

Physics

1. Match the following physical quantities with their respective dimensional formulas.

(A)	Thermal conductivity	(I)	$MLT^{-3}K^{-1}$
(B)	Boltzman constant	(II)	$M^0L^2T^{-2}K^{-1}$
(C)	Latent heat	(III)	$ML^2T^{-2}K^{-1}$
(D)	Specific heat	(IV)	$M^0L^2T^{-2}$

(a) A-I, B-III, C-IV, D-II

(b) A-I, B-II, C-IV, D-III

(c) A-III, B-II, C-I, D-IV

(d) A-II, B-I, C-III, D-IV

2. An object is projected such that it has to attain maximum range, while another body is projected to reach maximum height. If both objects reached the same maximum height, then find the ratio of their initial velocities.

(a) 2:1 (b) $\sqrt{2}:1$

(c) $1:\sqrt{2}$ (d) 1:2

3. A ball is projected at an angle of 45° with the horizontal. It passes through a wall of height h at a horizontal distance d_1 from the point of projection and strikes the ground at a distance $d_1 + d_2$ from the point of projection, then h is:

(a) $\frac{2d_1d_2}{d_1+d_2}$ (b) $\frac{d_1d_2}{d_1+d_2}$

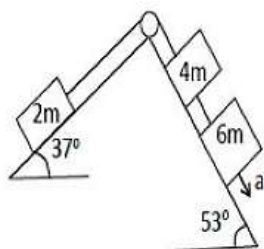
(c) $\frac{\sqrt{2}d_1d_2}{d_1+d_2}$ (d) $\frac{d_1d_2}{2(d_1+d_2)}$

4. One second after projection, a projectile is travelling in a direction inclined at 45° to horizontal. After two more seconds it is travelling horizontally. Then the magnitude of velocity of the projectile is ($g = 10 \text{ ms}^{-2}$):

(a) $10\sqrt{13} \text{ ms}^{-1}$ (b) 11 ms^{-1}

(c) $10\sqrt{2} \text{ ms}^{-1}$ (d) 20 ms^{-1}

5. Three blocks of masses 2 m, 4 m and 6 m are placed as shown in figure. If $\sin 37^\circ = \frac{3}{5}$, $\sin 53^\circ = \frac{4}{5}$, the acceleration of the system is:



(a) $\frac{17}{30}g$ (b) $\frac{13}{30}g$

(c) $\frac{13}{15}g$ (d) $\frac{15}{35}g$

6. Two masses m_1 and m_2 are connected by a light string passing over a smooth pulley. When set free, m_1 moves downwards by 3 m in 3 s. The ratio of $\frac{m_1}{m_2}$ is ($g = 10 \text{ m/s}^2$).

(a) $\frac{9}{7}$ (b) $\frac{8}{7}$

(c) $\frac{10}{7}$ (d) $\frac{15}{13}$

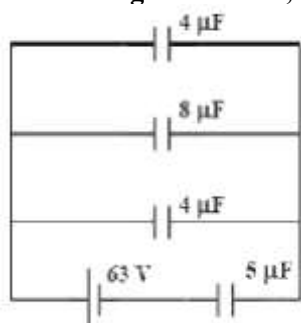
7. In an inelastic collision, after collision the kinetic energy

(a) increases by 2 times

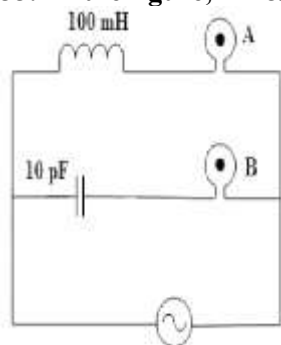
(b) is less than before collision

- (c) is more than before collision
(d) remains same
8. A spring of $5 \times 10^3 \text{ Nm}^{-1}$ spring constant is stretched initially by 10 cm from the unstretched position. The work required to stretch it further by another 10 cm is
(a) 75 N – m (b) 50 N – m
(c) 76 N – m (d) 82 N – m
9. The moments of inertia of a solid cylinder and a hollow cylinder of the same mass and same radius about the axes of the cylinders are I_1 and I_2 . The relation between I_1 and I_2 is
(a) $I_1 < I_2$ (b) $I_1 = I_2$
(c) $I_1 > I_2$ (d) $I_1 = I_2 = 0$
10. A wheel of angular speed 600rev/min is made to slow down at a rate of 2rad/s^2 . The number of revolutions made by the wheel before coming to rest is
(a) 157 (b) 314
(c) 177 (d) 117
11. Time period of a simple pendulum in air is T . If the pendulum is in water and executes SHM, its time period is t . The value of $\frac{T}{t}$ is
[Density of bob is $\frac{5000}{3} \text{ kg/m}^3$]
(a) $\frac{2}{5}$ (b) $\sqrt{\frac{2}{5}}$
(c) $\frac{5}{2}$ (d) $\sqrt{\frac{5}{2}}$
12. For a particle executing simple harmonic motion, match the following statements (conditions) from column I to statements (shapes of graph) in column II.
- | Column- I | | column -II | |
|-----------|---|------------|---------------|
| A | Velocity-displacement graph ($w = 1$) | I | Straight line |
| B | Acceleration-displacement graph | II | Sinusoidal |
| C | Acceleration - time graph | III | Circle |
| D | Acceleration - velocity ($w \neq 1$) | IV | Ellipse |
- (a) A-IV, B-I, C-II, D-III
(b) A-III, B-I, C-II, D-IV
(c) A-III, B-II, C-I, D-IV
(d) A-IV, B-II, C-I, D-III
13. Two satellites of masses m and $1.5 m$ are revolving around the Earth with different speeds in two circular orbits of heights R_E and $2R_E$ respectively, where R_E is the radius of the Earth. The ratio of the minimum and maximum gravitational forces on the Earth due to the two satellites is
(a) 2: 5 (b) 2: 3
(c) 1: 2 (d) 1: 5
14. Two copper wires A and B of lengths in the ratio 1: 2 and diameters in the ratio 3: 2 are stretched by forces in the ratio 3: 1. The ratio of the elastic potential energies stored per unit volume in the wires A and B is
(a) 2: 1 (b) 4: 9
(c) 16: 9 (d) 4: 3
15. 216 small identical liquid drops each of surface area A coalesce to form a bigger drop. If the surface tension of the liquid is T , the energy released in the process is
(a) 360 AT (b) 180 AT
(c) 90 AT (d) 120AT

