Physics

1. **Choose the correct statement from following.**
(a) Not all basic laws of physics are universal.
(b) Conservation laws have a deep connection with symmetries of nature.
(c) There are four to six fundamental forces in nature that govern the diverse phenomena of the world.
(d) Physics can generate new technology but new physics cannot come out from technology.

2. **If E and E_0 denote energies at time t and t_0 respectively, and L and L_0 distance from same point at t and t_0 respectively, then which of the following equations can be declared to be incorrect on dimensional grounds?**
(A) $E=\frac{2E_0L}{L_0}$ **(B)** $E=E_0e^{-2L/L_0}$
(C) $E=2Le^{-L/E_0}$ **(D)** $E=2(E_0/L_0)\times e^{-L/L_0}$
(a) A, B only (b) A, C only
(c) A, C, D only (d) C, D only

3. **A body starts from the rest and acquires a velocity of $10\ m/s$ in 2 s. What is the acceleration of the body and the distance travelled?**
(a) $5\ m/s^2$ and 10 m (b) $5\ m/s^2$ and 5 m
(c) $5\ m/s^2$ and 6 m (d) $6\ m/s^2$ and 5 m

4. **A bullet fired into a target losses one-third of its velocity after travelling a distance x metre into the target. If the bullet comes to rest by travelling a further distance x′, then the ratio $\frac{x'}{x}$ is**
(a) $\frac{2}{3}$ (b) $\frac{1}{3}$ (c) $\frac{4}{5}$ (d) $\frac{4}{9}$

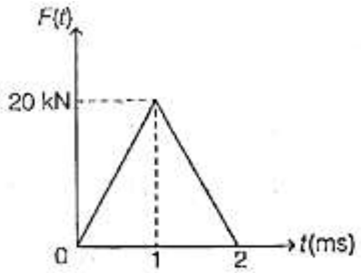
5. **An ant starts from the origin and crawls 10 cm along the X-axis and then 20 cm along the Y-axis. The dot product of the ant's displacement vector with the position vector of a point that makes 45° with the X-axis and has a magnitude of $\sqrt{2}$ cm is**
(a) 30 cm (b) $30\sqrt{2}$ cm
(c) $\frac{30}{\sqrt{2}}$ cm (d) 15 cm

6. **A projectile is launched with an initial speed of $40\ m/s$ at an angle 30° above the ground. The projectile lands on a hillside 2.0 s later. The net displacement from where the projectile lands on hillside 2.0 s later. The net displacement from where the projectile was launched to where it hits the target is (take, $g=10\ m/s^2$)**
(a) $20\sqrt{3}$ m (b) $30\sqrt{2}$ m
(c) 40 m (d) $20\sqrt{13}$ m

7. **Two blocks of masses 1 kg and 2 kg connected by a light rod and the system is slipping down a rough incline angle 45° with the horizontal. The frictional coefficient at both the contacts is 0.4 . If the acceleration of the system is $\alpha\sqrt{2}$, the value of α is (use, $g=10\ m/s^2$)**
(a) 4 (b) 3 (c) 2 (d) 6

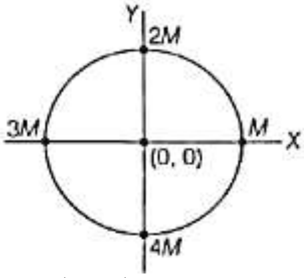
8. **The potential energy of an object is $U(x)=(5x^2-4x^3)$J, where x is the position in metre. The position at which the force becomes zero is**
(a) $\frac{1}{2}$m (b) $\frac{5}{6}$ m
(c) $\frac{1}{3}$ m (d) $\frac{2}{3}$m

9. **A time varying force acts on a ball of mass 100 g for 2 ms . The force versus time curve is shown below. If the initial speed of the ball is $10\ m/s$, then the speed of ball after 2 ms is**



(a) 210 m/s (b) 410 m/s
(c) 200 m/s (d) 400 m/s

10. Four masses are arranged along a circle of radius 1 m as shown in the figure. The centre of mass of this system of masses is at



(a) $-\frac{1}{5}\hat{\imath}-\frac{1}{5}\hat{\jmath}$ (b) $\frac{1}{5}\hat{\imath}+\hat{\jmath}$
(c) $\hat{\imath}-\frac{1}{5}\hat{\jmath}$ (d) $\frac{1}{5}\hat{\imath}+\frac{1}{5}\hat{\jmath}$

11. A body starting at $t=0$ from origin oscillates simple harmonically with a period of 4 s . After what time will its kinetic energy by 75% of its total energy?

(a) 1/2 s (b) 1/3 s
(c) 1/4 s (d) 1 s

12. Three particles, each of mass M, situated at the vertices of an equilateral triangle of side length l. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle moves in a circle while maintaining the original separation l. The initial speed that should be given to each particle is

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

13. Match the following.

	Column- I		Column-II
(A)	Shear modulus	(I)	Resistance to change in volume
(B)	Shearing stress	(II)	Proportionality constant
(C)	Elastic fatigue	(III)	Tangential stress
(D)	Modulus of elasticity	(IV)	Temporary loss of elastic property
		(v)	Resistance to change against deformation force

The correct match is

	A	B	C	D		A	B	C	D
(a)	II	V	I	III	(b)	V	III	IV	II
(c)	III	IV	II	V	(d)	V	II	IV	I

14. A large storage tank, open to the atmosphere at top and filled with water, develops a small hole in its side at a point 20.0 m below the water level. If the rate of flow from the hole is $3.08 \times 10^{-5}\ m^3/s$, then the diameter of the hole is (take, $g = 10\ m/s^2$)

(a) 1.0 mm (b) 1.2 mm

(c) 1.4 mm (d) 1.6 mm

15. An air bubble of radius 1 mm is at a depth of 8 cm below the free surface of a liquid column. If the surface tension and density of the liquid is $0.1\ N/m$ and $2000\ kg/m^3$, respectively, by what amount is the pressure inside the bubble greater than the atmospheric pressure? (take, $g = 10\ m/s^2$)

(a) $1500\ N/m^2$ (b) $1800\ N/m^2$

(c) $1600\ N/m^2$ (d) $1700\ N/m^2$

16. Find the ratio of the length of a steel rod and a copper rod, if the steel rod is 4 cm longer, then the copper rod at any temperature. (The coefficient of linear expansion for steel and copper are $1.1 \times 10^{-5}/{}^\circ C$ and $1.7 \times 10^{-5}/{}^\circ C$, respectively)

(a) $\frac{17}{11}$ (b) $\frac{11}{17}$ (c) $\frac{11}{4}$ (d) $\frac{17}{4}$

17. An object cools from $100^\circ C$ to $40^\circ C$ in 10 min , when the surrounding temperature is $10^\circ C$. Then the time taken by the object to cool from $70^\circ C$ to $20^\circ C$ is (take, $\ln 2 = 0.7, \ln 3 = 1.1, \ln 6 = 18$)

(a) 30 min (b) 8.5 min

(c) 22.4 min (d) 16.3 min

18. 1.00 kg of liquid water at $100^\circ C$ undergoes a phase change into steam at $100^\circ C$ at 1.0 atm (take it to be 1.00×10^5 Pa). The initial volume of the liquid water was $1.00 \times 10^{-3}\ m^3$ which is changed to $2.001\ m^3$ of steam. Find the change in the internal energy of the system. (Use heat of vaporisation $\approx 2000\ kJ/kg$)

(a) 1800 kJ (b) 200 kJ

(c) 2000 kJ (d) 180 kJ

19. A monoatomic gas does 100 J of work, when it is expanded isobarically. How much of heat is given to the gas in the process?

