Physics

1. Assertion (A) When we bounce a ball on the ground, it comes to rest after a few bounces, losing all its energy. This is an example of violation of conservation of energy.

Reason (R) Energy can change from one form to another but the total energy is always conserved.

Which of the following is true?

(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

2. A gas satisfies the relation $pV^{5/3} = k$, where p is pressure, V is volume and k is constant. The dimension of constant k are

(a) $[ML^4 T^{-2}]$ (b) $[ML^2 T^{-2}]$

(c) $[ML^6 T^{-2}]$ (d) $[MLT^{-2}]$

3. A car moves in positive y-direction with velocity v proportional to distance travelled y as $v(y) \propto y^{\beta}$, where β is a positive constant. The car covers a distance L with average velocity $\langle v\rangle$ proportional to L as $\langle v\rangle \propto L^{1/3}$. The constant β is given as

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

4. Consider a particle moving along the positive direction of X-axis. The velocity of the particle is given by $v = \alpha\sqrt{x}$ (α is a positive constant). At time $t = 0$, if the particle is located at $x = 0$, the time dependence of the velocity and the acceleration of the particle are respectively

(a) $\frac{\alpha^2}{2}t$ and $\frac{\alpha^2}{2}$ (b) $\alpha^2 t$ and α^2

(c) $\frac{\alpha}{2}t$ and $\frac{\alpha}{2}$ (d) $\frac{\alpha^2}{4}t$ and $\frac{\alpha^2}{4}$

5. The magnitude of velocity and acceleration and velocity of a particle moving in a plane, whose position vector $r = 3t^2\hat{i} + 2t\hat{j} + \hat{k}$ at $t = 2$ s are respectively

(a) $\sqrt{148}, 6$ (b) $\sqrt{144}, 6$

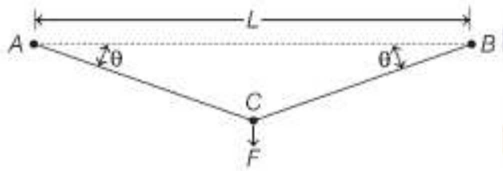
(c) $\sqrt{13}, 3$ (d) $\sqrt{14}, 3$

6. Two objects are located at height 10 m above the ground. At some point of time, the objects are thrown with initial velocity $2\sqrt{2}$ m/s at an angle $45°$ and $135°$ with the positive X-axis, respectively. Assuming $g = 10\ m/s^2$, the velocity vectors will be perpendicular to each other at time is equal to

(a) 0.2 s (b) 0.4 s

(c) 0.6 s (d) 0.8 s

7. String AB of unstretched length, L is stretched by applying a force F at the mid-point C such that the segments AC and BC make an angle θ with AB as shown in the figure. The string may be considered as an elastic element with a force to elongation ratio K. The force F is given by



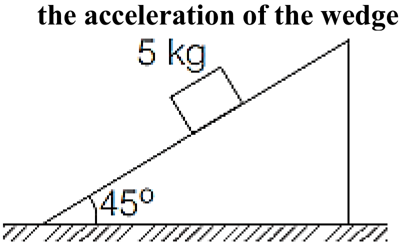
(a) $KL(1 - \tan\theta)\sin\theta$

(b) $2KL(1 - \cos\theta)\tan\theta$

(c) $KL(1 - \cos\theta)\tan\theta$

(d) $2KL(1 - \sin\theta)\tan\theta$

8. A block of mass 5 kg is kept against an accelerating wedge with a wedge angle of $45°$ to the horizontal. The coefficient of friction between the block and the wedge is $\mu = 0.4$. What is the minimum absolute value of the acceleration of the wedge to keep the block steady? [Assume, $g = 10\ m/s^2$]



(a) $\frac{60}{7}$ m/s^2 (b) $\frac{30}{7}$ m/s^2
(c) $\frac{30}{\sqrt{7}}$ m/s^2 (d) $\frac{60}{\sqrt{7}}$ m/s^2

9. An object moves along the circle with normal acceleration proportional to t^{α}, where t is the time and α is a positive constant. The power developed by all the forces acting on the object will have time dependence proportional to

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

10. A ball of mass 1 kg moving along x-direction collides elastically with a stationary ball of mass m. The first ball (mass = 1 kg) recoils at right angle to its original direction of motion. If the second ball starts moving at an angle 30° with the X-axis, then the value of m must be

(a) 0.5 kg (b) 1.5 kg
(c) 2.5 kg (d) 2 kg

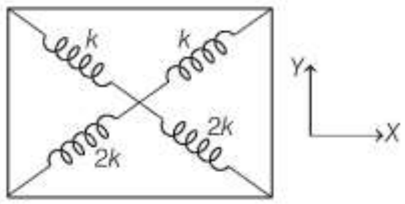
11. A machine gun can fire 200 bullets/min. If 35 g bullets are fired at a speed of 750 m/s, then the average force exerted by the gun on the bullets is

(a) 87.5 N (b) 26.2 N
(c) 78.9 N (d) 110.3 N

12. A solid sphere of radius R makes a perfect rolling down on a plane which is inclined to the horizontal axis at an angle θ. If the radius of gyration is k, then its acceleration is

(a) $\frac{g\sin\theta}{\left(1+\frac{k^2}{R^2}\right)}$ (b) $\frac{g\sin\theta}{(R^2+k^2)}$
(c) $\frac{g\sin\theta}{2(R^2+k^2)}$ (d) $\frac{g\sin\theta}{2\left(1+\frac{k^2}{R^2}\right)}$

13. A particle of mass m is attached to four springs with spring constant k, k, 2k and 2k as shown in the figure. Four springs are attached to the four corners of a square and a particle is placed at the center. If the particle is pushed slightly towards any sides of the square and released, the period of oscillation will be



(a) $2\pi\sqrt{\frac{m}{3k}}$ (b) $2\pi\sqrt{\frac{m}{3\sqrt{2}k}}$
(c) $2\pi\sqrt{\frac{m}{6k}}$ (d) $2\pi\sqrt{\frac{m}{2k}}$

14. The ratio of the height above the surface of earth to the depth below, the surface of earth, for gravitational accelerations to be the same (assuming small heights) is

(a) 0.25 (b) 0.5
(c) 1.0 (d) 1.25

15. A steel rod has radius 50 mm and length 2 m . It is stretched along its length with a force of 400 kN . This causes an elongation of 0.5 mm . Find the (approximate) Young's modulus of steel from this information.