16. The length of a metal bar is 20 cm and the area of cross-section is $4 \times 10^{-4} \text{ m}^2$. If one end of the rod is kept in ice at 0°C and the other end is kept in steam at 100°C , the mass of ice melted in one minute is 5g. The thermal conductivity of the metal in $\text{Wm}^{-1}\text{K}^{-1}$ is (Latent heat of fusion = 80 cal/gm)
 (a) 140 (b) 120
 (c) 100 (d) 160
17. The work done by an ideal gas of 2 moles in increasing its volume from V to $2V$ at constant temperature T is W . The work done by an ideal gas of 4 moles in increasing its volume from V to $8V$ at constant temperature $\frac{T}{2}$ is
 (a) W (b) $2W$
 (c) $3W$ (d) $4W$
18. When 40 J of heat is absorbed by a monatomic gas, the increase in the internal energy of the gas is
 (a) 12 J (b) 16 J
 (c) 24 J (d) 32 J
19. In a Carnot engine, the absolute temperature of the source is 25% more than the absolute temperature of the sink. The efficiency of the engine is
 (a) 10% (b) 50%
 (c) 25% (d) 20%
20. The molar specific heat capacity of a diatomic gas at constant pressure is C . The molar specific heat capacity of a monatomic gas at constant volume is
 (a) $\frac{2C}{7}$ (b) $\frac{3C}{7}$
 (c) $\frac{C}{7}$ (d) $\frac{4C}{7}$
21. Two stretched strings A and B when vibrated together produce 4 beats per second. If the tension applied to string A increased, the number of beats produced per second is increased to 7. If the frequency of string B is 480 Hz initially, the frequency of string A is
 (a) 473 Hz (b) 476 Hz
 (c) 484 Hz (d) 487 Hz
22. The focal length of a thin converging lens in air is 20 cm. When the lens is immersed in a liquid, it behaves like a concave lens of power 1 D. If the refractive index of the material of the lens is 1.5, the refractive index of the liquid is
 (a) $\frac{5}{3}$ (b) $\frac{4}{3}$
 (c) $\frac{5}{4}$ (d) $\frac{7}{4}$
23. In Young's double-slit experiment with monochromatic light of wavelength $6000 \text{ \AA}$, the fringe width is 3 mm . If the distance between the screen and slits is increased by 50% and the distance between the slits is decreased by 10%, then the fringe width is
 (a) 12 mm (b) 5 mm
 (c) 6 mm (d) 10 mm
24. Two point charges $+6\mu\text{C}$ and $+10\mu\text{C}$ kept at a certain distance repel each other with a force of 30 N . If each charge is given an additional charge of $-8\mu\text{C}$, the two charges
 (a) Attract with a force of 2 N
 (b) Repel with a force of 2 N
 (c) Attract with a force of 15 N
 (d) Repel with a force of 15 N
25. In the given circuit, the potential difference across the $5\mu\text{F}$ capacitor is



- (a) 48 V (b) 24 V
(c) 63 V (d) 21 V
26. In a region, the electric field is $(30\hat{i} + 40\hat{j})\text{NC}^{-1}$. If the electric potential at the origin is zero, the electric potential at the point (1 m, 2 m) is
(a) -60 V (b) -75 V
(c) -55 V (d) -110 V
27. In a potentiometer, the area of cross-section of the wire is 4 cm^2 , the current flowing in the circuit is 1 A , and the potential gradient is 7.5Vm^{-1} . Then the resistivity of the potentiometer wire is
(a) $3 \times 10^{-3}\Omega\text{ m}$ (b) $2 \times 10^{-6}\Omega\text{ m}$
(c) $2 \times 10^{-2}\Omega\text{ m}$ (d) $5 \times 10^{-4}\Omega\text{ m}$
28. Drift speed v varies with the intensity of the electric field E as per the relation
(a) $v \propto E$ (b) $v \propto \frac{1}{E}$
(c) $v \propto E^2$ (d) $v \propto E^{-2}$
29. A current-carrying coil experiences a torque due to a magnetic field. The value of the torque is 80% of the maximum possible torque. The angle between the magnetic field and the normal to the plane of the coil is
(a) 30° (b) 45°
(c) $\tan^{-1}\left(\frac{3}{4}\right)$ (d) $\tan^{-1}\left(\frac{4}{3}\right)$
30. An electron is moving with a velocity $(2\hat{i} + 3\hat{j})\text{ m/s}$ in an electric field $(3\hat{i} + 6\hat{j} + 2\hat{k})\text{ V/m}$ and a magnetic field $(2\hat{j} + 3\hat{k})\text{ T}$. The magnitude and direction (with x-axis) of the Lorentz force acting on the electron is
(a) $9.6 \times 10^{-19}\text{ N}, \theta = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$
(b) $9.6 \times 10^{-19}\text{ N}, \theta = \cos^{-1}\left(\frac{5}{\sqrt{2}}\right)$
(c) $2.15 \times 10^{-18}\text{ N}, \theta = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$
(d) $2.15 \times 10^{-18}\text{ N}, \theta = \cos^{-1}\left(\frac{5}{\sqrt{2}}\right)$
31. A magnet suspended in a uniform magnetic field is heated so as to reduce its magnetic moment by 19%. By doing this, the time period of the magnet approximately
(a) Increases by 11% (b) Decreases by 19%
(c) Increases by 19% (d) Decreases by 4%
32. If the current through an inductor increases from 2 A to 3 A , the magnetic energy stored in the inductor increases by
(a) 125% (b) 225%
(c) 50% (d) 75%
33. In the figure, if A&B are identical bulbs, which bulb glows brighter?

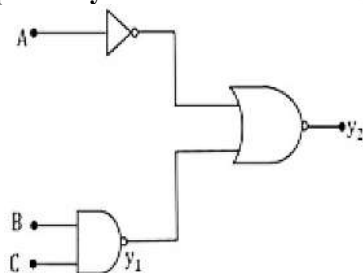


- (a) A
(b) B
(c) Both with equal brightness
(d) Both do not glow

34. The Solar Radiation is

- (a) Stationary wave
(b) Mechanical wave
(c) Transverse EM wave
(d) Longitudinal EM wave

35. Energy required to remove an electron from an aluminium surface is 4.2 eV . If light of wavelength 2000 Å falls on the surface, the velocity of the fastest electron ejected from the surface will be
 (a) $8.4 \times 10^5 \text{ ms}^{-1}$ (b) $7.4 \times 10^5 \text{ ms}^{-1}$
 (c) $6.4 \times 10^5 \text{ ms}^{-1}$ (d) $8.4 \times 10^6 \text{ ms}^{-1}$
36. If the bonding energy of the electron in a hydrogen atom is 13.6 eV , then the energy required to remove an electron from the first excited state of Li^{2+} is
 (a) 122.4 eV (b) 3.4 eV
 (c) 13.6 eV (d) 30.6 eV
37. A mixture consists of two radioactive materials A_1 and A_2 with half-lives of 20 s and 10 s respectively. Initially, the mixture has 40 g of A_1 and 160 g of A_2 . The amount of the two in the mixture will become equal after
 (a) 60 s (b) 80 s
 (c) 20 s (d) 40 s
38. If n_e and n_h are concentrations of electrons and holes in a semiconductor, then the intrinsic carrier concentration (n_i) in thermal equilibrium is
 (a) $n_i = \frac{\sqrt{n_e}}{n_h}$ (b) $n_i = \frac{n_h}{n_e}$
 (c) $n_i = \sqrt{n_e n_h}$ (d) $n_i = n_e + n_h$
39. In the given digital circuit, if the inputs are $A = 1, B = 1$ and $C = 1$, then the values of y_1 and y_2 are respectively



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

40. If the maximum and minimum voltages of an A.M wave are $V_{\max}$ and $V_{\min}$ respectively, then the modulation factor 'm' is
 (a) $\frac{V_{\max} + V_{\min}}{V_{\max} - V_{\min}}$ (b) $\frac{V_{\max} - V_{\min}}{V_{\max} + V_{\min}}$
 (c) $\frac{2V_{\max} V_{\min}}{V_{\max} + V_{\min}}$ (d) $\frac{V_{\max} + V_{\min}}{V_{\max} - V_{\min}}$

