} \right) - \frac{\pi}{6}$

69. If $y = y(x)$ is the solution of the differential equation $x \frac{dy}{dx} + 2y = x^x$, $y(1) = 0$ then the local maximum value of the function $z(x) = x^2 y(x) - e^x$, $x \in \mathbb{R}$ is:

- (a) $1 - e$ (b) 0
(c) $\frac{1}{2}$ (d) $\frac{4}{e} - e$

70. If the solution of the differential equation

$$\frac{dy}{dx} + e^x(x^2 - 2)y = (x^2 - 2x)(x^2 - 2)e^{2x} \text{ satisfies}$$

$y(0) = 0$, then the value of $y(2)$ is

- (a) -1 (b) 1
(c) 0 (d) e

71. If m is the slope of a common tangent to the curves $\frac{x^2}{16} + \frac{y^2}{9} = 1$ and $x^2 + y^2 = 12$, then $12m^2$ is equal to :

- (a) 6 (b) 9
(c) 10 (d) 12

72. The locus of the mid-point of the line segment joining the point $(4, 3)$ and the points on the ellipse $x^2 + 2y^2 = 4$ is an ellipse with eccentricity:

- (a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{2\sqrt{2}}$
(c) $\frac{1}{\sqrt{2}}$ (d) $\frac{1}{2}$

73. The normal to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{9} = 1$ at the point $(8, 3\sqrt{3})$ on it passes through the point :

- (a) $(15, -2\sqrt{3})$ (b) $(9, 2\sqrt{3})$
(c) $(-1, 9\sqrt{3})$ (d) $(-1, 6\sqrt{3})$

74. If the plane $2x + y - 5z = 0$ is rotated about its line of intersection with the plane $3x - y + 4z - 7 = 0$ by an angle of $\frac{\pi}{2}$, then the plane after the rotation passes through the point :

- (a) $(2, -2, 0)$ (b) $(-2, 2, 0)$
(c) $(1, 0, 2)$ (d) $(-1, 0, -2)$

75. If the lines $\vec{r} = (\hat{i} - \hat{j} + \hat{k}) + \lambda(3\hat{j} - \hat{k})$ and $\vec{r} = (\alpha\hat{i} - \hat{j}) + \mu(2\hat{i} - 3\hat{k})$ are co-planar, then distance of the plane containing these two lines from the point $(\cdot, 0, 0)$ is :

- (a) $\frac{2}{9}$ (b) $\frac{2}{11}$
(c) $\frac{4}{11}$ (d) 2

76. Let $\vec{a} = \hat{i} + \hat{j} + 2\hat{k}$, $\vec{b} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} + \hat{k}$ be three given vectors. Let $\vec{v}$ be a vector in the plane of $\vec{a}$ and $\vec{b}$ whose projection on $\vec{c}$ is $\frac{2}{\sqrt{3}}$. If $\vec{v} \cdot \hat{j} = 7$, then $\vec{v} \cdot (\hat{i} + \hat{k})$ is equal to:

- (a) 6 (b) 7
(c) 8 (d) 9

77. The mean and standard deviation of 50 observations are 15 and 2 respectively. It was found that one incorrect observation was taken such that the sum of correct and incorrect observations is 70. If the correct mean is 16, then the correct variance is equal to:

- (a) 10 (b) 36
(c) 43 (d) 60

78. $16\sin(20^\circ)\sin(40^\circ)\sin(80^\circ)$ is equal to:

- (a) $\sqrt{3}$ (b) $2\sqrt{3}$
(c) 3 (d) $4\sqrt{3}$

79. If the inverse trigonometric functions take principal values, then $\cos^{-1}\left(\frac{3}{10}\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right) + \frac{2}{5}\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)\right)$ is equal to :

- (a) 0 (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{6}$

80. Let $r \in \{p, q, \sim p, \sim q\}$ be such that the logical statement $r \vee (\sim p) \Rightarrow (p \wedge q) \vee r$ is a tautology. Then 'r' is equal to:

- (a) p (b) q
(c) $\sim p$ (d) $\sim q$

SECTION-B

81. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ satisfy $f(x+y) = 2^x f(y) + 4^y f(x)$, $\forall x, y \in \mathbb{R}$. If $f(2) = 3$, then $14 \cdot \frac{f'(4)}{f'(2)}$ is equal to

82. Let p and q be two real numbers such that $p+q=3$ and $p^4+q^4=369$. Then $\left(\frac{1}{p} + \frac{1}{q}\right)^{-2}$ is equal to

83. Let $X = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$, $Y = \alpha I + \beta X + \gamma X^2$ and $Z = \alpha^2 I - \alpha \beta X + (\beta^2 - \alpha \gamma) X^2$, $\alpha, \beta, \gamma \in \mathbb{R}$. If $Y^{-1} = \begin{bmatrix} \frac{1}{5} & \frac{-2}{5} & \frac{1}{5} \\ 0 & \frac{1}{5} & \frac{-2}{5} \\ 0 & 0 & \frac{1}{5} \end{bmatrix}$, then $(\alpha - \beta + \gamma)^2$ is equal to

84. The total number of 3-digit numbers, whose greatest common divisor with 36 is 2, is

85. If $({}^{40}C_0) + ({}^{41}C_1) + ({}^{42}C_2) + \dots + ({}^{60}C_{20}) = \frac{m}{n} {}^{60}C_{20}$, m and n are coprime, then m + n is equal to

86. If $a_1(>0)$, a_2, a_3, a_4, a_5 are in a G.P., $a_2 + a_4 = 2a_3 + 1$ and $3a_2 + a_3 = 2a_4$, then $a_2 + a_4 + 2a_5$ is equal to

87. The integral $\frac{24}{\pi} \int_0^{\sqrt{2}} \frac{(2-x^2)dx}{(2+x^2)\sqrt{4+x^4}}$ is equal to

88. Let a line L_1 be tangent to the hyperbola $\frac{x^2}{16} - \frac{y^2}{4} = 1$ and let L_2 be the line passing through the origin and perpendicular to L_1 . If the locus of the point of intersection of L_1 and L_2 is $(x^2 + y^2)^2 = \alpha x^2 + \beta y^2$, then $\alpha + \beta$ is equal to
89. If the probability that a randomly chosen 6-digit number formed by using digits 1 and 8 only is a multiple of 21 is p , then $96p$ is equal to
90. If $z^2 + z + 1 = 0, z \in \mathbb{C}$, then $\left| \sum_{n=1}^{15} \left(z^n + (-1)^n \frac{1}{z^n} \right)^2 \right|$ is equal to