(a) 150 J (b) 200 J

(c) 250 J (d) 300 J

20. If the root mean square (rms) speed of nitrogen molecules at room temperature is $100\ m/s$, then the rms speed of helium molecule at the same temperature is

(a) $100\sqrt{7}\ m/s$ (b) $350\ m/s$

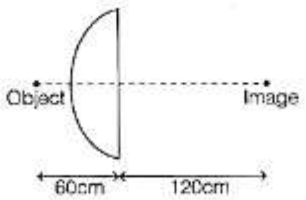
(c) $50\sqrt{14}\ m/s$ (d) $100\ m/s$

21. Two waves of amplitudes A_1 and A_2 respectively, are superimposed. The ratio between the maximum and minimum intensities of the resultant waves is $9:4$. The value of $\frac{A_2}{A_1}$ is (assume $A_1 > A_2$)

(a) 0.66 (b) 0.20

(c) 0.75 (d) 0.44

22. A lens is made of glass having an index of refraction 1.5. One side of the lens is flat and the other side is convex with a radius R. If an object is placed 60 cm , towards the convex side of the lens, the image is formed at 120 cm on the other side of the lens. The value of R is



(a) 20 cm (b) $\frac{40}{2}$ cm

(c) 33 cm (d) 18 cm

23. A Young's double slit experiment apparatus has slits separated by 0.2 mm and a screen 60 cm away from the slits. The whole apparatus is immersed in a liquid medium of refractive index 11/9 and the slits are illuminated with green light ($\lambda = 550$ nm in vacuum). Find the fringe width of the pattern formed on the screen.

(a) 0.95 mm (b) 1.25 mm

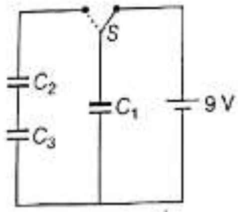
(c) 1.35 mm (d) 1.45 mm

24. An electron is released from a distance of 4 m from a stationary point charge 20 nC . What will be the speed of the electron, when it is 2 m away from the point charge? (Charge of electron $= 1.6 \times 10^{-19}$C, mass of electron $= 9 \times 10^{-31}$ kg, $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$SI unit)

(a) 2×10^6 m/s (b) 4×10^6 m/s

(c) 16×10^6 m/s (d) 2.4×10^6 m/s

25. The following figure shows a 9 V battery and 3 uncharged capacitors of capacitances $C_1 = C_2 = C_3 = 1\mu$ F. The switch is thrown to the right side until capacitor C_1 is fully charged, then the switch is thrown to the left. The final charge on capacitor C_2 is



(a) 1μC (b) 2μC

(c) 3μC (d) 4μC

26. A metal wire of length L and radius r has a resistance R. If a wire of the same metal of length 2L and radius 3r is taken, then what will be its resistance?

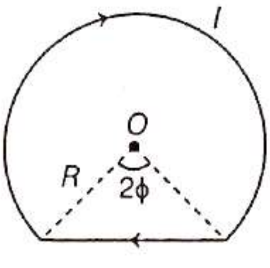
(a) $\frac{2}{9}$R (b) $\frac{2}{3}$R

(c) $\frac{2}{9\pi}$R (d) $\frac{2}{3\pi}$R

27. Balancing point of a potentiometer shifts from a length of 60 cm to 40 cm by shunting the cell with a 4Ω resistance. What is the internal resistance of the cell?

(a) 1Ω (b) 2Ω (c) 4Ω (d) 6Ω

28. A current $I = 5$ A flows along a thin wire shaped as shown in figure. The radius of curved part of the wire is equal to $R = 100$ mm, the angle $2\phi = 90^\circ$. The magnitude of magnetic field at the point O is approximately $\left(\text{use}, \frac{\mu_0}{4\pi} = 10^{-7}\text{TmA}^{-1}\right)$



(a) 33.6μ T (b) 38.4μ T

(c) 48.7μ T (d) 252μ T

29. A toroid has a core (non-ferro magnetic) of inner radius 24 cm and outer radius 26 cm around which 2000 turns of a wire is wound. If the current in the wire is 12 A , the magnetic field inside the core of the toroid is

(a) 1.92×10^{-2} T (b) 1.88×10^{-2} T

(c) 2.12×10^{-2} T (d) 1.98×10^{-2} T

30. A planet has magnetic dipole moment of 27×10^{22} A.m ^{2}. If the radius of the planet is 300 km , what would be the magnetic field at its equator? (use, $\frac{\mu}{4\pi} = 10^{-7}$)

(a) 1 T (b) 27 T
(c) 11 T (d) 30 T

31. A long solenoid has 20 turns per cm. A small loop of area $4/\pi cm^2$ is placed inside the solenoid normal to its axis. If the current carried by the solenoid changed steadily from 1.0 A to 3.0 A in 0.2 s , what is the magnitude of the induced emf in the loop while the current is changing?

(a) 2.4μ V (b) 32μ V
(c) 72μ V (d) 4.8μ V

32. An AC current is given by the expression, $I(t) = 50\sin(200\pi t)$ in amperes. The frequency and rms value of the current, respectively are

(a) 100 Hz, $50\sqrt{2}$ A (b) 100 Hz, $25\sqrt{2}$ A
(c) 200 Hz, $50\sqrt{2}$ A (d) 200 Hz, $25\sqrt{2}$ A

33. An electromagnetic wave is propagating in vacuum along $-\hat{j}$ direction. The magnetic field of the wave is given by $B = (2 \times 10^{-8})\cos\left[\pi \times 10^{15}\left(t + \frac{y}{c}\right)\right]\hat{k}T$. The electric field E of this wave is ($c \equiv$ speed of light)

(a) $E = 4\cos\left[\pi \times 10^{15}\left(t + \frac{y}{c}\right)\right]\hat{j}V/m$
(b) $E = 6\cos\left[\pi \times 10^{15}\left(t + \frac{y}{c}\right)\right]\hat{i}V/m$
(c) $E = 6\cos\left[\pi \times 10^{15}\left(t - \frac{y}{c}\right)\right]\hat{j}V/m$
(d) $E = 4\cos\left[\pi \times 10^{15}\left(t - \frac{y}{c}\right)\right]\hat{j}V/m$

34. For photoelectric effect which of the following statements are true.
(I) The kinetic energies of the photoelectrons do not depend on the frequency of light.
(II) Photoelectric effect will always occur for highly intense light.
(III) The maximum kinetic energy of photoelectron does not depend upon the intensity of the light.
(IV) The escaping electron's kinetic energy is larger for larger frequency.

(a) I and II only (b) II and III only
(c) III and IV only (d) IV and I only

35. Which of the following statements is not true?

(a) Electromagnetic radiation is made up of particles called photons.
(b) Each photon moves with the speed of light.
(c) Photon energy is dependent on the intensity of radiation.
(d) Photons are not deflected by electric and magnetic field.

36. The light emitted in the transition $n = 3$ to $n = 2$, (where n is the principal quantum number of the state) in hydrogen is called H_a-light. Find the maximum work function that a metal can have, so that H_a-light can emit photoelectrons from it.