Chemistry

41. The de Broglie wavelength of a particle of mass 1 mg moving with a velocity of 10 ms^{-1} is ($h = 6.63 \times 10^{-34} \text{ Js}$)
 (a) $6.63 \times 10^{-29} \text{ m}$ (b) $6.63 \times 10^{-31} \text{ m}$
 (c) $6.63 \times 10^{-34} \text{ m}$ (d) $6.63 \times 10^{-22} \text{ m}$
42. Correct set of four quantum numbers for the valence electron of strontium ($Z = 38$) is
 (a) $5, 0, 0, +\frac{1}{2}$ (b) $5, 1, 0, +\frac{1}{2}$
 (c) $5, 1, 1, +\frac{1}{2}$ (d) $6, 0, 0, +\frac{1}{2}$

43. Match the following:

List I Element		List II Electron gain enthalpy (in kJ mol^{-1})	
A	F	I	-141
B	Cl	II	-328
C	O	III	-200

D	S	IV	-349
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- (a) A-II, B-IV, C-I, D-III
 (b) A-IV, B-II, C-I, D-III
 (c) A-III, B-IV, C-IV, D-I
 (d) A-III, B-III, C-IV, D-I

44. The bond lengths of diatomic molecules of elements X, Y, and Z respectively are 143, 110, and 121 pm. The atomic numbers of X, Y, and Z respectively are:

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

45. The correct formula used to determine the formal charge (Q_f) on an atom in the given Lewis structure of a molecule or ion is

(V = number of valence electrons in free atom, U = number of unshared electrons on the atom, B = number of bonds around the atom)

- (a) $Q_f = V - \left(\frac{U}{B}\right)$
 (b) $Q_f = V + (U - B)$
 (c) $Q_f = V - (U + B)$
 (d) $Q_f = V - \left(\frac{B}{U}\right)$

46. RMS velocity of one mole of an ideal gas was measured at different temperatures. A graph of $(u_{rms})^2$ (on y-axis) and T/K (on x-axis) gave a straight line passing through the origin, and its slope is $249 \text{ m}^2 \text{ s}^{-2} \text{ K}^{-1}$. What is the molar mass (in kg mol^{-1}) of the ideal gas?

($R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$)

- (a) 10 (b) 1.0
 (c) 24.9 (d) 1×10^{-1}

47. Given below are two statements:

Statement I: Viscosity of liquid decreases with an increase in temperature.

Statement II: The units of viscosity are $\text{kg m}^{-1} \text{ s}^{-2}$.

The correct answer is:

- (a) Both Statement I and Statement II are correct
 (b) Both Statement I and Statement II are not correct
 (c) Statement I is correct, but Statement II is not correct
 (d) Statement I is not correct, but Statement II is correct

48. A hydrocarbon containing C and H has 92.3% C. When 39 g of hydrocarbon was completely burnt in O_2 , x moles of water and y moles of CO_2 were formed. x moles of water is sufficient to liberate 0.75 moles of H_2 with Na metal. What is the weight (in g) of oxygen consumed?

($C = 12 \text{ u}, H = 1 \text{ u}$)

- (a) 120 (b) 240
 (c) 360 (d) 480

49. At 300 K, for the reaction $A \rightarrow P$, the ΔS_{sys} is $5 \text{ J K}^{-1} \text{ mol}^{-1}$. What is the heat absorbed (in kJ mol^{-1}) by the system?

- (a) 1.5 (b) 15
 (c) 1500 (d) 0.6

50. Identify the incorrect statements from the following:

I. $\Delta S_{system} = (\Delta S_{total} + \Delta S_{sur})$

II. $A(l) \rightarrow A(s)$; for this process entropy change decreases

III. Entropy units are $\text{J K}^{-1} \text{ mol}^{-1}$

- (a) I, III only (b) I, II only
 (c) I, II, III (d) II, III only

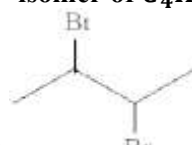
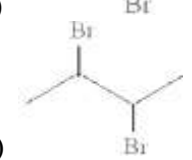
51. At temperature $T(K)$, the equilibrium constant K_c for the reaction:

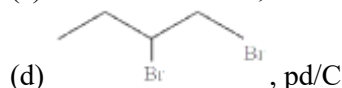
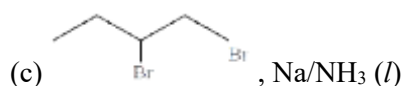
$A_2(g) \rightleftharpoons B_2(g)$ is 99.0. Two moles of $A_2(g)$ were heated in a 1 L closed flask to reach equilibrium. What are the equilibrium concentrations (in mol L^{-1}) of $A_2(g)$ and $B_2(g)$?

- (a) 1.86, 0.0187 (b) 1.98, 0.02
(c) 0.0187, 1.86 (d) 0.02, 1.98
52. At 27°C, the degree of dissociation of weak acid (HA) in its 0.5 M aqueous solution is 1%. Its K_a value is approximately:
(a) 5×10^{-4} (b) 5×10^{-5}
(c) 5×10^{-6} (d) 5×10^{-8}
53. Aluminium carbide on reaction with D_2O gives $Al(OD)_3$ and 'X'. What is 'X' ?
(a) C_2D_2 (b) C_3D_4
(c) C_2D_4 (d) CD_4
54. Lithium forms an alloy with 'X'. This alloy is used to make armor plates. What is 'X' ?
(a) Mg (b) Pb
(c) Al (d) Cr
55. In which of the following reactions, dihydrogen is not evolved?
(a) Oxidation of sodium borohydride with iodine
(b) Hydrolysis of boranes
(c) Heating the adduct formed by the reaction of ammonia with diborane
(d) Burning of diborane in oxygen
56. Match the following bond enthalpies with their respective bonds:

List-I Bond		List-II Bond enthalpy (in kJmol^{-1})	
A	Si – Si	I	240
B	C – C	II	297
C	Sn – Sn	III	348
D	Ge – Ge	IV	260

- (a) A-II, B-III, C-I, D-IV
(b) A-II, B-IV, C-III, D-I
(c) A-III, B-I, C-I, D-IV
(d) A-III, B-I, C-IV, D-II
57. Arrange the following pesticides in the chronological order of their release into the market:
A: Organophosphates
B: Organochlorides
C: Sodium chlorate
(a) B, A, C (b) B, C, A
(c) C, B, A (d) A, B, C
58. From the following, identify the groups that exhibit negative resonance (-R) effect when attached to a conjugated system:
Formyl (A), Amino (B), Alkoxy (C), Cyano (D), Nitro (E)
(a) A, C, E only (b) B, C, D only
(c) A, D, E only (d) B, D, E only
59. A dibromide $X(C_4H_8Br_2)$ on dehydrohalogenation gave Y, which on reduction with Z gave a non-polar isomer of C_4H_8 . What are X and Z respectively?

- (a)  , Na/NH₃(l)
- (b)  , Pd/C



60. The diffraction pattern of a crystalline solid gave a peak at $2\theta = 60^\circ$. What is the distance (in cm) between the layers that gave this peak?