(a) 2×0^{10}Nm^2 (b) 10^{11}Nm^2
(c) 2×10^{11}Nm^2 (d) 10^{12}Nm^2

16. Consider a vessel filled with a liquid up to height H. The bottom of the vessel lies in the XY-plane passing through the origin. The density of the liquid varies with Z-axis as $\rho(z) = \rho_0\left[2-\left(\frac{z}{H}\right)^2\right]$. If p_1 and p_2 are the pressures at the bottom surface and top surface of the liquid, the magnitude of $(p_1 - p_2)$ is

(a) $\rho_0 gH$ (b) $\frac{8}{5}\rho_0 gH$
(c) $\frac{3}{2}\rho_0 gH$ (d) $\frac{5}{3}\rho_0 gH$

17. A one mole of ideal gas goes through a process in which pressure p varies with volume V as $p = 3 - g\left(\frac{V}{V_0}\right)^2$, where, V_0 is a constant. The maximum attainable temperature by the ideal gas during this process is (all quantities are is SI units and R is gas constant)

(a) $\frac{2V_0}{3R}$ (b) $\frac{2V_0}{R}$
(c) $\frac{3V_0}{2R}$ (d) None of these

18. The internal energy of the air, in a room of volume V, at temperature T and with outside pressure p increasing linearly with time, varies as
(a) increases linearly
(b) increases exponentially
(c) decreases linearly
(d) remains constant

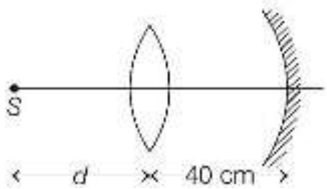
19. The efficiency of Carnot engine is η, when its hot and cold reservoirs are maintained at temperature T_1 and T_2, respectively. To increase the efficiency to 1.5η, the increase in temperature (ΔT) of the hot reservoir by keeping the cold one constant at T_2 is
(a) $\frac{T_1T_2}{(1-\eta)(1-1.5\eta)}$ (b) $\frac{0.5T_2\eta}{(1-1.5\eta)(1-\eta)}$
(c) $\frac{T_1}{(1-\eta)}-\frac{T_2}{(1-1.5\eta)}$ (d) $\frac{(1-\eta)(1-1.5\eta)}{T_1T_2}$

20. An air bubble rises from the bottom of a water tank of height 5 m . If the initial volume of the bubble is $3\ mm^3$, then what will be its volume as it reaches the surface? Assume that its temperature does not change. $[g=9.8\ m/s^2, 1\ atm=10^5$ Pa, density of water $=1 gm/cc]$
(a) $1.5\ mm^3$ (b) $4.5\ mm^3$
(c) $9\ mm^3$ (d) $6\ mm^3$

21. Two harmonic travelling waves are described by the equations $y_1=a\sin(kx-\omega t)$ and $y_2=a\sin(-kx+\omega t+\phi)$. The amplitude of the superimposed wave is
(a) $2a\cos\frac{\phi}{2}$ (b) $2a\sin\phi$
(c) $2a\cos\phi$ (d) $2a\sin\frac{\phi}{2}$

22. Where should an object be placed on the axis of a convex lens of focal length 8 cm , so as to achieve magnification of -4 ? (Distances are measured from optic centre of the lens)
(a) -6 cm (b) -10 cm
(c) -12 cm (d) -9 cm

23. A converging mirror is placed on the right- hand side of a converging lens as shown in the figure. The focal length of the mirror and the lens are 20 cm and 15 cm , respectively. The separation between the lens and the mirror is 40 cm and their principal axis coincide. A point source is placed on the principal axis at a distance d to the left of the lens. If the final beam comes out parallel to the principal axis, then the value of d is

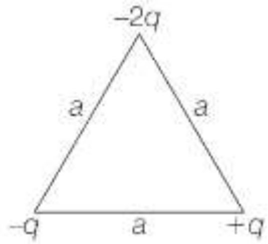


(a) 4 cm (b) 8 cm
(c) 12 cm (d) 16 cm

24. Interference fringes are obtained in a Young's double slit experiment using beam of light consisting two wavelengths 500 nm and 600 nm . Bright fringes due to both wavelengths coincide at 2.5 mm from the central maximum. If the separation between the slits is 3 mm , then the distance between the screen and plane of the slits is
(a) 1.2 m (b) 2.8 m
(c) 2.5 m (d) 3.2 m

25. A point charge of $50\mu C$ is placed in the XY-plane at a location with radius vector $r_0=2\hat{i}+3\hat{j}$ m. The electric field strength and its magnitude at a point with radius vector $r=8\hat{i}-5\hat{j}$ m is $(\varepsilon_0=8.85\times10^{-12}C^2/N-m^2)$
(a) $4.5 kV/m$ (b) $45 kV/m$
(c) $0.45 kV/m$ (d) $450 kV/m$

26. The work done to assemble the three charges in a configuration as shown in the figure below is



(a) $\frac{-3q^2}{4\pi\varepsilon_0 a}$ (b) $\frac{-2q^2}{4\pi\varepsilon_0 a}$

(c) $\frac{-q^2}{4\pi\varepsilon_0 a}$ (d) 0

27. Consider the following two circuits
[A] 20 bulbs are connected in series to a power supply line.
[B] 20 bulbs identical to [A] are connected in a parallel circuit to an identical power supply line.
Identify which of the following is not true?

(a) If one bulb in [A] blows out, all others will stop glowing
(b) Bulbs in [A] glow brighter, since the current flowing in [A] is higher
(c) If one bulb in [B] blows, other bulbs will still glow
(d) Bulbs in [B] have the highest voltage across each bulb

28. A tapered bar of length L and end diameters D_1 and D_2 is made of a material of electrical resistivity ρ. The electrical resistance of the bar is

(a) $\frac{4\rho L}{\pi(D_1+D_2)^2}$ (b) $\frac{4\rho L}{\pi(D_1-D_2)^2}$

(c) $\frac{\rho\pi\sqrt{D_1D_2}}{4L^2}$ (d) $\frac{4\rho L}{\pi D_1 D_2}$

29. Two circular loops L_1 and L_2 of wire carrying equal and opposite currents are placed parallel to each other with a common axis. The radius of loop L_1 is R_1 and that of L_2 is R_2. The distance between the centres of the loops is $\sqrt{3}R_1$. The magnetic field at the centre of L_2 shall be zero, if

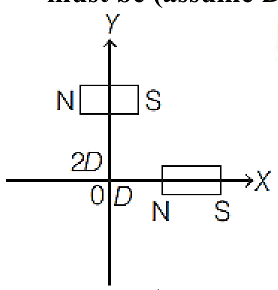
(a) $R_2 = 4R_1$ (b) $R_2 = 2R_1$

(c) $R_2 = \sqrt{2}R_1$ (d) $R_2 = 8R_1$

30. A non-conducting thin disc of radius R rotates about its axis with an angular velocity ω. The surface charge density on the disc varies with the distance r from the centre as $\sigma(r) = \sigma_0\left[1+\left(\frac{r}{R}\right)^{\beta}\right]$, where σ_0 and β are constants. If the magnetic induction at the center is $B = \left(\frac{9}{10}\right)\mu_0\sigma_0\omega R$, the value of β is

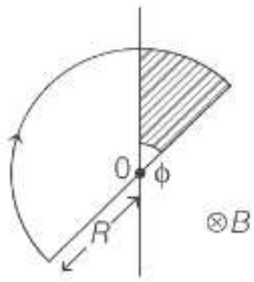
(a) $\frac{1}{4}$ (b) 4 (c) $\frac{1}{2}$ (d) 2

31. A bar magnet of magnetic moment M is placed at a distance D with its axis along positive X-axis. Likewise, second bar manget of magnetic moment M is placed at a distance 2D on positive Y-axis and perpendicular to it as shown in the figure. The magnitude of magnetic field at the origin is $|B| = \alpha\left[\frac{\mu_0}{4\pi}\frac{M}{D^3}\right]$. The value of α must be (assume $D \gg l$, where l is the length of magnets)