(a) 1.5 eV (b) 2.89 eV
(c) 1.89 eV (d) 3.5 eV

37. As the mass number A increases, which of the following quantities related to a nucleus does not change?

(a) Mass (b) Volume
(c) Density (d) Binding energy

38. In a p-type semiconductor, which of the following statements is true?

(a) Holes are majority carriers and trivalent atoms are the dopants.
(b) Electrons are minority carriers and pentavalent atoms are the dopants.
(c) Electrons ate majority carriers and trivalent atoms are the dopants.
(d) Holes are minority carriers and pentavalent atoms are the dopants.

39. In a NAND gate, A and B are inputs and Y is the output, then the correct option is

(a) $A = 0, B = 0, Y = 0$ (b) $A = 0, B = 1; Y = 0$
(c) $A = 1, B = 0, Y = 0$ (d) $A = 1, B = 1; Y = 0$

40. A TV transmission antenna is 40 m tall. How much service area is can cover, if the receiving antenna is at the ground level? (radius of the earth = 6400 km)

(a) $640\pi \times 10^6$ m^2 (b) $512\pi \times 10^6$ m^2
(c) $480\pi \times 10^6$ m^2 (d) $440\pi \times 10^6$ m^2

Chemistry

41. In hydrogen atom, the minimum energy required to excite an electron from 2 nd orbit to the 3 rd orbit is

(a) 2.2 Ev (b) 2.7 eV
(c) 1.9 eV (d) 7 eV

42. The velocity (v) of de-Broglie wave is given by

$$\begin{bmatrix} \nu = \text{frequency} \\ m = \text{mass} \\ C = \text{velocity of light} \end{bmatrix}$$

(a) mC^2 (b) $\nu\lambda$
(c) $\frac{h\nu}{mC}$ (d) $\frac{C^2}{\nu}$

43. How many of the following statements are correct?

(A) ' He ' is the second most abundant element in the universe.
(B) The symbol for the element with atomic number 110 is Ds.
(C) Osmium has the highest density among all elements.
(D) Francium is the most electropositive element in the periodic table.

(a) 3 (b) 2 (c) 4 (d) 1

44. The correct order of the first ionisation enthalpies of the following elements is

(a) $Li < B < Be < N$
(b) $Li < Be < B < N$
(c) $N < Be < B < Li$
(d) $N < B < Be < Li$

45. The correct order of $C - O$ bond length is

(a) $CO_3^{2-} < CO_2 < CO$ (b) $CO_2 < CO_3^{2-} < CO$
(c) $CO < CO_3^{2-} < CO_2$ (d) $CO < CO_2 < CO_3^{2-}$

46. How many of the following species have the bond order 2? C_2, B_2^{2-}, N_2^{2+}, CN^+, NO^-, O_2, C_2^+

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

47. Gases deviate from ideal behaviour at high pressures because the gas molecules

(a) attract each other
(b) repel each other
(c) show Brownian motion
(d) Obey Tyndall effect

48. According to kinetic molecular theory of gases, which of the following statements are correct?

(A) The actual volume of the molecules is negligible in comparison to the empty space between them.
(B) Collisions of gas molecules are inelastic.
(C) At any particular time, different particles in the gas have same speed and same kinetic energies.
(D) Pressure is exerted by the gas as a result of collision of the particles with the walls of the container.

(a) A and B only (b) A, B and C only
(c) A and D only (d) A, B, C and D

49. The amount of $50\%(w/w)$ solution of hydrochloric acid required to react with 200 g of $CaCO_3$ would be

(a) 73 g (b) 292 g
(c) 146 g (d) 100 g

50. Identify the pair of reactions undergoing disproportionation from the following.

(a) $2H_2O_2 \longrightarrow 2H_2O + O_2$ and $Cl_2 + 2NaOH \longrightarrow NaCl + NaOCl + H_2O$
(b) $P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_4$ and $Cl_2 + 2Na \longrightarrow 2NaCl$
(c) $Cl_2 + 2KBr \longrightarrow 2KCl + Br_2$ and $5Cl_2 + I_2 + 6H_2O \longrightarrow 2O_3^- + 10Cl^- + 2H^+$
(d) $Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + H_2O$ and $P_4 + 3NaOH \longrightarrow 3H_2O + PH_3 + 3NaH_2PO_4$

51. If 92 g Na reacts with water in open vessel at 300 K . What is the value of work done?
[Assume ideal nature of the gaseous product.]

(a) 0.0 (b) -49884 J
(c) -2494.2 J (d) -99768 J

52. For a reaction, $A(s) \rightleftharpoons B(s) + C(g)$ the set of all correct statements are

(A) K is independent of [A].

(B) K is dependent on partial pressure of C at a given temperature.

(C) ΔH will be independent of temperature.

(D) ΔH is independent of the catalyst addition.

(a) A, B, C, D (b) A, B only
(c) A, B, D only (d) A, B, C only

53. The pH of pure water at 80°C is

(a) 7.0 (b) ∞
(c) > 7.0 (d) < 7.0

54. On passing electric current over molten ionic hydrides of s-block elements,

(a) H_2 is liberated at the anode
(b) H_2 is liberated at the cathode
(c) no reaction takes place
(d) metal oxidises at the cathode

55. Lithium nitrate on heating gives

(a) $Li_2O + NO_2$ (b) $Li_2O + NO_2 + O_2$
(c) $LiNO_2 + O_2$ (d) $Li_2O_2 + NO_2 + O_2$

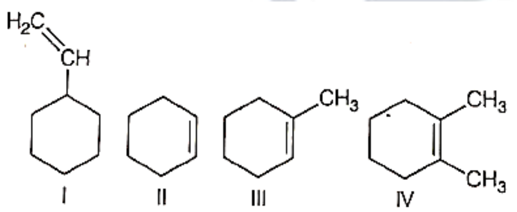
56. Aluminium when treated with aqueous NaOH , liberates a gaseous molecule majorly. The gas is

(a) H_2 (b) O_2
(c) D_2 (d) O_3

57. Aluminium when treated with aqueous NaOH , liberates a gaseous molecule majorly. The gas is

(a) C > Ge > Pb (b) Ge > C > Pb
(c) Pb > C > Ge (d) C > Pb > Ge

58. The correct order of the stability of the following compounds based upon hyperconjugation is



(a) IV > III > II > I (b) IV > II > I > III
(c) IV > II > III > I (d) IV > I > III > II

59. The correct order of rate of addition of Br_2 /water to the following alkenes is

$\underset{[A]}{CH_2 = CH_2}$ $\underset{[B]}{CH_2 = CH - NO_2}$

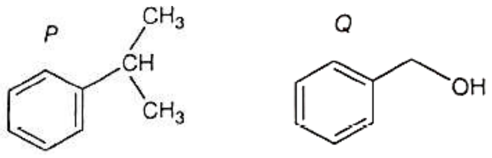
$\underset{[C]}{CH_3 - CH_2 - CH = CH_2CH_3}$ $\underset{[D]}{CH_3\ \overset{CH_3}{\overset{|}{CH}} = CH_2}$

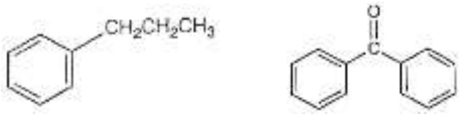
(a) [D] > [C] > [A] > [B]
(b) [D] > [C] > [B] > [A]
(c) [A] > [B] > [C] > [D]
(d) [A] > [B] > [D] > [C]

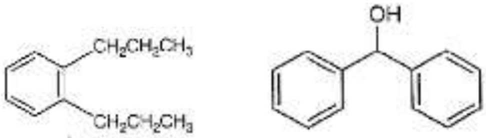
60. The major products P and Q formed in the following reactions schemes are