(Given: Wavelength $\lambda = 1.544 \text{ \AA}$, $\sin 30^\circ = 0.5$, $\sin 60^\circ = 0.866$, $n = 1$)

- (a) $8.89 \times 10^{-9} \text{ cm}$ (b) $8.89 \times 10^{-1} \text{ cm}$
(c) $1.54 \times 10^{-8} \text{ cm}$ (d) 1.54 cm

61. The concentration of 1 L of CaCO₃ solution is 1000 ppm. What is its concentration in mol L⁻¹?

(Ca = 40u, O = 16u, C = 12u)

- (a) 10^{-3} (b) 10^{-1}
(c) 10^{-4} (d) 10^{-2}

62. At 293 K, methane gas was passed into 1 L of water. The partial pressure of methane is 1 bar. The number of moles of methane dissolved in 1 L water is (K_H of methane = 0.4 kbar).

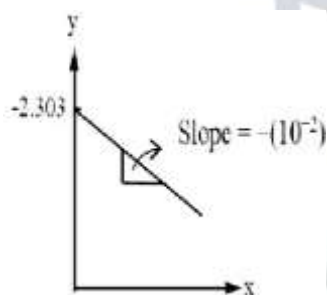
- (a) 1.38 (b) 1.38×10^{-2}
(c) 1.38×10^{-3} (d) 1.38×10^{-1}

63. The $E^\ominus$ of $M^{2+} | M$ is 0.3 V. At what concentration of Cu^{2+} (in mol L⁻¹), the E_{cell} value becomes zero?

$\left(\frac{2.303RT}{F} = 0.06\right)$ (Conc. of $M^{2+} = 0.1 M$).

- (a) 10^{-9} (b) 10^{-8}
(c) 10^{-11} (d) 10^{-10}

64. At 298 K, for a first order reaction ($A \rightarrow P$) the following graph is obtained. The rate constant (in s⁻¹) and initial concentration (in mol L⁻¹) of 'A' are respectively:



- (a) 2.303; 10^{-1} (b) 10^{-2} ; 2.303
(c) 10^{-1} ; 10^{-2} (d) 10^{-2} ; 10^{-1}

65. Given below are two statements:

Statement-I: Easily liquefiable gases are readily adsorbed.

Statement-II: Adsorption enthalpy for physisorption is less compared to adsorption enthalpy for chemisorption.

The correct answer is:

- (a) Both Statement-I and statement-II are correct
(b) Both Statement-I and statement-II are not correct
(c) Statement-I is correct but statement-II is not correct
(d) Statement-II is correct but statement-I is not correct

66. The validity of Freundlich isotherm can be verified by plotting:

- (a) $\log \frac{x}{m}$ on y-axis and $\log p$ on x-axis
(b) $\frac{x}{m}$ on y-axis and p on x-axis
(c) $\log \frac{x}{m}$ on x-axis and p on y-axis
(d) $\frac{x}{m}$ on x-axis and $\log p$ on y-axis

67. Which one of the following sets is not correctly matched?

- (a) Cuprite, haematite - oxide ores
(b) Calamine, siderite - carbonate ores
(c) Magnetite, malachite - silicate ores
(d) Sphalerite, fool's gold - sulphide ores

68. When chlorine reacts with hot and conc. NaOH, the products formed are

- (a) NaCl, NaClO₃, H₂O (b) NaCl, NaOCl, H₂O
(c) NaCl, H₂O only (d) NaOCl, H₂O

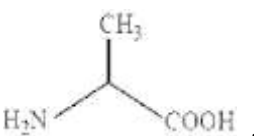
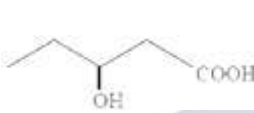
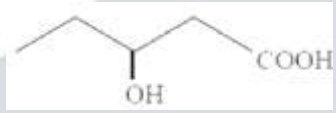
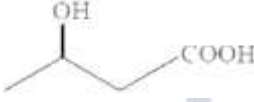
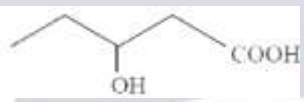
69. Identify the basic oxide from the following

- (a) Cr₂O₃ (b) CrO₃
(c) V₂O₅ (d) V₂O₃

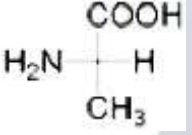
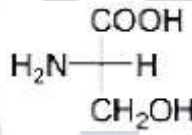
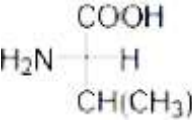
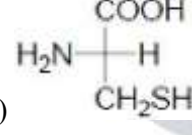
70. Which of the following does not show optical isomerism?

- (a) Cis - [CrCl₂(C₂O₄)₂]³⁻
(b) [PtCl₂(en)₂]²⁺
(c) [Co(NH₃)₃(NO₂)₃]
(d) [Co(en)₃]³⁺

71. A polymer X is biodegradable and is obtained from the monomers Y, Z. What are Y and Z?

- (a) , 
- (b) , 
- (c) , 
- (d) , 

72. Which of the following is an essential amino acid?

- (a)  (b) 
- (c)  (d) 

73. Which of the following hormones is responsible for preparing the uterus for implantation of a fertilized egg?

- (a) Estradiol (b) Progesterone
(c) Testosterone (d) Thyroxin

74. Identify the correct set from the following.

- (a) Penicillin - narrow spectrum - bacteriostatic
(b) Chloramphenicol - broad spectrum - bacteriostatic
(c) Ampicillin - narrow spectrum - bactericidal
(d) Ofloxacin - broad spectrum - bacteriostatic

75. Chlorobenzene (X) when reacted with reagent 'A' gets converted to phenol (Y). The major product obtained from nitration of X gets converted to p-nitrophenol (Z) by reaction with reagent B. What are A and B respectively?

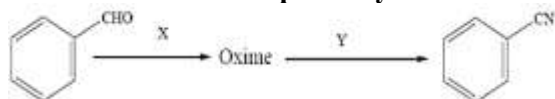
- (a) A = NaOH, 623 K, 300 atm; B = NaOH, 443 K, H⁺
(b) A = NaOH, 443 K, H⁺; B = H₂O, Δ
(c) A = NaOH, 323 K, H⁺; B = NaOH, 443 K, H⁺
(d) A = NaOH, 623 K, 300 atm; B = H₂O, Δ

76. Match the following reactions with the product obtained from them:

List-I		List-II	
A	Sandmeyer reaction	I	R-I
B	Finkelstein reaction	II	R-F
C	Swarts reaction	III	Ar · Br
		IV	R · Br

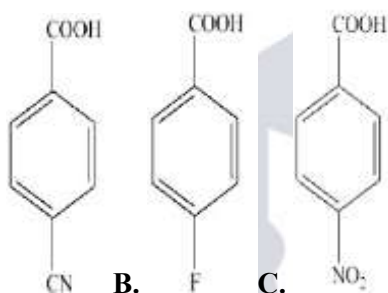
- (a) A – III, B – I, C – IV
 (b) A – IV, B – II, C – I
 (c) A – III, B – IV, C – II
 (d) A – III, B – I, C – II