(a) 2 (b) $\frac{15}{8}$ (c) $\frac{17}{8}$ (d) $\frac{9}{8}$

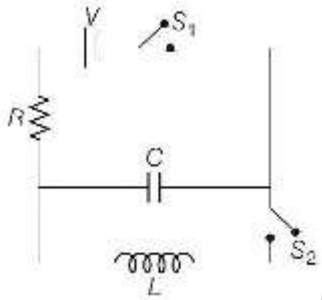
32. A wire loop enclosing a semi-circle of radius R is located on the boundary of a uniform magnetic field of induction B. At time $t = 0$, the loop is set into rotation with angular velocity angular ω about its axis 0 , coinciding with a line vector B on the boundary as shown in the figure. The emf induced in the loop is



(a) $\frac{BR^2}{2}\omega$ (b) $BR\omega$

(c) $BR^2\omega$ (d) $\frac{BR^2}{2\omega}$

33. In the circuit given below, the capacitor C is charged by closing the switch S_1 and opening the switch S_2. After charging, the switch S_1 is opened and S_2 is closed, then the maximum current in the circuit



(a) $V\sqrt{\frac{L}{C}}$ (b) $V\sqrt{\frac{C}{L}}$

(c) $\frac{V}{2\pi}\sqrt{\frac{L}{C}}$ (d) $2\pi V\sqrt{\frac{L}{C}}$

34. A 100 W electric bulb produces electromagnetic radiation with electric field amplitude of $\frac{2\text{ V}}{\text{m}}$ at a distance of 10 m . Assuming it as a point source, estimate the efficiency of the bulb.

(a) 4.9% (b) 2.5%

(c) 6.6% (d) 19.7%

35. At an incident radiation frequency of v_1, which is greater than the threshold frequency, the stooping potential for a certain metal is V_1. At frequency $2v_1$, the stopping potential is $3V_1$. If the stopping potential at frequency $4v_1$ is nV_1, then n is

(a) 2 (b) 3 (c) 6 (d) 7

36. The de-Broglie wavelength of an electron of kinetic energy 9 eV is (take, $h = 4 \times 10^{-15}\text{eV} - s, c = 3 \times 10^{10}$ cm/s and the mass m_e of electron as $m_e c^2 = 0.5\text{MeV}$)

(a) 4×10^{-8} cm (b) 3×10^{-8} cm

(c) 4×10^{-7} cm (d) 3×10^{-7} cm

37. An active nucleus decays to $\left(\frac{1}{3}\right)$rd in 20 h . The fraction of original activity remaining after 80 h is

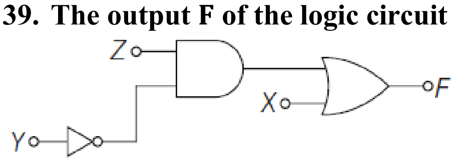
(a) $\frac{1}{16}$ (b) $\frac{1}{81}$ (c) $\frac{1}{36}$ (d) $\frac{1}{54}$

38. Consider an amplifier circuit, where in a transistor is used in common emitter mode. The change in collector current and base current respectively are 4 mA and 20μ A when a signal of 40 mV is added to the base-emitter voltage. If the load resistance is 10kΩ, then power gain in the circuit is

(a) 1×10^4 (b) 2×10^7

(c) 8×10^5 (d) 1×10^6

39. The output F of the logic circuit given below is



(a) $X + \bar{Y} \cdot Z$ (b) $(Y + Z) \cdot X$

(c) $(\bar{Y} + Z) + X$ (d) $X + \bar{Y} + Z$

40. A carrier wave of peak voltage 20 V is used to transmit a message signal. For getting a modulation index of 60%, the peak voltage of the modulating signal is

(a) 6 V (b) 8 V

(c) 12 V (d) 33.3 V

Chemistry

41. The energy of an electron in the 3rd orbit of H -atom (in J) is approximately.

(a) -2.18×10^{-18} (b) -2.42×10^{-19}

(c) -1.21×10^{-19} (d) -3.63×10^{-19}

42. The wavelength (in m) of a particle of mass 11.043×10^{-26} kg moving with a velocity of $6.0 \times 10^{7}\ ms^{-1}$ is

(a) 1.0×10^{16} (b) 6.0×10^{-16}

(c) 1.0×10^{-16} (d) 6.0×10^{16}

43. Covalent bond length of chlorine molecule is 1.98Å. Covalent radius (in Å) of chlorine atom is

(a) 1.98 (b) 0.99

(c) 3.96 (d) 0.49

44. The covalency of Al in $[AlCl(H_2O)_5]^{2+}$ is

(a) 3 (b) 5 (c) 1 (d) 6

45. The correct order of bond angles of the given compounds is

(a) $NH_3 < PH_3 < AsH_3 < SbH_3$

(b) $SbH_3 < AsH_3 < PH_3 < NH_3$

(c) $NH_3 < AsH_3 < SbH_3 < PH_3$

(d) $PH_3 < SbH_3 < AsH_3 < NH_3$

46. The molecular orbital theory supports paramagnetic behaviour of

(a) Be_2 (b) C_2

(c) N_2 (d) O_2

47. Which of the following represents van der Waals' equation for n moles of the gas?

(a) $\left(p + \frac{a}{V^2}\right)(V - b) = nRT$

(b) $p(V - b) = nRT$

(c) $\left(p + \frac{a}{V^2}\right)V = nRT$

(d) $pV + \frac{an^2}{V} - \frac{abn^3}{V^2} - pnb = nRT$

48. The kinetic energy in J of 1 mole of N_2 at 27°C is ($R = 8.314\ J\ mol^{-1}\ K^{-1}$)

(a) 2,494 (b) 18,706

(c) 7,482 (d) 3.741

49. In the titration of $I_2(aq)$ by $S_2O_3^{2-}$ (aq) using the starch indicator, the end point is indicated by

(a) colourless to blue (b) blue to colourless

(c) pink to colourless (d) blue to pink

50. When 10 g of 90% pure limestone is heated, the approximate volume (in L) of CO_2 liberated at STP is

(a) 4.4 (b) 2.0

(c) 4.0 (d) 22.4

51. At 298 K , the equilibrium constant of the process $1.5O_2(g) \rightleftharpoons O_3(g)$ is 3×10^{-29}. Standard free energy change (in $kJmol^{-1}$) of the process is approximately ($R = 8.314$ J $mol^{-1}\ K^{-1}; \log 3 = 0.47$)

(a) 724 (b) 612

(c) 247 (d) 163

52. For a reaction $2A(g) \rightleftharpoons 2B(g) + C(g)$, $K_C = 3.75 \times 10^{-6}$ at 1069 K . The approximate value of K_p for this reaction at the same temperature is ($R = 0.082\ Lbarmol^{-1}\ K^{-1}$)

(a) 2.4×10^{-4} (b) 3.3×10^{-4}

(c) 33×10^{2} (d) 7.2×10^{4}

53. The degree of dissociation of $0.1\ NCH_3COOH$ is (given $K_a = 1 \times 10^{-5}$) approximately

(a) 1×10^{-6} (b) 1×10^{-7}

(c) 1×10^{-3} (d) 1×10^{-2}

54. Match the reactants in List-I with the products in List-II.

List I	List II
(A) $H_2O + H_2S$	(i) (H_3O^+, HS^-)
(B) $H_2O + N^{3-}$	(ii) (NH_3, OH^-)
(C) $H_2O + SiCl_4$	(iii) (OH^-, H_3S^+)
(D) $H_2O + F_2$	(iv) (SiO_2, HCl)
	(v) (SiO_4^{4-}, Cl_2)
	(vi) (O_2, F^-)
	(vii) $(HF^a\ OH^-)$
	(viii) (OH^-, HN_3)