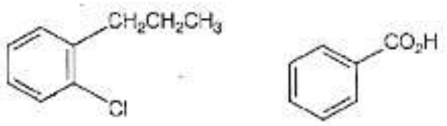
(A)  $+CH_3CH_2CH_2Cl \xrightarrow{AlCl_3(anhyd.)}$ **P**

(B)  $\xrightarrow[\text{(ii)}Br_2.hv\ \text{(iii)aq.KOH}]{\text{(i)}CH_3Cl/AlCl_3(anhyd.)}$ **Q**

(a) 

(b) 

(c) 

(d) 

61. Iron crystalises in FCC with an edge length of 400 pm . If it contains 0.1% Schottky defects, calculate its approximate density [Atomic weight of Fe = 56 g/mol]

(a) $5.8 \mathrm{~g/cm^3}$ (b) $1.5 \mathrm{~g/cm^3}$
(c) $2.9 \mathrm{~g/cm^3}$ (d) $8.5 \mathrm{~g/cm^3}$

62. Which of the following are correct for an ideal solution?

(A) $\Delta V_{mix} = 0$
(B) $V_{solvent} + V_{solute} = V_{solution}$
(C) $\Delta H_{mix} = 0$
(D) $H_2O + CO_2 \longrightarrow H_2CO_3$ is an example of ideal solution

(a) A, B only (b) B, C only
(c) A, B, C only (d) A, B, C, D

63. At 0°C urea solution has an osmotic pressure of 400 mm . On dilution by x times, its osmotic pressure decreased to 100 mm at 20°C. The dilution factor x is approximately

(a) 4.3 (b) 2 (c) 5 (d) 6.8

64. The electric charge for electrode deposition of one equivalent of a substance is equal to

(a) 1 As
(b) 193000 coulombs
(c) $\frac{96500}{\text{(Atomic weight of the substance)}}$
(d) Charge on 1 mole of electrons

65. If the definition of the temperature coefficient of the reaction holds good for a reaction between 27°C and 37°C, the activation energy for the reaction in $\mathrm{kJmol^{-1}}$ is

(a) 102 (b) 53.5
(c) ∞ (d) 141.5

66. For As_2S_3 sol, the most effective coagulating agent is

(a) $CaCO_3$ (b) NaCl
(c) $FeCl_3$ (d) clay

67. In which of the following reactions there is no liberation of nitrogen gas

(a) $NO_2^-(aq) + NH_4^+(s) \xrightarrow{\Delta}$
(b) $CO(NH_2)_2(s) + HNO_2(l) \longrightarrow$
(c) $NH_3(g) + NaOCl(aq) \xrightarrow{\text{Gelatine}}$
(d) $(NH_4)_2Cr_2O_7(s) \xrightarrow{\Delta}$

68. The correct order of boiling points of H_2O, H_2S, H_2Se and H_2Te respectively is

(a) $H_2O > H_2S = H_2Se = H_2Te$
(b) $H_2O < H_2S < H_2Se < H_2Te$

(c) $H_2O > H_2S > H_2Se > H_2Te$
(d) $H_2O > H_2Te > H_2Se > H_2S$

69. Which of the following is not a mineral of fluorine?
(a) Fluorspar (b) Cryolite
(c) Fluoroapatite (d) Carnallite

70. The element that even can diffuse through silica glass is
(a) He (b) Ar (c) Kr (d) Xe

71. The compound with more covalent character in the following is
(a) FeF_3 (b) VF_5
(c) VF_2 (d) TiF_2

72. The correct order of decreasing field strength of the below given ligands is

NCS^-	S^{2-}	en	SCN^-
I	II	III	IV

(a) I > II > IV > III
(b) III > II > IV > I
(c) III > I > IV > II
(d) III > IV > I > II

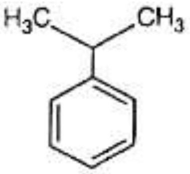
73. Assertion (A) The denaturation of proteins can destroy all 1°, 2° and 3° protein structures.
Reason (R) Curdling of milk is due to denaturation of proteins.
The correct option among the following is
(a) (A) is true, (R) is true and (R) is the correct explanation for (A)
(b) (A) is true, (R) is true but (R) is not the correct explanation for (A)
(c) (A) is true but (R) is false
(d) (A) is false but (R) is true

74. The major product formed in the following reaction sequence is

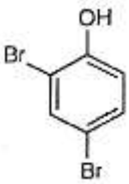
$$CH_3CH = CH_2 \xrightarrow[\text{(III)}CH_2CH_2CHO \\ \text{(IV)}CrO_3]{\text{(I)HBr.Peroxide} \\ \text{(II)Mg}}$$

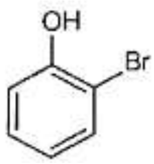
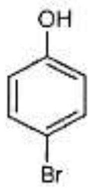
(a) 3-hexanone (b) 2-hexanone
(c) 2-methyl-3-pentanone (d) hexanal

75. The major aromatic product of the following reaction sequence is



$$\xrightarrow[\text{(iii)}Br_2 \text{in} CHCl_3.273\text{ K}]{\text{(i)}O_2 \\ \text{(ii)}H_3O^+}$$

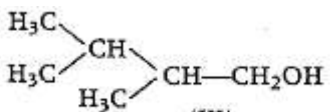
(a)  (b) 

(c)  (d) 

76. The order of reactivity of the following compounds towards the esterification with acetic acid is

$CH_3 - CH_2OH$ (I)

$(H_3C)_2CH - CH_2OH$ (II)



(III) $CH_3-CH_2-CH_2OH$

(IV)

(a) I > II > III > IV (b) IV > III > II > I
(c) I > IV > II > III (d) I > IV > III > II

77. Consider following reaction, where
(A) the change in the functional group and
(B) the corresponding change in the hybridisation from starting to the final product A and B are

$CH_3C\equiv N \xrightarrow[\text{(ii)}H_3O^+ \\ \text{(iii)HI+Red P}]{\text{(i)}SnCl_2,HCl}$

(a) -CN to $\overset{A}{-}CH_2-OH$ B $sp^2 \overset{B}{\text{to}} sp^3$
(b) -CN to $\overset{A}{-}CONH_2$ sp $\overset{B}{\text{to}}$ sp^2
(c) -CN to $\overset{A}{-}CH_2NH_2$ sp $\overset{B}{\text{to}}$ sp^2
(d) -CN to $\overset{A}{-}CH_3$ $\overset{B}{\text{sp}}$ to sp^3

78. Which of the following reactions will give benzophenone as major product?
(A) Benzoyl chloride + benzene +$AlCl_3$ (anhyd).
(B) Benzoyl chloride + phenyl magnesium bromide (excess)
(C) Benzoyl chloride + diphenyl cadmium

(a) A and B only (b) B and C only
(c) A and C only (d) A, B and C

79. The reagent that can reduce the carboxylic acid group to the corresponding alcohol is

(a) $NaBH_4/H_3O^+$ (b) B_2H_6/H_3O^+
(c) Zn − Hg/ conc. HCl (d) H_2, Pd/C

80. The starting material that produce pentanamine by Hoffmann bromamide reaction is

(a) $CH_3CH_2CH_2CH_2CN$
(b) $CH_3CH_2CH_2CH_2CONH_2$
(c) $CH_3CH_2CH_2CH_2NCO$
(d) $CH_3CH_2CH_2CH_2CH_2CONH_2$

Mathematics

81. The domain of the real valued function $f(x)=\frac{\sqrt{6x^2+5x-6}}{\sqrt{4-x}-\sqrt{x+4}}$ is

(a) $\left[-4,-\frac{3}{2}\right]\cup\left[\frac{2}{3},4\right]$
(b) $\left(-\infty,-\frac{3}{2}\right]\cup\left[\frac{2}{3},\infty\right)$
(c) $[-4,4]$
(d) $\left[-\frac{3}{2},\frac{2}{3}\right]$