77. What are X and Y respectively in the following reaction sequence?



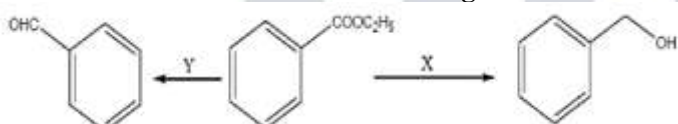
- (a) NH_2NH_2 , $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ / Pyridine
 (b) NH_2NH_2 , $(\text{CH}_3\text{CO})_2\text{O}$
 (c) NH_2OH , $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ / Pyridine
 (d) NH_2OH , $(\text{CH}_3\text{CO})_2\text{O}$

78. Arrange the following in decreasing order of their acidity:



- A. CN B. F C. NO₂
 (a) $C > B > A$ (b) $C > A > B$
 (c) $B > C > A$ (d) $B > A > C$

79. What are X and Y in the following set of reactions?



- (a) X = (i) DIBAL-H, (ii) H_2O , Y = (i) DIBAL-H, (ii) H_2O
 (b) X = H_2 / Catalyst, Y = H_2 / Catalyst
 (c) X = H_2 / Catalyst, Y = (i) DIBAL-H, (ii) H_2O
 (d) X = (i) DIBAL-H, (ii) H_2O , Y = H_2 / Catalyst

80. An alkyl halide $\text{C}_3\text{H}_7\text{Cl}$, on reaction with a reagent X, gave the major product Y ($\text{C}_4\text{H}_7\text{N}$). Y on hydrolysis released a gas, which turns red litmus to blue. What are X and Y ?

- (a) $\text{KCN}/\text{C}_2\text{H}_5\text{OH}$, 
 (b) $\text{KCN}/\text{C}_2\text{H}_5\text{OH}$, 
 (c) $\text{AgCN}/\text{C}_2\text{H}_5\text{OH}$, 
 (d) $\text{AgCN}/\text{C}_2\text{H}_5\text{OH}$, 

Mathematics

81. If a function $f: \mathbb{R} \rightarrow \mathbb{R}$ is defined by $f(x) = x^3 - x$, then f is:

- (a) One-one and onto
 (b) One-one but not onto
 (c) Onto but not one-one
 (d) Neither one-one nor onto

82. If $f(x) = \sqrt{x} - 1$ and $g(f(x)) = x + 2\sqrt{x} + 1$, then $g(x)$ is:

- (a) $(x + 2)^2$ (b) $(x - 2)^2$
(c) $(\sqrt{x} + 2)^2$ (d) $(\sqrt{x} - 2)^2$

83. For all positive integers n , if $3(5^{2n+1}) + 2^{3n+1}$ is divisible by k , then the number of prime numbers less than or equal to k is:

- (a) 17 (b) 6
(c) 7 (d) 8

84. If α, β, γ are the roots of the determinant equation:

$$\begin{vmatrix} 1-x & -2 & 1 \\ -2 & 4-x & -2 \\ 1 & -2 & 1-x \end{vmatrix} = 0 \text{ then } \alpha\beta + \beta\gamma + \gamma\alpha \text{ is:}$$

- (a) 6 (b) 8
(c) 0 (d) -4

85. If the determinant of a 3rd order matrix A is K , then the sum of the determinants of the matrices (AA^T) and $(A - A^T)$ is:

- (a) $2K$ (b) 0
(c) K^2 (d) K

86. While solving a system of linear equations $AX = B$ using Cramer's rule, if $\Delta = \begin{vmatrix} 1 & 1 & 1 \\ 2 & -1 & 2 \\ -1 & 1 & 5 \end{vmatrix}; \Delta_1 =$

$$\begin{vmatrix} 5 & 1 & 1 \\ 4 & -1 & 2 \\ 11 & 1 & 5 \end{vmatrix} \text{ and } X = \begin{bmatrix} \alpha \\ 2 \\ \beta \end{bmatrix}, \text{ then } \alpha^2 + \beta^2 =$$

- (a) 9 (b) 13
(c) 5 (d) 25

87. If real parts of $\sqrt{-5 - 12i}, \sqrt{5 + 12i}$ are positive values, the real part of $\sqrt{-8 - 6i}$ is a negative value. If

$$a + ib = \frac{\sqrt{-5 - 12i} + \sqrt{5 + 12i}}{\sqrt{-8 - 6i}} \text{ then } 2a + b \text{ is:}$$

- (a) 3 (b) 2
(c) -3 (d) -2

88. The set of all real values of c for which the equation

$$zz' + (4 - 3i)z + (4 + 3i)z' + c = 0 \text{ represents a circle is:}$$

- (a) $[25, \infty)$ (b) $[-5, 5]$
(c) $(-\infty, -5] \cup [5, \infty)$ (d) $(-\infty, 25]$

89. If $Z = x + iy$ is a complex number, then the number of distinct solutions of the equation

$$z^3 + \bar{z} = 0 \text{ is:}$$

- (a) 1 (b) 3
(c) Infinite (d) 5

90. If the roots of the quadratic equation $x^2 - 35x + c = 0$ are in the ratio 2:3 and $c = 6K$, then K is:

- (a) 49 (b) 14
(c) 21 (d) 7

91. For real values of x and a , if the expression

$$\frac{x+a}{2x^2-3x+1} \text{ assumes all real values, then:}$$

- (a) $a < -1$ or $a > -\frac{1}{2}$ (b) $-1 < a < -\frac{1}{2}$
(c) $\frac{1}{2} < a < 1$ (d) $a < \frac{1}{2}$ or $a > 1$

92. If the sum of two roots α, β of the equation $x^4 - x^3 - 8x^2 + 2x + 12 = 0$ is zero and $\gamma, \delta (\gamma > \delta)$ are its other roots, then $3\gamma + 2\delta$ is:

- (a) 0 (b) 1
(c) 3 (d) 5

93. If $f(x + h) = 0$ represents the transformed equation of $f(x) = x^4 + 2x^3 - 19x^2 - 8x + 60 = 0$ and this transformation removes the term containing x^3 , then h is:

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

94. The number of different ways of preparing a garland using 6 distinct white roses and 6 distinct red roses such that no two red roses come together is:

- (a) 43200 (b) 86400
(c) 59200 (d) 76800

95. The number of ways a committee of 8 members can be formed from a group of 10 men and 8 women such that the committee contains at most 5 men and at least 5 women is:

- (a) 8061 (b) 8612
(c) 6082 (d) 8271

96. If all the letters of the word CRICKET are permuted in all possible ways and the words (with or without meaning) thus formed are arranged in dictionary order, then the rank of the word CRICKET is:

- (a) 561 (b) 531
(c) 546 (d) 513

97. The square root of the independent term in the expansion of

$$\left(\frac{2x^2}{5} + \frac{5}{\sqrt{x}}\right)^{10} \text{ is:}$$

- (a) $15\sqrt{10}$ (b) $10\sqrt{15}$
(c) $30\sqrt{5}$ (d) $20\sqrt{5}$

98. The coefficient of x^5 in the expansion of $(3 + x + x^2)^6$ is:

- (a) 18 (b) 540
(c) 1620 (d) 2178

99. The absolute value of the difference of the coefficients of x^4 and x^6 in the expansion of

$$\frac{2x^2}{(x^2+1)(x^2+2)} \text{ is:}$$

- (a) $\frac{13}{4}$ (b) $\frac{1}{4}$
(c) $\frac{9}{4}$ (d) 1

100. Evaluate the expression:

$$\tan 6^\circ \tan 42^\circ \tan 66^\circ \tan 78^\circ$$

- (a) $\frac{3}{4}$ (b) 1
(c) 0 (d) $\frac{1}{3}$

101. The maximum value of $12\sin x - 5\cos x + 3$ is:

- (a) 18 (b) 13
(c) 16 (d) 10

102. Evaluate the expression:

$$\sin^2 76^\circ + \sin^2 16^\circ - \sin 76^\circ \sin 16^\circ$$

- (a) 0 (b) $\frac{1}{4}$
(c) $\frac{3}{4}$ (d) $\frac{4}{3}$

103. Find the value of x satisfying: $1 + \sin x + \sin^2 x + \sin^3 x + \dots = 4 + 2\sqrt{3}$ where $0 < x < \pi, x \neq \frac{\pi}{2}$.