The correct answer is

A B C D **A B C D**

(a) (i) (viii) (v) (vi) (b) (iii) (ii) (v) (vii)

(c) (ii) (viii) (iv) (vii) (d) (i) (ii) (iv) (vi)

55. When sodium (Na) metal is dissolved in liquid ammonia (NH_3), it imparts a blue colour to the solution. This blue colouration is due to

(a) liquid NH_3 (b) $[Na(NH_3)_x]^+$

(c) $NaNH_2$ (d) $[\bar{e}(NH_3)_x]^+$

56. Identify the correct statements from the following:

(i) In orthoboric acid, boron is in planar geometry

(ii) In $BCl_3 . NH_3$, boron has tetrahedral geometry

(iii) Aqueous solution of borax is acidic

(a) (i), (ii) (b) (ii), (iii)

(c) (i), (iii) (d) (i), (ii), (iii)

57. Si reacts with CH_3Cl at 573 K in the presence of Cu powder to form methyl substituted chlorosilanes. Among the given methyl substituted chlorosilanes, whose yield is minimum?

(a) CH_3SiCl_3 (b) $(CH_3)_2SiCl_2$

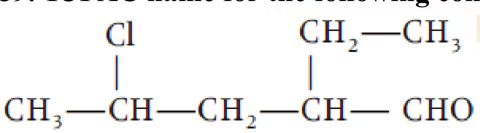
(c) $(CH_3)_3SiCl$ (d) $(CH_3)_4Si$

58. When vegetation is burnt in the absence of oxygen, which of the following will be formed?

(a) CH_4 (b) $H_2C = CH_2$

(c) $H - C \equiv C - H$ (d) $H_3C - CH_3$

59. IUPAC name for the following compound is



(a) 2-chloro-4-ethylpentanal

(b) 2-ethyl-4-chloropentanal

(c) 4-chloro-2-ethylpentanal

(d) 2-chlorohexane-4-al

60. What are the products formed in the reaction given below?

$$Ph - CH_2 - CH = CH - CH_3 \xrightarrow[\text{(ii) } Zn + H_2O]{\text{(i) } O_3} ?$$

(a) Acetic acid and 2-phenyl acetic acid

(b) 2-phenyl ethanal and ethanal

(c) 2-phenyl ethanol and ethanol

(d) 1-phenyl butan-2, 3-diol

61. **The major product obtained in the reaction of isobutyl benzene with acetic anhydride in the presence of anhydrous $AlCl_3$ is**
(a) p-isobutyl acetophenone
(b) acetophenone
(c) m-isobutyl acetophenone
(d) o-isobutyl acetophenone

62. **A compound is formed by elements of X, Y and Z. Atoms of Z (anions) make fcc lattice. Atoms of X (cations) occupy all the octahedral voids. Atoms of Y (cations) occupy $\frac{1}{3}$ rd of the tetrahedral voids. The formula of the compound is**
(a) $X_3Y_2Z_3$ (b) X_2YZ
(c) XY_2Z (d) X_2Y_2Z

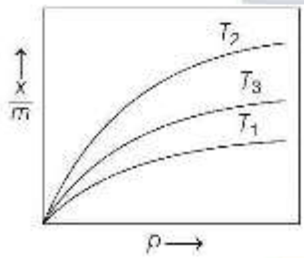
63. **A litre of sea water (which weights 1030 g) contains 6×10^{-3} g of dissolved oxygen. The concentration of dissolved oxygen in ppm is**
(a) 5.8 (b) 6.0 (c) 6. (d) 6.4

64. **At 300 K , a one litre solution of sucrose (molecular weight : 342) was prepared by dissolving 40 g of sucrose. What is the approximate osmotic pressure (in kPa) of solution at the same temperature? $\left(R = 8.314 \times 10^6\ cm^3\ Pa\ K^{-1}\ mol^{-1}\right)$**
(a) 292 (b) 500
(c) 292000 (d) 600

65. **The EMF of a galvanic cell consisting of two hydrogen electrodes is 0.17 V . If the solution of one of the electrodes has $[H^+] = 10^{-3}M$, the pH at the other electrode is**
(a) 5.87 (b) 4.88
(c) 2.08 (d) 3.08

66. **If the rate constants of a reaction at 500 K and 700 K are $0.002\ s^{-1}$ and $0.06\ s^{-1}$ respectively, the value of K^{-1} activation energy is ($R = 8.314\ J\ mol^{-1}\ K^{-1}, \log 3 = 0.477$)**
(a) 49.49 kJ mol^{-1} (b) 98.98 kJ mol^{-1}
(c) 24.75 kJ mol^{-1} (d) 12.37 kJ mol^{-1}

67. **The following graph is obtained for physisorption of a gas as a function of pressure at different temperatures.**



The correct order of temperatures is
(a) $T_3 < T_2 < T_1$ (b) $T_2 < T_3 < T_1$
(c) $T_2 < T_1 < T_3$ (d) $T_1 < T_3 < T_2$

68. **Identify the correct set of sulphide ores from the following.**
(a) Fool's gold, calamine, kaolinite
(b) Sphalerite, fool's gold, chalcopyrites
(c) Copper glance, siderite, malachite
(d) Bauxite, magnetite, zincite

69. **Identify the reactions in which N_2 is liberated**
(i) $(NH_4)_2SO_4 + NaOH \longrightarrow$
(ii) $NH_3 + Cl_2 \longrightarrow$ (iii) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta}$
(iv) $NH_4NO_3 \xrightarrow{\Delta}$
(v) $NH_4Cl(aq) + NaNO_2(aq) \longrightarrow$

(a) (i), (ii), (iii) (b) (iii), (iv), (v)
(c) (ii), (iii), (v) (d) (i), (iii), (iv)

70. What are X and Y, respectively in the following reactions?

$Au + \text{aqua-regia} \longrightarrow AuCl_4^- + H_2O + X$

$Pt + \text{aqua-regia} \longrightarrow PtCl_6^{2-} + H_2O + Y$

(a) N_2O, NO (b) N_2O, N_2O
(c) NO, NO (d) NO, NO_2

71. Which of the following sets correctly represent the increasing paramagnetic property of the ion?

(a) $Cu^{2+} < V^{2+} < Cr^{2+} < Mn^{2+}$
(b) $Cu^{2+} < Cr^{2+} < V^{2+} < Mn^{2+}$
(c) $Mn^{2+} < V^{2+} < Cr^{2+} < Cu^{2+}$
(d) $Mn^{2+} < Cu^{2+} < Cr^{2+} < V^{2+}$

72. Which of the following molecules/ions can exhibit isomerism?

(i) Tetrahedral $NiCl_2Br_2^{2-}$
(ii) Square planar $Pt(NH_3)_2Cl_2$
(iii) Octahedral $Co(NH_3)_3Cl_3$
(iv) Square planar $Pd(NH_3)_3Br^+$
(v) Octahedral $Co(en)_3^{3+}$
where, $(en) = 1,2$-diaminoethane

(a) (i), (ii), (iii), (iv) (b) (ii), (iii), (v)
(c) (ii), (iii), (iv) (d) (i), (ii), (iii), (v)

73. The formation of terylene (or dacron) from ethylene glycol and terephthalic acid is

(a) a condensation polymerisation reaction
(b) an anionic polymerisation reaction
(c) an addition polymerisation reaction
(d) a cationic polymerisation reaction

74. Which of the following carbohydrates has a glycosidic linkage?

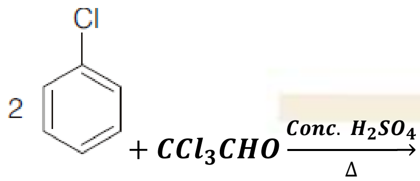
(a) Fructofuranose (b) Glucopyranose
(c) Maltose (d) β-D-fructose

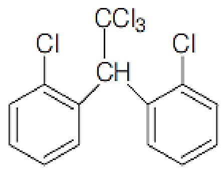
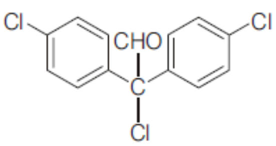
75. Identify an antioxidant, an antiseptic, and an antibiotic respectively from the following.