82. If [x] represents the greatest integer ≤ x, then the range of the real valued function $f(x)=\frac{1}{\sqrt{[x]^2+[x]-2}}$ is

(a) $[-\infty,0]\cup\left(\frac{1}{2},\infty\right)$ (b) $\left(0,\frac{1}{2}\right]$
(c) $(-\infty,0)\cup[2,\infty)$ (d) $(0,2]$

83. Let $A=\begin{bmatrix} a & 3 & 5 \\ 5 & -1 & 3 \\ 2 & 3 & -4 \end{bmatrix}$ and $B=\begin{bmatrix} b & 1 & 4 \\ 4 & c & 1 \\ -3 & 1 & d \end{bmatrix}$. If the trace of A is -4 and $AB=\begin{bmatrix} -1 & 0 & 17 \\ -3 & 10 & 25 \\ 28 & -8 & 3 \end{bmatrix}$ then a + b + c + d =

(a) 7 (b) -1 (c) 3 (d) 1

84. $\begin{vmatrix} 1 & 1 & 1 \\ a^2 & b^2 & c^2 \\ a^3 & b^3 & c^3 \end{vmatrix}=$

(a) $a^2b^2(a-b)+b^2c^2(b-c)+c^2a^2(c-a)$
(b) $a^2(b^3-c^3)+b^3(c^3-a^3)+c^2(a^3-b^3)$
(c) $a^3(b^2-c^2)+b^3(c^2-a^2)+c^2(a^2-b^2)$
(d) $ab(a^3-b^3)+bc(b^3-c^3)+ca(c^3-a^3)$

85. Let α,β,γ be real numbers. If $A=\begin{bmatrix}7 & 3 & \alpha\\ \beta & 1 & -11\\ -5 & \gamma & 19\end{bmatrix}$ is a 3×3 matrix satisfying $A\begin{bmatrix}5\\-13\\11\end{bmatrix}=\begin{bmatrix}-290\\-119\\210\end{bmatrix}$, then $(\text{adj }A)^{-1}+\text{adj }A^{-1}=$

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

86. If $[\alpha\beta\gamma]\begin{bmatrix}1 & 2 & 3\\ 2 & 3 & -5\\ 1 & 2 & 5\end{bmatrix}=[352]$, then $\alpha^3+\beta^3+\gamma^3=$

(a) 8 (b) -6 (c) 6 (d) -10

87. $\sqrt{(-3+4i)(8+6i)}=$

(a) $\pm(1+2i)$ (b) $\pm(3+i)$
(c) $\pm(1+7i)$ (d) $\pm(7-i)$

88. If $\left(\frac{\sqrt{3}+i}{\sqrt{3}-i}\right)^m=1, 2022<m<2029$, then $m=$

(a) 2023 (b) 2024
(c) 2028 (d) 2026

89. If $1,\omega,\omega^2$ are the cube roots of unity, $n\in N$ and $n>2$ then the least value of n such that $1+\omega$ is a root of $x^n-x=0$ is

(a) 3 (b) 5 (c) 7 (d) 4

90. If $A=\left\{x\in R/\sqrt{x^2-8x+15}\in R\right\}$ and $B=\left\{x\in R/\frac{x-3}{2x-5}<\frac{x-6}{2x-11}\right\}$, then $A\cap B=$

(a) ϕ (b) $\left(\frac{5}{2},3\right]\cup\left[5,\frac{11}{2}\right)$
(c) $\left(\frac{5}{2},\frac{21}{4}\right)$ (d) $\left(\frac{5}{2},\frac{11}{2}\right)$

91. If the extreme value of $3x-2x^2+1$ is k, then the set of all real values of x for which $kx^2+2x+1>0$ is

(a) $\left(\frac{1}{2},1\right)$ (b) $\left(-\infty,\frac{1}{2}\right)\cup(1,\infty)$
(c) $(-2,\infty)$ (d) $\left(-\infty,\frac{17}{8}\right)$

92. If α,β,γ are the roots of the equation $x^3-5x^2-2x+24=0$, then $\frac{\beta\gamma}{\alpha}+\frac{\gamma\alpha}{\beta}+\frac{\alpha\beta}{\gamma}=$

(a) 244 (b) $-1/6$
(c) 61 (d) $-61/6$

93. If α,β,γ are the roots of the equation $3x^3-26x^2+52x-24=0$ such that α,β,γ are in geometric progression and $\alpha<\beta<\gamma$, then $3\alpha+2\beta+\gamma=$

(a) 68/3 (b) 56/3
(c) 12 (d) 24

94. Let $p(x)$ be a quadratic polynomial with real coefficients. If $p(x)=0$ has only purely imaginary roots, then the zeroes of the polynomial $p(p(x))$ are

(a) only real numbers
(b) only purely imaginary numbers
(c) only rational numbers
(d) only complex numbers of the form $a+ib$ with $a\neq 0$ and $b\neq 0$

95. If α,β,γ are the roots of the equation $4x^3+12x^2-7x+165=0$ and $\alpha+5,\beta+5,\gamma+5$ are the roots of the equation $ax^3+bx^2+cx+d=0$ then the product of the roots of the second equation is

(a) 27 (b) 0
(c) -3 (d) $3\sqrt{5}+4$

96. The number of 3 -digit odd numbers divisible by 3 that can be formed using the digits 1, 2, 3, 4, 5, 6 when repetition is not allowed, is

(a) 18 (b) 21 (c) 24 (d) 36

97. Match the items of List-I to the items of List-II

List-I		List-II
(A)	The number of ways of not selecting $(n-r)$ things from n different things	(I) $1+{}^nC_1+{}^nC_2+\cdots+{}^nC_r$
(B)	$(n-r+1)\cdot{}^nC_{r-1}$	(II) $(r+1)\cdot{}^nC_{r+1}$
(C)	The number of ways of selecting atleast $(n-r)$ things from n different things	(III) $r\cdot{}^nC_r$
(D)	$(n-r)\left({}^{(n-1)}C_{r-1}+{}^{(n-1)}C_r\right)$	(IV) $2^n-1-n-{}^nC_2-\cdots-{}^nC_r$
		(v) ${}^nC_{n-1}$

The correct match is

	A	B	C	D		A	B	C	D
(a)	V	III	IV	II	(b)	I	II	IV	III
(c)	V	III	I	II	(d)	I	V	IV	III

98. If L and M are respectively the coefficient of x^{-7} in $\left(ax+\frac{b}{x^2}\right)^{11}$ and the coefficient of x^7 in $\left(bx^2+\frac{a}{x^2}\right)^{11}$, then $L+M=$

(a) $\frac{1}{b}\left[\text{ coefficient of } x^{-6} \text{ in } \left(ax+\frac{b}{x^2}\right)^{12}\right]$

(b) $\frac{1}{a}\left[\text{ coefficient of } x^{-6} \text{ in } \left(ax^2+\frac{b}{x}\right)^{12}\right]$

(c) $a\left[\text{ coefficient of } x^{-10} \text{ in } \left(ax+\frac{b}{x^2}\right)^{11}\right]$

(d) $b\left[\text{ coefficient of } x^{4} \text{ in } \left(ax^2+\frac{b}{x}\right)^{11}\right]$