- (a) $\frac{\pi}{6}, \frac{\pi}{4}$ (b) $\frac{\pi}{4}, \frac{5\pi}{6}$
(c) $\frac{2\pi}{5}, \frac{\pi}{6}$ (d) $\frac{\pi}{3}, \frac{2\pi}{3}$

104. Evaluate: $\tan^{-1} 2 + \tan^{-1} 3$

- (a) $-\frac{\pi}{4}$ (b) $\frac{\pi}{4}$
(c) $\frac{3\pi}{4}$ (d) $\frac{5\pi}{4}$

105. Evaluate: $\cosh^{-1} 2$

- (a) $\log(2 + \sqrt{3})$ (b) $\log(2 + \sqrt{5})$
(c) $\log(2 - \sqrt{5})$ (d) $\log(2 + \sqrt{2})$

106. In $\triangle ABC$, evaluate: $\cos A + \cos B + \cos C$

(a) $1 + \frac{r}{2R}$ (b) $1 - \frac{r}{R}$
 (c) $1 + \frac{R}{r}$ (d) $1 + \frac{r}{R}$

107. In $\triangle ABC$, given: $a = 26, b = 30, \cos C = \frac{63}{65}$ Find c .

(a) 2 (b) 4
 (c) 6 (d) 8

108. If H is the orthocenter of $\triangle ABC$ and $AH = x, BH = y, CH = z$, then evaluate:

$\frac{abc}{xyz}$

(a) 1 (b) $\frac{a+b+c}{x+y+z}$
 (c) $\frac{a}{x} + \frac{b}{y} + \frac{c}{z}$ (d) $\frac{ab+bc+ca}{xy+yz+zx}$

109. In a regular hexagon $ABCDEF$, if $\overrightarrow{AB} = a$ and $\overrightarrow{BC} = b$, then find $\overrightarrow{FA}$.

(a) $a - b$ (b) $a + b$
 (c) $b - a$ (d) $2b - a$

110. If the points with position vectors

$(a\mathbf{i} + 10\mathbf{j} + 13\mathbf{k}), (6\mathbf{i} + 11\mathbf{j} + 11\mathbf{k}), \left(\frac{9}{2}\mathbf{i} + \beta\mathbf{j} - 8\mathbf{k}\right)$
 are collinear, then evaluate $(19a - 6\beta)^2$.

(a) 16 (b) 36
 (c) 25 (d) 49

111. If f, g, h are mutually orthogonal vectors of equal magnitudes, then find the angle between the vectors $f + g + h$ and h .

(a) $\cos^{-1}\left(\frac{\sqrt{3}}{4}\right)$ (b) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$
 (c) $\pi - \cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (d) $\pi - \cos^{-1}\left(\frac{\sqrt{3}}{4}\right)$

112. Let a, b be two-unit vectors. If $c = a + 2b$ and $d = 5a - 4b$ are perpendicular to each other, find the angle between a and b .

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$
 (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{8}$

113. If the vectors $a = 2\mathbf{i} - \mathbf{j} + \mathbf{k}, b = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}, c = 3\mathbf{i} + p\mathbf{j} + 5\mathbf{k}$ are coplanar, find p .

(a) 4 (b) 14
 (c) -4 (d) 41

114. For a dataset, if the coefficient of variation is 25 and the mean is 44, find the variance.

(a) 11 (b) 121
 (c) 110 (d) 19

115. If 5 letters are to be placed in 5-addressed envelopes, then the probability that at least one letter is placed in the wrongly addressed envelope is:

(a) $\frac{1}{5}$ (b) $\frac{1}{120}$
 (c) $\frac{4}{5}$ (d) $\frac{119}{120}$

116. A student writes an exam with 8 true/false questions. He passes if he answers at least 6 correctly. Find the probability that he fails.

(a) $\frac{37}{256}$ (b) $\frac{19}{256}$
 (c) $\frac{119}{256}$ (d) $\frac{219}{256}$

117. The probability that a person goes to college by car, $\frac{1}{5}$ bus, $\frac{2}{5}$ or train $\frac{3}{5}$ is given. If he reaches college on time, find the probability he traveled by car.

(a) $\frac{6}{29}$ (b) $\frac{24}{29}$
 (c) $\frac{5}{29}$ (d) $\frac{23}{29}$

118. P, Q , and R try to hit the same target one after another. Their probabilities of hitting are $\frac{2}{3}, \frac{3}{5}, \frac{5}{7}$ respectively. Find the probability that the target is hit by P or Q but not by R .
- (a) $\frac{26}{105}$ (b) $\frac{79}{105}$
(c) 0 (d) $\frac{75}{105}$
119. A box contains 20 percent defective bulbs. Five bulbs are randomly chosen. Find the probability that exactly 3 are defective.
- (a) $\frac{32}{625}$ (b) $\frac{32}{125}$
(c) $\frac{16}{625}$ (d) $\frac{16}{125}$
120. A random variable X follows a Poisson distribution with mean 5. Find the probability that $X < 3$.
- (a) $\frac{37}{2e^5}$ (b) $6e^5$
(c) $6e^{-5}$ (d) $\frac{37}{2e^{-5}}$
121. Find the locus of points satisfying the equation $axy + byz = cy$.
- (a) zx -plane or planes perpendicular to zx -plane
(b) Planes perpendicular to x -axis
(c) Lines perpendicular to zx -plane
(d) Lines perpendicular to xy -plane
122. If the coordinate axes are rotated by 45° about the origin in the counterclockwise direction, then the transformed equation of $y^2 = 4ax$ is:
- (a) $(x + y)^2 = 4\sqrt{2}a(x - y)$
(b) $(x - y)^2 = 4\sqrt{2}a(x + y)$
(c) $(x - y)^2 = \frac{4a}{\sqrt{2}}(x + y)$
(d) $(x + y)^2 = \frac{4a}{\sqrt{2}}(x - y)$
123. If the lines $3x + y - 4 = 0, x - \alpha y + 10 = 0, \beta x + 2y + 4 = 0$ and $3x + y + k = 0$ represent the sides of a square, then find $\alpha\beta(k + 4)^2$.
- (a) -256 (b) -512
(c) -128 (d) -1024
124. Find the equation of a line passing through the intersection of $3x + y - 4 = 0$ and $x - y = 0$, and making a 45° angle with $x - 3y + 5 = 0$.
- (a) $x + y = 2$ (b) $x + 2y = 3$
(c) $4x + 3y = 7$ (d) $x + 3y = 4$
125. The equation $2x^2 - 3xy - 2y^2 = 0$ represents two lines L_1 and L_2 . The equation $2x^2 - 3xy - 2y^2 - x + 7y - 3 = 0$ represents another two lines L_3 and L_4 . Let A be the point of intersection of lines L_1 and L_3 , and B be the point of intersection of lines L_2 and L_4 . The area of the triangle formed by the lines AB, L_3 , and L_4 is: .
- (a) $\frac{3}{10}$ (b) $\frac{3}{5}$
(c) $\frac{15}{2}$ (d) $\frac{5}{2}$
126. The area of the triangle formed by the pair of lines $23x^2 - 48xy + 3y^2 = 0$ with the line $2x + 3y + 5 = 0$ is:
- (a) $\frac{1}{13\sqrt{3}}$ (b) $\frac{25}{13\sqrt{3}}$
(c) $\frac{7}{13\sqrt{5}}$ (d) $\frac{9}{25\sqrt{3}}$
127. If θ is the angle between the tangents drawn from the point $(2, 3)$ to the circle $x^2 + y^2 - 6x + 4y + 12 = 0$, then θ is:
- (a) $\cos^{-1}\left(\frac{5}{13}\right)$ (b) $\sin^{-1}\left(\frac{4}{5}\right)$
(c) $2\tan^{-1}\left(\frac{5}{12}\right)$ (d) $\tan^{-1}\left(\frac{5}{12}\right)$
128. The length of the tangent drawn from the point $\left(\frac{k}{4}, \frac{k}{3}\right)$ to the circle $x^2 + y^2 + 8x - 6y - 24 = 0$ is:
- (a) 7 (b) 1
(c) 12 (d) 24