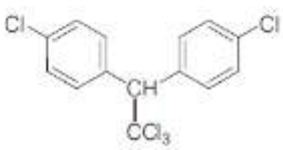
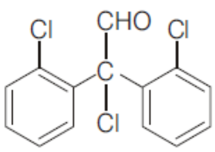
Equanil Chloramphenicol Bithionol
(A) (B) (C)
Aspartame Dimetapp Butylated hydroxytoluene
(D) (E) (F)

(a) A, C, E (b) F, C, B
(c) B, D, E (d) C, D, F

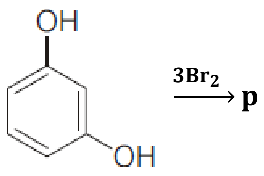
76. The major product (P) formed in the following reaction is

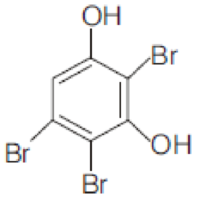


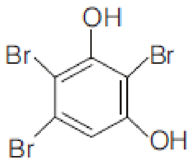
(a)  (b) 

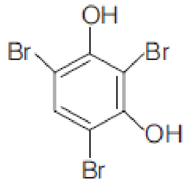
(c)  (d) 

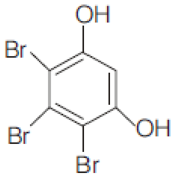
77. The product (P) of the below reaction is



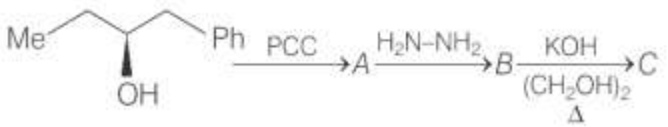
(a)


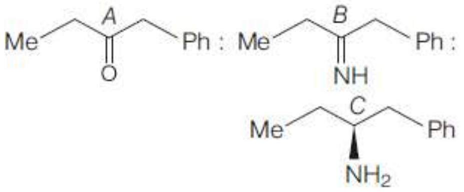
(b)


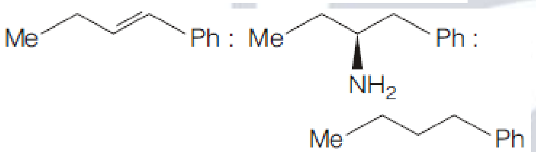
(c)


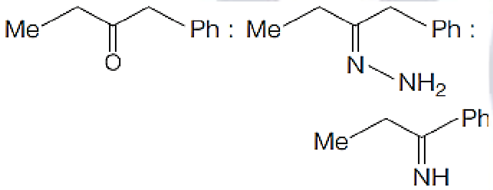
(d)


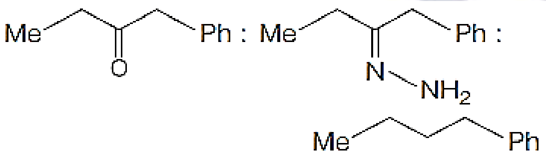
78. The products A, B and C in the following reaction sequence are





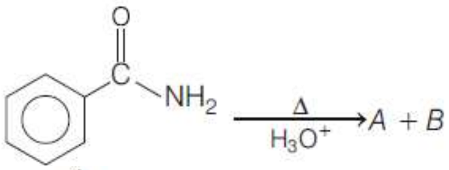
(a)


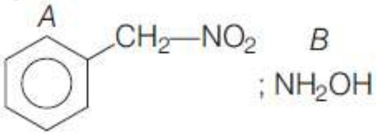
(b)


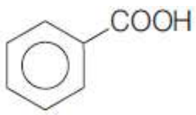
(c)


(d)

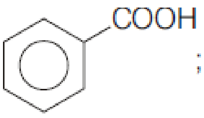
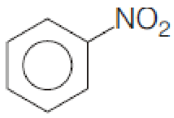
79. Identify A and B in the following reaction

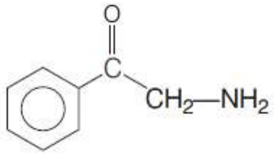


(a)


(b)  ; NH_3

A B

(c)  ; 

(d)  ; NH_3

80. Which product of the following reactions fails to give carbylamine test?

(a) Hoffmann-bromamide degradation
(b) Gabriel phthalimide synthesis
(c) Reduction of nitrites with $LiAlH_4$
(d) Reduction of tertiary amides with $LiAlH_4$

Mathematics

81. Let $f: R \to R, g: R \to R$ be differentiable functions such that $(fog)(x) = x$. If $f(x) = 2x + \cos x + \sin^2 x$, then the value of $\sum_{n=1}^{99} g(1 + (2n - 1)\pi)$ is

(a) 1250π (b) $(99)^2 \frac{\pi}{2}$
(c) $(99)^2\pi$ (d) 2500π

82. If $f: [1, \infty) \to [1, \infty]$ is defined by $f(x) = \frac{1+\sqrt{1+4\log_2 x}}{2}$, then $f^{-1}(3) =$

(a) 0 (b) 1
(c) 64 (d) $\frac{1+\sqrt{5}}{2}$

83. If α and β are the greatest divisors of $n(n^2 - 1)$ and $2n(n^2 + 2)$ respectively for all $n \in N$, then $\alpha\beta =$

(a) 18 (b) 36 (c) 27 (d) 9

84. Let $A = \begin{bmatrix} \frac{1}{6} & \frac{-1}{3} & \frac{-1}{6} \\ \frac{-1}{3} & \frac{2}{3} & \frac{1}{3} \\ \frac{-1}{6} & \frac{1}{3} & \frac{1}{6} \end{bmatrix}$. If $A^{2016l} + A^{2017m} + A^{2018n} = \frac{1}{\alpha}A$, for every $l, m, n \in N$, then the value of α is

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

85. Let $l, m, n \in R$ and $A = \begin{bmatrix} 1 & r & r^2 & l \\ r & r^2 & 1 & m \\ r^2 & 1 & r & n \end{bmatrix}$. Then, the set of all real values of r for which the rank of A is 3 , is

(a) $(0, \infty)$ (b) R
(c) $R - \{1\}$ (d) $R - \{0\}$

86. The following system of equations
$x + y + z = 9$, $2x + 5y + 7z = 52$
and $x + 7y + 11z = 77$ has

(a) no solution
(b) exactly 2 solution
(c) only one solution
(d) infinitely many solutions

87. Z is a complex number such that $|Z| \le 2$ and $-\frac{\pi}{3} \le ampZ \le \frac{\pi}{3}$. The area of the region formed by locus of Z is