99. If $\frac{x^2-3x+2}{(x-4)(x-3)^2}=\frac{A}{x-4}+\frac{B}{x-3}+\frac{C}{(x-3)^2}$ then $A+B+C=$

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

100. If $\frac{x^2+3}{(x^2+1)(x^2+2)}=\frac{Ax+B}{x^2+1}+\frac{Cx+D}{x^2+2}$ then $A+B+C+D=$

(a) 3 (b) 2 (c) 0 (d) 1

101. If A and B$(A>B)$ are acute angles, $\sin(A-B)=\frac{16}{65}$ and $\sin B=\frac{5}{13}$, then $\tan A+\cot A=$

(a) $\frac{25}{12}$ (b) $\frac{12}{25}$ (c) $\frac{5}{12}$ (d) $\frac{12}{5}$

102. If $\tan A=\frac{2}{3}$, then $\sin 4A=$

(a) $\frac{8}{27}$ (b) $\frac{120}{169}$ (c) $\frac{144}{169}$ (d) $\frac{16}{27}$

103. $\frac{\sqrt{2}\cos 45^{\circ}+\cos 56^{\circ}+\cos 58^{\circ}-\cos 66^{\circ}}{\sqrt{2}\cos 28^{\circ}\cos 29^{\circ}\sin 33^{\circ}}$

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

(c) $\frac{\sqrt{2}}{2}$ (d) $4\sqrt{2}$

104. If $\theta=\frac{\pi}{12}$ and $x=\log\left(\cot\left(\frac{\pi}{4}+\theta\right)\right)$ then $\cosh x=$

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

105. $2\cosh(x+y)\sinh(x-y)+\sinh 2y=$

(a) $\sinh 2x$ (b) $\frac{\sinh 2x+\sinh 2y}{2}$

(c) $\frac{\sinh 2x-\sinh 2y}{2}$ (d) $\cosh 2x$

106. In a $\triangle ABC$, if $(b+c)^2\sin^2\frac{A}{2}+(b-c)^2\cos^2\frac{A}{2}=K(1-\cos 2A)$, then $K=$

(a) R^2 (b) $2R^2$

(c) R (d) $2R$

107. In a $\triangle ABC$, if $b=7, c=4\sqrt{3}$ and $A=\frac{\pi}{6}$ then $a\sin B\sin C=$

(a) $\frac{\sqrt{13}}{12}$ (b) $\frac{\sqrt{13}}{7\sqrt{3}}$ (c) $\frac{12}{\sqrt{13}}$ (d) $\frac{7\sqrt{3}}{\sqrt{13}}$

108. In $\triangle ABC$, if BC is the hypotenuse, then $r_2+r_3=$

(a) r_1+r (b) a

(c) $r-r_1$ (d) $2(R+r)$

109. In a $\triangle ABC$, D and E divide the sides BC and CA in the ratio 2:1 respectively. If P is the point of intersection of AD and BE, then the ratio in which P divides AD is

(a) 2: 1 (b) 3: 4

(c) 4: 3 (d) 1: 2

110. If the points with position vectors $\hat{i}-2\hat{j}+3\hat{k}, 2\hat{i}+3\hat{j}-4\hat{k}, -3\hat{i}+\hat{j}-5\hat{k}$ and $a\hat{i}-2\hat{j}+4\hat{k}$ are coplanar, then $a=$

(a) $\frac{-4}{19}$ (b) $\frac{42}{19}$ (c) $\frac{-49}{19}$ (d) $\frac{4}{19}$

111. If P is a point on the line parallel to the vector $2\hat{i}-3\hat{j}-6\hat{k}$ and passing through the point A whose position vector is $\hat{i}+2\hat{j}-2\hat{k}$ and $AP=21$, then the position vector of P can be

(a) $6\hat{i}-9\hat{j}-18\hat{k}$ (b) $6\hat{i}+9\hat{j}-18\hat{k}$

(c) $-5\hat{i}+11\hat{j}+16\hat{k}$ (d) $5\hat{i}-11\hat{j}+16\hat{k}$

112. Let a be a vector in the plane containing vectors $b=\hat{i}+2\hat{j}+\hat{k}$ and $c=2\hat{i}-\hat{j}+\hat{k}$. If a is perpendicular to $\hat{i}+\hat{j}+3\hat{k}$ and its projection on b is $3\sqrt{6}$, then $|a|^2=$

(a) 186 (b) 36

(c) 128 (d) 264

113. The cartesian equation of the plane passing through the point $(1,-2,3)$ and perpendicular to the vector $-\hat{i}+2\hat{j}-3\hat{k}$, is

(a) $-x+2y-3z=14$

(b) $x-2y+3z=14$

(c) $x+2y-3z=14$

(d) $-x+2y+3z=14$

114. Let $a=\hat{i}+\hat{j}+\hat{k}, b=\hat{i}-2\hat{j}+\hat{k}, c=\hat{i}+3\hat{j}-2\hat{k}, d=2\hat{i}+\hat{j}-\hat{k}$ be four vectors and let $l=b\cdot c$ and $m=c\cdot a$. Then, $[mb+labd]=$

(a) 79 (b) -63 (c) 0 (d) 1

115. If $\bar{x}$ is the mean of n observations $x_1, x_2, \ldots, x_n$ then the mean of the absolute deviations of these observations from $\bar{x}$ is

(a) the variance of the data

(b) the mean proportion of the data
(c) the standard deviation of the data
(d) the mean deviation of the data

116. **A cube having edge of length 5 cm is painted on all faces and then it is cut into equal cubes of unit volume. A small cube is selected at random and found that a face of it is painted, then the probability that two more faces of it are also painted is**

(a) $\frac{27}{125}$ (b) $\frac{4}{49}$ (c) $\frac{1}{8}$ (d) $\frac{8}{125}$

117. **A pair of dice is thrown twice in succession. The probability of getting prime number on both the dice in first throw and composite numbers on both the dice in second throw is**

(a) $\frac{1}{216}$ (b) $\frac{1}{16}$
(c) $\frac{1}{36}$ (d) $\frac{1}{9}$

118. **3 balls are drawn one after the other without replacement from an urn containing 4 red, 5 blue and 6 yellow balls. The probability of getting three different coloured balls is**

(a) $\frac{12}{91}$ (b) $\frac{24}{91}$ (c) $\frac{8}{225}$ (d) $\frac{8}{75}$

119. **Two balls are drawn at random from a bag containing 5 black balls and 3 white balls. If the random variable X denotes the number of white balls drawn, then the mean of X is**

(a) $\frac{1}{2}$ (b) $\frac{5}{8}$ (c) $\frac{3}{4}$ (d) $\frac{3}{8}$

120. **If the mean and variance of a binomial distribution are 4 and $\frac{4}{3}$ respectively, then $P(X=2)=$**

(a) $\frac{20}{243}$ (b) $\frac{40}{243}$ (c) $\frac{28}{729}$ (d) $\frac{8}{27}$

121. **Let $A(5,-3), B(3,-2), C(-1,5)$ be three points. If P is a point satisfying the condition $PA^2+2PB^2=3PC^2$, then a point that lies on the locus of P is**

(a) $\left(-\frac{1}{7},\frac{1}{2}\right)$ (b) $\left(-\frac{5}{2},-2\right)$
(c) $\left(-\frac{2}{21},\frac{31}{66}\right)$ (d) $\left(2,\frac{37}{22}\right)$