129. If $Q(h, k)$ is the inverse point of $P(1, 2)$ with respect to the circle $x^2 + y^2 - 4x + 1 = 0$, then $2h + k$ is:
 (a) 3 (b) 4
 (c) 7 (d) 11
130. If (a, b) and (c, d) are the internal and external centres of similitude of the circles $x^2 + y^2 + 4x - 5 = 0$ and $x^2 + y^2 - 6y + 8 = 0$ respectively, then $(a + d)(b + c)$ is:
 (a) 4 (b) 9
 (c) 13 (d) 22
131. A Circle S passes through the points of intersection of the circles $x^2 + y^2 - 2x + 2y - 2 = 0$ and $x^2 + y^2 + 2x - 2y + 1 = 0$. If the centre of this circle S lies on the line $x - y + 6 = 0$, then the radius of the circle S is:
 (a) $\sqrt{5}$ (b) 5
 (c) $\sqrt{41}$ (d) $\sqrt{14}$
132. The line $x - 2y - 3 = 0$ cuts the parabola $y^2 = 4ax$ at points P and Q . If the focus of this parabola is $(\frac{1}{4}, k)$, then PQ is:
 (a) $16a\sqrt{5}$ (b) $8a\sqrt{5}$
 (c) $4a\sqrt{5}$ (d) $2a\sqrt{5}$
133. If $4x - 3y - 5 = 0$ is a normal to the ellipse $3x^2 + 8y^2 = k$, then the equation of the tangent at point $(-2, m)$ is:
 (a) $3x + 4y - 14 = 0$ (b) $3x - 4y + 10 = 0$
 (c) $3x - 4y + 1 = 0$ (d) $4x + 3y - 3 = 0$
134. If the line $5x - 2y - 6 = 0$ is a tangent to the hyperbola $5x^2 - ky^2 = 12$, then the equation of the normal to this hyperbola at $(\sqrt{6}, p)$ is:
 (a) $\sqrt{6}x + 2y = 0$ (b) $2\sqrt{6}x + 3y = 3$
 (c) $\sqrt{6}x - 5y = 21$ (d) $3\sqrt{6}x - y = 21$
135. If the angle between the asymptotes of the hyperbola $x^2 - ky^2 = 3$ is $\frac{\pi}{3}$ and e is its eccentricity, then the pole of the line $x + y - 1 = 0$ w.r.t. this hyperbola is:
 (a) $(k, \frac{\sqrt{3}e}{2})$ (b) $(-k, \frac{\sqrt{3}e}{2})$
 (c) $(-k, -\frac{\sqrt{3}e}{2})$ (d) $(k, -\frac{\sqrt{3}e}{2})$
136. Let $P(a, 4, 7)$ and $Q(3, \beta, 8)$ be two points. If the YZ -plane divides the join of the points P and Q in the ratio 2:3 and the ZX -plane divides the join of P and Q in the ratio 4:5, then the length of line segment PQ is:
 (a) $\sqrt{107}$ (b) $\sqrt{27}$
 (c) $\sqrt{83}$ (d) $\sqrt{97}$
137. If (α, β, γ) are the direction cosines of an angular bisector of two lines whose direction ratios are $(2, 2, 1)$ and $(2, -1, -2)$, then $(\alpha + \beta + \gamma)^2$ is:
 (a) 3 (b) 2
 (c) 4 (d) 5
138. If the distance between the planes $2x + y + z + 1 = 0$ and $2x + y + z + \alpha = 0$ is 3 units, then the product of all possible values of α is:
 (a) -43 (b) 43
 (c) 53 (d) -53
139. Evaluate the limit:

$$\lim_{x \rightarrow 0} \frac{1 - \cos x \cos 2x}{\sin^2 x}$$

- (a) $\frac{11}{4}$ (b) $\frac{5}{2}$
 (c) 3 (d) 5

140. Evaluate the limit:

$$\lim_{x \rightarrow \infty} \left(\frac{3x^2 - 2x + 3}{3x^2 + x - 2} \right)^{3x-2}$$

- (a) -3 (b) e^{-1}
(c) e^{-3} (d) -1

141. Given the function:

$$f(x) = \begin{cases} \frac{(2x^2 - ax + 1) - (ax^2 + 3bx + 2)}{x + 1}, & \text{if } x \neq -1 \\ k, & \text{if } x = -1 \end{cases}$$

If $a, b, k \in \mathbb{R}$ and $f(x)$ is continuous for all x , then the value of k is:

- (a) $-\frac{1}{3}$ (b) 6
(c) $a - 2$ (d) $a - 3$

142. Given the function:

$$f(x) = \begin{cases} \frac{2xe^{1/2x} - 3xe^{-1/2x}}{e^{1/2x} + 4e^{-1/2x}}, & \text{if } x \neq 0 \\ 0, & \text{if } x = 0 \end{cases}$$

Determine the differentiability of $f(x)$ at $x = 0$.

- (a) $f'(0^+) = -\frac{3}{4}$
(b) $f'(0^-) = 2$
(c) $f(x)$ is not differentiable at $x = 0$
(d) $f(x)$ is differentiable at $x = 0$

143. If $y = \tan^{-1} \left(\frac{2-3\sin x}{3-2\sin x} \right)$

then find $\frac{dy}{dx}$.