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

88. **The points in the argand plane given by $Z_1 = -3 + 5i, Z_2 = -1 + 6i, Z_3 = -2 + 8i, Z_4 = -4 + 7i$ form a**
(a) parallelogram (b) rectangle
(c) rhombus (d) square

89. **When $n = 8, (\sqrt{3} + i)^n + (\sqrt{3} - i)^n =$**
(a) -256 (b) -128
(c) 256i (d) 128i

90. **If 2 cis $\frac{7\pi}{5}$ is one of the values of $z^{1/5}$, then $z =$**
(a) $32 + 32i$ (b) -32
(c) -1 (d) 32

91. **The set of real values of x for which the inequality $|x - 1| + |x + 1| < 4$ always holds good is**
(a) $(-2,2)$
(b) $(-\infty,-2) \cup (2,\infty)$
(c) $(-\infty,-1] \cup [1,\infty)$
(d) $(-2,-1) \cup (1,2)$

92. **If the roots of the equation $x^2 + x + a = 0$ exceed a, then**
(a) $a > 2$ (b) $a < -2$
(c) $2 < a < 3$ (d) $-2 < a < -1$

93. **If the roots of the equation $\sqrt{\frac{x}{1-x}} + \sqrt{\frac{1-x}{x}} = \frac{5}{2}$ are p and $q(p > q)$ and the roots of the equation $(p + q)x^4 - pqx^2 + \frac{p}{q} = 0$ are $\alpha, \beta, \gamma, \delta$, then $(\Sigma\alpha)^2 - \Sigma\alpha\beta + \alpha\beta\gamma\delta =$**
(a) 0 (b) $\frac{104}{25}$ (c) $\frac{25}{4}$ (d) $\frac{16}{5}$

94. **The equation $x^5 - 5x^3 + 5x^2 - 1 = 0$ has three equal roots. If α, β are the other two roots of this equation, then $\alpha + \beta + \alpha\beta =$**
(a) -4 (b) 3 (c) -2 (d) -5

95. **If all possible numbers are formed by using the digits 1, 2, 3, 5, 7 without repetition and they are arranged in descending order, then the rank of the number 327 is**
(a) 31 (b) 175
(c) 149 (d) 271

96. **If a is the number of all even divisors and b is the number of all odd divisors of the number 10800, then $2a + 3b =$**
(a) 72 (b) 132
(c) 96 (d) 136

97. **If the coefficient of x^5 in the expansion of $\left(ax^2 + \frac{1}{bx}\right)^{13}$ is equal to the coefficient of x^{-5} in the expansion of $\left(ax - \frac{1}{bx^2}\right)^{13}$, then $ab =$**
(a) 1 (b) $\frac{1}{6}$ (c) $\frac{7}{6}$ (d) $\frac{4}{2}$

98. **For $n \in N$, in the expansion of $\left(\sqrt[4]{x^{-3}} + a\sqrt[4]{x^5}\right)^n$, the sum of all binomial coefficients lies between 200 and 400 and the term independent of x is 448. Then, the value of a is**
(a) 1 (b) 2 (c) $\frac{1}{2}$ (d) 0

99. **If $\frac{x^4+x^3+2x^2-2x+1}{x^3+x^2} = P(x) + \frac{A}{x} + \frac{B}{x^2} + \frac{C}{x+1}$, then $A + B + C =$**
(a) P(0) (b) P(2)
(c) P(3) (d) P(4)

100. **If $A(n) = \sin^n\alpha + \cos^n\alpha$, then $A(1)A(4) + A(2)A(5) =$**
(a) $A(1)A(2) + A(4)A(5)$
(b) $A(1)A(6) + A(2)A(3)$
(c) $A(1)A(3) + A(2)A(6)$
(d) $A(1)A(2) + A(3)A(6)$

101. When $\frac{\sin 9\theta}{\cos 27\theta}+\frac{\sin 3\theta}{\cos 9\theta}+\frac{\sin\theta}{\cos 3\theta}=k(\tan 27\theta-\tan\theta)$ is defined, then k =
(a) $\frac{\pi}{2}$ (b) $-\frac{1}{2}$ (c) $\frac{1}{2}$ (d) $\frac{\pi}{4}$

102. If $x=\sum_{n=0}^{\infty}\cos^{2n}\theta, y=\sum_{n=0}^{\infty}\sin^{2n}\theta, z=\sum_{n=0}^{\infty}\cos^{2n}\theta\sin^{2n}\theta$ and $0<\theta<\frac{\pi}{2}$, then
(a) $xz+yz=xy+z$
(b) $xyz=yz+x$
(c) $xy+z=xy+zx$
(d) $x+y+z=xyz+z$

103. Number of solutions of the equation $\sin x-\sin 2x+\sin 3x=2\cos^2 x-2\cos x$ in $(0,\pi)$ is
(a) 1 (b) 3 (c) 2 (d) 4

104. $2\tan^{-1}\frac{1}{5}+\sec^{-1}\frac{5\sqrt{2}}{7}+2\tan^{-1}\frac{1}{8}=$
(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{8}$

105. If $\cosh x=\frac{\sqrt{14}}{3}$, $\sinh x=\cos\theta$ and $-\pi<\theta<-\frac{\pi}{2}$, then $\sin\theta=$
(a) $\frac{1}{3}$ (b) $\frac{2}{3}$ (c) $-\frac{1}{3}$ (d) $-\frac{2}{3}$

106. In $\triangle ABC$, if $a=5$ and $\tan\frac{A-B}{2}=\frac{1}{4}\tan\frac{A+B}{2}$, then $\sqrt{a^2-b^2}=$
(a) 2 (b) 3 (c) 4 (d) 5

107. In a $\triangle ABC$, if $A=2B$ and the sides opposite to the angles A, B, C are $\alpha+1, \alpha-1$ and α respectively, then $\alpha=$
(a) 3 (b) 4 (c) 5 (d) 6

108. In $\triangle ABC$, right angled at A, the circumradius, inradius and radius of the excircle opposite to A are respectively in the ratio $2:5:\lambda$, then the roots of the equation $x^2-(\lambda-5)x+(\lambda-6)=0$ are
(a) 3,4 (b) 5,13
(c) 1,3 (d) 8,13

109. Let $3\hat{i}+\hat{j}-\hat{k}$ be the position vector of a point B. Let A be a point on the line which is passing through B and parallel to the vector $2\hat{i}-\hat{j}+2\hat{k}$. If $|BA|=18$, then the position vector of A is
(a) $-9\hat{i}+7\hat{j}-13\hat{k}$ (b) $-9\hat{i}+3\hat{j}+12\hat{k}$
(c) $9\hat{i}-3\hat{j}+2\hat{k}$ (d) $3\hat{i}-\hat{j}+7\hat{k}$

110. The vector that is parallel to the vector $2\hat{i}-2\hat{j}-4\hat{k}$ and coplanar with the vectors $\hat{i}+\hat{j}$ and $\hat{j}+\hat{k}$ is
(a) $\hat{i}-\hat{k}$ (b) $\hat{i}+\hat{j}-\hat{k}$
(c) $\hat{i}-\hat{j}-2\hat{k}$ (d) $3\hat{i}+3\hat{j}+6\hat{k}$