122. **When the coordinate axes are rotated about the origin in the positive direction through an angle $\frac{\pi}{4}$, if the equation $49x^2+25y^2=1225$ is transformed to $px^2+qxy+ry^2=t$ and the GCD of p,q,r,t is 1 , then**

(a) $(p-q+r-32)^2=4t$
(b) $(p-q-r+12)^2=t$
(c) $(p+q+r-15)^2=t$
(d) $(-p-q+r+13)^2=t$

123. **Let the slope of a diameter AC of a circle of radjus 25 units be $\frac{3}{4}$. If $(3,2)$ is the centre of the circle, $A=(x_1,y_1)$ and $C=(x_2,y_2)$, then $\frac{x_1x_2}{y_1y_2}=$**

(a) $\frac{-13}{23}$ (b) $\frac{13}{23}$ (c) $\frac{-23}{13}$ (d) $\frac{23}{13}$

124. **If θ is the acute angle between the lines $\frac{x}{a}+\frac{y}{b}=1, \frac{x}{b}+\frac{y}{a}=1$, then $\sin\theta=$**

(a) $\left|\frac{2ab}{a^2+b^2}\right|$ (b) $\left|\frac{a-b}{a+b}\right|$
(c) $\left|\frac{a^2-b^2}{2ab}\right|$ (d) $\left|\frac{a^2-b^2}{a^2+b^2}\right|$

125. **If the line $x-y+1=0$ cuts the lines $2x+2y+3=0$ and $3x+3y+2=0$ at the points A and B respectively, then $AB=$**

(a) $\frac{5}{6\sqrt{2}}$ (b) $\frac{1}{6\sqrt{2}}$
(c) $\frac{5}{\sqrt{3}}$ (d) $\frac{5}{6\sqrt{3}}$

126. **If the incentre and the circumcentre of the triangle formed by the lines $x=2, 4x+3y+7=0$ and $y=3$ are I and S respectively, then $IS=$**

(a) 5 (b) $\sqrt{5}$

(c) $4\sqrt{2}$ (d) $2\sqrt{5}$

127. $\mathbf{ax^2 - 4xy - 2y^2 = 0}$ **represents a pair of lines. If θ is the angle between these lines, $\cos\theta = \frac{1}{5}$ and the possible values of ' a ' are a_1 and $a_2 (a_1 < a_2)$, then $a_1 + 3a_2 =$**

(a) 11 (b) 10 (c) -5 (d) -6

128. **Let L_1, L_2 be the lines represented by the equation $4x^2 - 5xy + 3y^2 = 0$. Let L_3, L_4 be two lines passing through the point $(4, 3)$ such that L_3 and L_4 are perpendicular to L_1 and L_2 respectively. If the combined equation of L_3 and L_4 is $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, and $af + bg + ch =$**

(a) 144 (b) 66

(c) 78 (d) 2135

129. **The equation $x^2 - y^2 + ax + b = 0$ represents a pair of lines for the ordered pair $(a, b) =$**

(a) (2,6) (b) (3,4)

(c) (4,8) (d) (6,9)

130. **A circle passes through the points (1,2), $(3, 4)$. If its centre lines on the line $x - y + 3 = 0$, then its radius is equal to**

(a) 4 (b) 3 (c) 1 (d) 2

131. **A line drawn through the point $A(5, 7)$ cut the circle $x^2 + y^2 - 36 = 0$ at the points P and Q. Then, $AP \cdot AQ =$**

(a) 110 (b) 60 (c) 38 (d) 12

132. **Let P be any point on the circle $x^2 + y^2 - 2x - 1 = 0$ and C be its centre. Let AB be the chord of contact of P with respect to the circle $x^2 + y^2 - 2x = 0$. Then, the locus of the circumcentre of the $\triangle$ CAB is**

(a) $2x^2 + 2y^2 - 4x + 1 = 0$

(b) $x^2 + y^2 - 4x + 2 = 0$

(c) $x^2 + y^2 - 4x + 1 = 0$

(d) $2x^2 + 2y^2 - 4x + 3 = 0$

133. **If a circle C passing through $(4, 0)$ touches the circle $x^2 + y^2 + 4x - 6y - 12 = 0$ externally at the point (1 , -1), then the radius of C is**

(a) $\sqrt{12}$ (b) 4

(c) $\sqrt{3}$ (d) 5

134. **If the circles $C_1: x^2 + y^2 + 2x + 4y - 20 = 0$, $C_2: x^2 + y^2 + 6x - 8y + 9 = 0$ have n common tangents and the length of the tangent drawn from the centre of similitude to the circle C_2 is l, then $\frac{l}{n^2} =$**

(a) $4\sqrt{39}$ (b) $\sqrt{39}$

(c) $\frac{\sqrt{39}}{4}$ (d) $2\sqrt{39}$

135. **If the common chord of the circles $x^2 + y^2 + 4y = 0$ and $x^2 + y^2 - 4x - 5 = 0$ is the diameter of the circle $S = 0$, then the abscissa of the centre of the circle $S = 0$ is**

(a) $\frac{-13}{8}$ (b) $\frac{3}{8}$

(c) $\frac{3}{4}$ (d) $\frac{-13}{4}$

136. **If $y^2 = 16x$ is the given parabola, then the point of intersection of the focal chord through the point $(2, 2)$ and the double ordinate of length 24 is**

(a) (3,1) (b) $(9, -5)$

(c) (9,3) (d) $(8, -4)$

137. **Let PQ and RT be two focal chords of the parabola $y^2 = 16x$. If $P = (4, 8)$ are $R = (16, 16)$, then $QT =$**

(a) 5 (b) $4\sqrt{5}$

(c) $4\sqrt{13}$ (d) 13

138. If the eccentricity and the length of the latus rectum of an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}-1$ are $\frac{\sqrt{3}}{2}$ and 1 respectively, then the sum of the lengths of major axis and minor axis of the ellipse is

(a) 6 (b) 3 (c) 10 (d) 8

139. The parametric equations of the ellipse whose focii are $(-3,0),(9,0)$ and eccentricity is $\frac{1}{3}$, are

(a) $x=3+12\sqrt{2}\cos\theta, y=18\sin\theta$

(b) $x=3+18\cos\theta, y=12\sqrt{2}\sin\theta$

(c) $x=18\cos\theta, y=3+12\sqrt{2}\sin\theta$

(d) $x=3+4\sqrt{2}\cos\theta, y=18\sin\theta$

140. If $\frac{x^2}{k-\frac{5}{2}}+\frac{y^2}{\frac{7}{3}-k}=1$(k is a real number) represents a hyperbola, then the set of all values of k is

(a) $\left(-\infty,\frac{7}{3}\right)\cup\left(\frac{5}{2},\infty\right)$ (b) $\left(\frac{7}{3},\frac{5}{2}\right)$

(c) $\left(-1,\frac{7}{3}\right)\cup\left(\frac{5}{2},1\right)$ (d) $R-\left(\frac{7}{3},\frac{5}{2}\right)$

141. Let $A(\theta_1)$ and $B(\theta_2)$ be two points on the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ and S be the focus of the hyperbola, if A, S, B are collinear and $a\cos\left(\frac{\theta_1+\theta_2}{2}\right)=k\cos\left(\frac{\theta_1-\theta_2}{2}\right)$, then $k=$

(a) a^2+b^2 (b) $\sqrt{a^2+b^2}$

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

142. Let $A(1,2,3), B(-1,4,6), C(0,-6,4)$ and $D(1,1,1)$ be the vertices of a tetrahedron, G be its centroid and G_1 be the centroid of its face BCD. Then, $\frac{AG_1}{AG}=$