- (a) $\frac{(3-2\sin x)^2}{13\sin^2 x - 24\sin x + 13}$ (b) $\frac{-5\cos x}{13\sin^2 x - 24\sin x + 13}$
(c) $\frac{5\sin x}{13\sin^2 x - 24\sin x + 13}$ (d) $\frac{-5\sin x}{13\sin^2 x - 24\sin x + 13}$

144. If $x = 3 \left[\sin t - \log \left(\cot \frac{t}{2} \right) \right]$, $y = 6 \left[\cos t + \log \left(\tan \frac{t}{2} \right) \right]$ then find $\frac{dy}{dx}$.

- (a) $\frac{2\sin^2 t}{1+\sin t \cos t}$ (b) $\frac{2\cos^2 t}{1+\sin 2t}$
(c) $\frac{2\cos^2 t}{1+\sin t \cos t}$ (d) $\frac{1+\cos 2t}{1+\sin 2t}$

145. By considering $1' = 0.0175$, the approximate value of $\cot 45^\circ 2'$ is:

- (a) 1.07 (b) 0.965
(c) 1.035 (d) 0.93

146. A point moves on the curve $y = x^3 - 3x^2 + 2x - 1$ and its y -coordinate increases at a rate of 6 units per second. When the point is at $(2, -1)$, the rate of change of its x -coordinate is:

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

147. The length of the tangent drawn at the point $P \left(\frac{\pi}{4} \right)$ on the curve $x^{2/3} + y^{2/3} = 2^{2/3}$ is:

- (a) $\frac{2}{3}$ (b) 1
(c) $\frac{4}{3}$ (d) 2

148. The set of all real values of a such that the function $f(x) = x^3 + 2ax^2 + 3(a+1)x + 5$ is strictly increasing in its entire domain is:

- (a) $\left(-\infty, -\frac{3}{4} \right) \cup (3, \infty)$ (b) $\left(-\frac{3}{4}, 3 \right)$
(c) $(1, 3)$ (d) $(-\infty, 1) \cup (3, \infty)$

149. Evaluate the integral:

$$\int \frac{1}{x^5 \sqrt{x^5 + 1}} dx.$$

- (a) $\frac{4}{5} \sqrt{x^5 + 1} + C$ (b) $4x^4(x^5 + 1)^{4/5} + C$
(c) $-\frac{(x^5 + 1)^{4/5}}{4x^4} + C$ (d) $-\frac{(x^5 + 1)^{4/5}}{4x^5} + C$

150. Evaluate the integral:

$$I = \int \frac{x+1}{\sqrt{x^2+x+1}} dx$$

- (a) $\frac{1}{2}\sqrt{x^2+x+1} + \frac{1}{2}\cosh^{-1}\left(\frac{x+2}{\sqrt{3}}\right) + C$
 (b) $\frac{1}{2}\sqrt{x^2+x+1} + \frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + C$
 (c) $\sqrt{x^2+x+1} + \frac{2}{\sqrt{3}}\log|x^2+x+1| + C$
 (d) $\sqrt{x^2+x+1} + \frac{1}{2}\sinh^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + C$

151. Evaluate the integral:

$$I = \int (\tan^7 x + \tan x) dx$$

- (a) $\frac{\tan^2 x}{12}(2\tan^4 x - 3\tan^2 x + 6) + C$
 (b) $\frac{\tan^2 x}{6} - \frac{\tan^5 x}{4} + \frac{\tan^4 x}{2} + C$
 (c) $\frac{\tan^2 x}{6}(\tan^4 x + 3\tan^2 x + 4) + C$
 (d) $\frac{\tan x}{12}(\tan^4 x - 3\tan^2 x + 6) + C$

152. Evaluate the integral:

$$I = \int \frac{\csc x}{3\cos x + 4\sin x} dx$$

- (a) $\frac{1}{2}\log\left|\frac{\cos x}{3\sin x + 4\cos x}\right| + C$
 (b) $\frac{1}{3}\log\left|\frac{\sin x}{3\cos x + 4\sin x}\right| + C$
 (c) $\frac{1}{3}\log\left|\frac{3\cos x + \sin x}{3\cos x + 4\sin x}\right| + C$
 (d) $\frac{1}{2}\log\left|\frac{\cos x + 4\sin x}{3\cos x + 4\sin x}\right| + C$

153. Evaluate the integral:

$$I = \int e^{2x+3} \sin 6x dx$$

- (a) $\frac{e^{2x+3}}{40}(2\sin 6x + 6\cos 6x) + C$
 (b) $\frac{e^{2x+3}}{40}(2\cos 6x + 6\sin 6x) + C$
 (c) $\frac{e^{2x+3}}{20}(\sin 6x - 3\cos 6x) + C$
 (d) $\frac{e^{2x+3}}{20}(\cos 6x - 3\sin 6x) + C$

154. Evaluate the limit:

$$\lim_{n \rightarrow \infty} n^4 \left[\sum_{k=0}^{\infty} \frac{1}{(n^2 + k)^{5/2}} \right]$$

- (a) $\frac{3}{4\sqrt{2}}$ (b) $\frac{3\sqrt{2}}{4}$
 (c) $\frac{5}{6\sqrt{2}}$ (d) $\frac{5\sqrt{2}}{6}$

155. Evaluate $\int_{\log 4}^{\log 5} \frac{e^{2x} + e^x}{e^{2x} - 5e^x + 6} dx$:

- (a) $\log\left(\frac{64}{9}\right)$ (b) $\log\left(\frac{256}{81}\right)$
 (c) $\log\left(\frac{32}{3}\right)$ (d) $\log\left(\frac{128}{27}\right)$

156. Evaluate $\int_1^2 \frac{x^4 - 1}{x^6 - 1} dx$:

- (a) 1 (b) $\frac{121}{6}$
 (c) $\sqrt{2} - 1$ (d) $\frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

157. Find the area enclosed by the curve $y = x^3 - 19x + 30$ and the X-axis.

- (a) $\frac{167}{2}$ (b) $\frac{517}{2}$
(c) 36 (d) 72

158. Find the differential equation representing the family of circles having their centers on the Y-axis.

Given that $y_1 = \frac{dy}{dx}$ and $y_2 = \frac{d^2y}{dx^2}$.

- (a) $y_2 = y(y_1^2 + 1)$ (b) $y_2 = xy(y_1^2 + 1)$
(c) $xy_2 = y_1(y_1^2 + 1)$ (d) $xy_2 = y(y_1^2 + 1)$

159. Find the general solution of the differential equation

$$(\sin y \cos^2 y - x \sec^2 y) dy = (\tan y) dx$$

- (a) $\tan y = 3x \cos^3 y + c$
(b) $x(\sec y + \tan y) = \cos^2 y + c$
(c) $y \sin y = x^2 \cos^2 y + c$
(d) $3x \tan y + \cos^3 y = c$

160. Find the general solution of the differential equation $(x - y - 1)dy = (x + y + 1)dx$.

- (a) $\tan^{-1}\left(\frac{y+1}{x}\right) - \frac{1}{2} \log(x^2 + y^2 + 2y + 1) = c$
(b) $(x - y) + \log(x + y) = c$
(c) $y^2 - x^2 + xy - 3y - x = c$
(d) $(x - y - 1)^2(x + y + 1)^3 = c$