111. A line L is passing through the point A whose position vector is $\hat{i}+2\hat{j}-3\hat{k}$ and parallel to the vector $2\hat{i}+\hat{j}+2\hat{k}$. A plane π is passing through the points $\hat{i}+\hat{j}+\hat{k}, \hat{i}-\hat{j}-\hat{k}$ and parallel to the vector $\hat{i}-2\hat{j}$. Then, the point where this plane π meets the line L is
(a) $\frac{1}{3}(-7\hat{i}+\hat{j}-19\hat{k})$ (b) $7\hat{i}+\hat{j}-19\hat{k}$
(c) $3\hat{i}+3\hat{j}-\hat{k}$ (d) $2\hat{i}-\hat{j}+\hat{k}$

112. If the position vectors of three points A, B, C respectively are $\hat{i}+2\hat{j}+\hat{k}, 2\hat{i}-\hat{j}+2\hat{k}$ and $\hat{i}+\hat{j}+2\hat{k}$, then the perpendicular distance of the point C from the line AB is
(a) $\sqrt{\frac{3}{11}}$ (b) $\sqrt{\frac{4}{11}}$ (c) $\sqrt{\frac{6}{11}}$ (d) $\sqrt{\frac{8}{11}}$

113. The volume of a tetrahedron whose vertices are $4\hat{i}+5\hat{j}+\hat{k}, -\hat{j}+\hat{k}, 3\hat{i}+9\hat{j}+4\hat{k}$ and $-2\hat{i}+4\hat{j}+4\hat{k}$ is (in cubic units)
(a) $\frac{14}{3}$ (b) 5 (c) 6 (d) 30

114. If the vectors **b**, **c**, **d** are not coplanar, then the vector $(\mathbf{a}\times\mathbf{b})\times(\mathbf{c}\times\mathbf{d})+(\mathbf{a}\times\mathbf{c})\times(\mathbf{d}\times\mathbf{b})+(\mathbf{a}\times\mathbf{d})\times(\mathbf{b}\times\mathbf{c})$ is
(a) parallel to a (b) parallel to **b**
(c) parallel to **C** (d) perpendicular to a

115. $x_1, x_2, \dots, x_n$ are n observations with mean $\bar{x}$ and standard deviation σ. Match the items of List-I with those of List-II

	List-I		List-II

(A)	$\sum_{i=1}^{n}(x_i - \bar{x})$	(i)	Median
(B)	Variance (σ^2)	(ii)	Coefficient of variation
(C)	Mean deviation	(iii)	Zero
(D)	Measure used to find the homogeneity of given two series	(iv)	Mean of the absolute deviations from any measure of central tendency
		(v)	Mean of the squares of the deviations from mean

The correct answer is

A B C D A B C D
(a) (i) (v) (ii) (iii) (b) (i) (iv) (iii) (ii)
(c) (iii) (v) (iv) (ii) (d) (iii) (v) (ii) (i)

116. The variance of 50 observations is 7 . If each observation is multiplied by 6 and then 5 is subtracted from it, then the variance of the new data is
(a) 37 (b) 42
(c) 247 (d) 252

117. Two dice are thrown and two coins are tossed simultaneously. The probability of getting prime numbers on both the dice along with a head and a tail on the two coins is
(a) $\frac{1}{8}$ (b) $\frac{1}{2}$ (c) $\frac{3}{16}$ (d) $\frac{1}{4}$

118. 5 persons entered a lift cabin on the ground floor of a 7- floor house. Suppose, that each of them independently and with equal probability can leave the cabin at any floor beginning with the first. The probability of all the 5 persons leaving the cabin at different floors, is
(a) $\frac{360}{2401}$ (b) $\frac{5}{54}$
(c) $\frac{5}{18}$ (d) $\frac{5!}{7!}$

119. A company produces 10000 items per day. On a particular day 2500 items were produced on machine A, 3500 on machine B and 4000 on machine C . The probability that an item produced by the machines A, B, C to be defective is respectively 2%, 3% and 5%. If one item is selected at random from the output and is found to be defective, then the probability that it was produced machine C , is
(a) $\frac{10}{71}$ (b) $\frac{16}{71}$ (c) $\frac{40}{71}$ (d) $\frac{21}{71}$

120. A random variable X takes the values 1, 2, 3 and 4 such that $2P(X = 1) = 3P(X = 2) = P(X = 3) = 5P(X = 4)$. If σ^2 is the variance and μ is the mean of X. Then, $\sigma^2 + \mu^2 =$
(a) $\frac{421}{61}$ (b) $\frac{570}{61}$ (c) $\frac{149}{61}$ (d) $\frac{3480}{3721}$

121. An executive in a company makes on an average 5 telephone calls per hour at a cost of ₹2 per cell. The probability that in any hour the cost of the calls exceeds a sum of ₹ 4 is
(a) $\frac{2e^4-35}{2e^5}$ (b) $\frac{2e^5-37}{2e^5}$
(c) $1 - \frac{37}{e^4}$ (d) $1 - (18.5)e^5$

122. A quadrilateral ABCD is divided by the diagonal AC into two triangles of equal areas. If A, B, C are respectively, $(3, 4), (-3, 6), (-5, 1)$, then the locus of D is
(a) $(x - 8y - 57)(x - 8y + 11) = 0$
(b) $(x - 8y - 57)(x - 8y - 11) = 0$

(c) $(3x-8y-57)(3x-8y+11)=0$
(d) $(3x-8y-11)(3x-8y+57)=0$

123. By rotating the coordinate axes in the positive direction about the origin by an angle α, if the point $(1,2)$ is transformed to $\left(\frac{3\sqrt{3}-1}{2\sqrt{2}},\frac{\sqrt{3}+3}{2\sqrt{2}}\right)$ in new coordinate system Then, $\alpha=$

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{6}$ (c) $\frac{\pi}{9}$ (d) $\frac{\pi}{12}$

124. Let $a\neq 0, b\neq 0, c$ be three real numbers and $L(p,q)=\frac{ap+bq+c}{\sqrt{a^2+b^2}}, \forall p,q\in R$. If $L\left(\frac{2}{3},\frac{1}{3}\right)+L\left(\frac{1}{3},\frac{2}{3}\right)+L(2,2)=0$, then the line $ax+by+c=0$ always passes through the fixed point

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

125. The incentre of the triangle formed by the straight line having 3 as X-intercept and 4 as Y-intercept, together with the coordinate axes, is

(a) (2,2) (b) $\left(\frac{3}{2},\frac{3}{2}\right)$
(c) (1,2) (d) (1,1)

126. The equation of the straight line in the normal form which is parallel to the lines $x+2y+3=0$ and $x+2y+8=0$ and dividing the distance between these two lines in the ratio $1:2$ internally is

(a) $x\cos\alpha+y\sin\alpha=\frac{10}{\sqrt{45}}, \alpha=\tan^{-1}\sqrt{2}$
(b) $x\cos\alpha+y\sin\alpha=\frac{14}{\sqrt{45}}, \alpha=\pi+\tan^{-1}2$
(c) $x\cos\alpha+y\sin\alpha=\frac{14}{\sqrt{45}}, \alpha=\tan^{-1}2$
(d) $x\cos\alpha+y\sin\alpha=\frac{10}{\sqrt{45}}, \alpha=\pi+\tan^{-1}\sqrt{2}$

127. A pair of straight lines is passing through the point (1,1). One of the lines makes an angle θ with the positive direction of X-axis and the other makes the same angle with the positive direction of Y-axis. If the equation of the pair of straight lines is $x^2-(a+2)xy+y^2+a(x+y-1)=0, a\neq -2$, then the value of θ is