(a) $\frac{5}{3}$ (b) $\frac{4}{3}$ (c) $\frac{7}{6}$ (d) $\frac{5}{4}$

143. If a line L is common to the planes $x-y+z+2=0$ and $2x+y-2z+5=0$ then the direction cosines of the line L are

(a) $\left(\frac{1}{\sqrt{26}},\frac{4}{\sqrt{26}},\frac{3}{\sqrt{26}}\right)$ (b) $\left(\frac{1}{3},\frac{2}{3},\frac{2}{3}\right)$

(c) $\left(\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}}\right)$ (d) $\left(\frac{-1}{6},\frac{5}{6},\frac{\sqrt{10}}{6}\right)$

144. Let the foot of the perpendicular drawn from the point $(1,2,3)$ to a plane be $(-1,3,-2)$. Then, the perpendicular distance from the origin to the plane is

(a) $\frac{5}{\sqrt{30}}$ (b) $\sqrt{\frac{15}{2}}$ (c) $\frac{2}{\sqrt{15}}$ (d) $\frac{1}{\sqrt{3}}$

145. $\lim_{x\to3^-}\frac{x^3-3x^2-4x+12}{2x^3-7x^2+2x+3}=$

(a) 0 (b) ∞ (c) $\frac{5}{14}$ (d) $\frac{6}{13}$

146. $\lim_{x\to0}\frac{2^{2x}-2^{x+1}+2-\cos 2x}{x^2}=$

(a) $2+\log 2$

(b) $2+(\log 2)^2$

(c) $2+(\log 4)^2$

(d) $2+\log 4$

147. If $f(x)=\begin{cases}\frac{x^2-16}{x-4} & \text{if } x>4\\ 2x & \text{if } x\le 4\end{cases}$ then $f'(4^-)+f'(4^+)=$

(a) 1 (b) 2 (c) 3 (d) 4

148. If $f(x)=\log_e\left(e^{2x}\left(\frac{3x+5}{5-3x}\right)^{2/3}\right), x\neq\frac{-5}{3},\frac{5}{3}$, then the value of $\frac{df}{dx}$ at $x=1$, is

(a) $\frac{5}{4}$ (b) $\frac{7}{4}$ (c) $\frac{11}{4}$ (d) $\frac{13}{4}$

149. If $x = \operatorname{cosec}\theta - \sin\theta, y = \operatorname{cosec}^{2022}\theta - \sin^{2022}\theta$ and $\left(\frac{dy}{dx}\right)^2 = \frac{k(y^2+4)}{g(x)}$ where $k \in R$, then $10 + k - g(2022) =$

(a) 0 (b) 6 (c) 10 (d) 14

150. The area of the triangle formed by the tangent and the normal drawn to the curve $y^2 = 4x$ at $(1, 2)$ with Y-axis is (in square units)

(a) 4 (b) 3 (c) 2 (d) 1

151. Consider two families of curves $y^2 = 4ax$ (a is a parameter) and $x^2 + \frac{y^2}{2} = c^2$ (c is parameter). If one curve from each family is chosen, then the angle between those two curves is

(a) π (b) $\frac{\pi}{4}$ (c) $\frac{3\pi}{4}$ (d) $\frac{\pi}{2}$

152. Let a function $f(x)$ be continuous in an interval $[a, b]$. Let $\delta > 0$ be a very small real number. Let $c \in (a, b)$ be such that $f(c - \delta) < f(c)$ and $f(c + \delta) < f(c)$ for every $\delta > 0$. Let $(f(\alpha - \delta) - f(\alpha))(f(\alpha + \delta)) < 0 \forall \alpha \in (a, b)$ and $\alpha \neq c$.

Then,

(a) $f(x)$ has a local maximum at c and a local minimum at α

(b) $f(x)$ has a local maximum at α and a local minimum atc

(c) $f(x)$ has only one local maximum at c

(d) $f(x)$ has only one local minimum at c

153. Let $f(x) = \int \frac{2x^3 - 3x^2 + 4x - 5}{x^2} dx$ and $f(1) = 1$. Then, $f(5) =$

(a) $10 + 4\log 5$ (b) $10 - 4\log 5$

(c) $9 + 4\log 5$ (d) $9 - 4\log 5$

154. If $x > 0$ and $x \neq (2n+1)\frac{\pi}{2}$, then

$$\int \left(x\sqrt{x} - e^{\log(\sec x \tan x)} + \frac{3x^2 - 2x + 1}{x^2}\right) dx =$$

(a) $x\sqrt{x} - \sec x + 3x - 2\log x - \frac{1}{x} + c$

(b) $\frac{2}{5}x^2\sqrt{x} - \sec x + 3x + \frac{2}{x^2} - \frac{1}{x} + c$

(c) $x\sqrt{x} - \sec x + 3x + \frac{2}{x^2} - \frac{1}{x} + c$

(d) $\frac{2}{5}x^2\sqrt{x} - \sec x + 3x - 2\log x - \frac{1}{x} + c$

155. $\int (2x - 3)\sqrt{3x + 2}dx =$

(a) $\frac{2}{135}(54x^2 - 123x + 106)\sqrt{3x + 2} + c$

(b) $\frac{2}{135}(54x^2 + 123x - 106)\sqrt{3x + 2} + c$

(c) $\frac{2}{135}(54x^2 - 123x - 106)\sqrt{3x + 2} + c$

(d) $\frac{2}{135}(54x^2 - 195x - 106)\sqrt{3x + 2} + c$

156. $\int_1^4 \left(x + \sqrt{x} + \frac{1}{x}\right) dx - \int_1^{2\log 2} dx =$

(a) $\frac{79}{6}$ (b) $\frac{643}{6}$

(c) $\frac{321}{5}$ (d) 64

157. Let $I = \int_{-\pi/4}^{\pi/4} \frac{1}{2 - \cos 2x}\left(\frac{3}{\pi} + \log\left(\frac{4 + \sin x}{4 - \sin x}\right)\right) dx$. Given that $\int \frac{dx}{1 + kx^2} = \frac{1}{\sqrt{k}}\tan^{-1}(\sqrt{k}x) + c, \tan^{-1}(0) = 0$ and $\tan^{-1}(\sqrt{3}) = \frac{\pi}{3}$. Then, $31^2 =$

(a) 4 (b) 9 (c) 16 (d) 1

158. The differential equation of the family of circles with fixed radius r units and centre on the line $y = 3$, is

(a) $1 + \left(\frac{dy}{dx}\right)^2 = \frac{r^2}{(y-3)^2}$ (b) $1 + \left(\frac{dy}{dx}\right)^2 = \frac{r^2}{y-3}$

(c) $\left(\frac{dy}{dx}\right)^2 = \frac{r^2}{(y-3)^2}$ (d) $\left(\frac{dy}{dx}\right)^2 = \frac{r^2}{y-3}$

159. The degree of the differential equation

$$x\left(\frac{d^2y}{dx^2}\right)^{1/3} + 2x^2\left(\frac{d^2y}{dx^2}\right)^{5/3} + 7\frac{dy}{dx} + y = 0$$

(a) 15 (b) 5 (c) 12 (d) 3

160. The curve that satisfies the differential equation $xydy - (1 + y^2)dx = 0$ passes through $(1, 0)$ and intersects the curve $x^2 + 3y^2 = 3$ at an angle θ. Then, $\frac{2\theta}{\pi} =$

(a) 2 (b) 0 (c) 4 (d) 1