(a) $\frac{1}{2}\sin^{-1}\left(\frac{2}{a+2}\right)$ (b) $\frac{1}{2}\sin\left(\frac{2}{a+2}\right)$
(c) $\frac{1}{2}\tan^{-1}\left(\frac{2}{a+2}\right)$ (d) $\frac{1}{2}\tan\left(\frac{2}{a+2}\right)$

128. If the pair of lines $6x^2+xy-y^2=0$ and $3x^2-axy-y^2=0, a>0$ have a common line, then $a=$

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

129. If the chord $L\equiv y-mx-1=0$ of the circle $S\equiv x^2+y^2-1=0$ touches the circle $S_1\equiv x^2+y^2-4x+1=0$, then the possible points for which $L=0$ is a chord of contact of $S=0$ are

(a) $(2\pm\sqrt{6},0)$ (b) $(2\pm\sqrt{6},1)$
(c) (2,0) (d) $(\sqrt{6},1)$

130. If $y+c=0$ is a tangent to the circle $x^2+y^2-6x-2y+1=0$ at $(a,4)$, then

(a) $ac=360$ (b) $ac=-12$
(c) $a+c=0$ (d) $4a=c$

131. If the circles given by $S\equiv x^2+y^2-14x+6y+33=0$ and $S'\equiv x^2+y^2-a^2=0 (a\in N)$ have 4 common tangents, then the possible number of circles $S'=0$ is

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

132. The centre of the circle passing through the point $(1,0)$ and cutting the circles $x^2+y^2-2x+4y+1=0$ and $x^2+y^2+6x-2y+1=0$ orthogonally is

(a) $\left(-\frac{2}{3},\frac{2}{3}\right)$ (b) $\left(\frac{1}{2},\frac{1}{2}\right)$

(c) (0,1) (d) (0,0)

133. The equation of the tangent at the point $(0,3)$ on the circle which cuts the circles $x^2+y^2-2x+6y=0$, $x^2+y^2-4x-2y+6=0$ and $x^2+y^2-12x+2y+3=0$ orthogonally is

(a) $y=3$ (b) $x=0$

(c) $3x+y-3=0$ (d) $x+3y-9=0$

134. If two tangents to the parabola $y^2=8x$ meet the tangent at its vertex in M and N such that $MN=4$, then the locus of the point of intersection of those two tangents is

(a) $y^2=8(x+3)$ (b) $y^2=8(x-2)$

(c) $y^2=8(x+2)$ (d) $y^2=4(x+2)$

135. Three normals are drawn from the point $(c,0)$ to the curve $y^2=x$. If one of the normals is X-axis, then the value of c for which the other two normals are perpendicular to each other is

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

136. If the normal drawn at one end of the latus rectum of the ellipse $b^2x^2+a^2y^2=a^2b^2$ with eccentricity ' e' passes through one end of the minor axis. Then,

(a) $e^4+e^2=2$ (b) $e^4-e^2=1$

(c) $e^4+e^2=1$ (d) $e^2+e=1$

137. A variable tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ makes intercepts on both the axes. The locus of the middle point of the portion of the tangent between the coordinate axes is

(a) $\frac{x^2}{b^2}+\frac{y^2}{a^2}=1$ (b) $\frac{a^2}{x^2}+\frac{b^2}{y^2}=1$

(c) $b^2x^2+a^2y^2=4$ (d) $\frac{a^2}{x^2}+\frac{b^2}{y^2}=4$

138. If the eccentricity of a conic satisfies the equation $2x^3+10x-13=0$, then that conic is

(a) a circle (b) a parabola

(c) an ellipse (d) a hyperbola

139. Assertion (A) If $(-1,3,2)$ and $(5,3,2)$ are respectively the orthocentre and circumcentre of a triangle, then $(3,3,2)$ is its centroid.

Reason (R) Centroid of the triangle divides the line segment joining the orthocentre and the circumcentre in the ratio $1:2$.

Which one of the following is true?

(a) (A) and (R) are true and (R) is the correct explanation to (A)

(b) (A) and (R) are true, but (R) is not the correct explanation to (A)

(c) (A) is true, (R) is false

(d) (A) is false, (R) is true

140. The lines whose direction cosines are given by the relations $al+bm+cn=0$ and $mn+nl+lm=0$ are

(a) perpendicular if $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=0$

(b) perpendicular if $\sqrt{a}+\sqrt{b}+\sqrt{c}=0$

(c) parallel if $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=0$

(d) parallel to $a+b+c=0$

141. If the plane passing through the points $(1,2,3),(2,3,1)$ and $(3,1,2)$ is $ax+by+cz=1$, then $a+2b+3c=$

(a) 0 (b) 1 (c) 6 (d) 18

142. $\lim_{x\to-\infty}\frac{3|x|-x}{|x|-2x}-\lim_{x\to0}\frac{\log(1+x^3)}{\sin^3 x}=$

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

143. If $f(x) = \begin{cases} \frac{x-2}{|x-2|} + a, & x < 2 \\ a + b, & x = 2 \\ \frac{x-2}{|x-2|} + b, & x > 2 \end{cases}$

is continuous at $x = 2$, then $a + b =$

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

144. If $f(x) = \begin{cases} \frac{x^2 \log(\cos x)}{\log(1+x^2)}, & x \neq 0 \\ 0, & x = 0 \end{cases}$, then f is

(a) discontinuous at zero

(b) continuous but not differentiable at zero

(c) differentiable at zero

(d) not continuous and not differentiable at zero

145. Match the items given in List-I with those of the items of List-II

LIST-I	LIST- II
(A) If $y = |x| + |x-2|$ then at $x = 2, \frac{dy}{dx}$	(i) 2
(B) If $f(x) = |\cos 2x|$, then $f'\left(\frac{\pi^+}{4}\right) =$	(ii) 0
(C) If $f(x) = \sin \pi[x]$ where $[\cdot]$ denotes the greatest integer function, then $f'(1^-) =$	(iii) -2
(D) If $f(x) = \log|x-1|, x \neq 1$ then $f'\left(\frac{1}{2}\right) =$	(iv) does not exits
	(v) $\frac{1}{2}$

The correct answer is

	A	B	C	D		A	B	C	D
(a)	(v)	(iiii)	(i)	(ii)	(b)	(iv)	(ii)	(i)	(iii)
(c)	(iv)	(i)	(ii)	(iii)	(d)	(i)	(iii)	(iv)	(ii)

146. If $y = \frac{(\sin^{-1} x)^2}{2}$, then $(1 - x^2)y_2 - xy_1 =$

(a) y (b) 2y (c) 1 (d) 2

147. If the relative errors in the base radius and the height of a cone are same and equal to 0.02 , then the percentage error in the volume of that cone is

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

148. The normal at a point θ to the curve $x = a(1 + \cos\theta), y = a\sin\theta$ always passes through the fixed point

(a) $(0, a)$ (b) $(2a, 0)$

(c) $(a, 0)$ (d) (a, a)

149. Let $f(x)$ be continuous on $[0, 6]$ and differentiable on $(0, 6)$. Let $f(0) = 12$ and $f(6) = -4$.

If $g(x) = \frac{f(x)}{x+1}$, then for some Lagrange's constant $c \in (0, 6), g'(c) =$

(a) $-\frac{44}{3}$ (b) $-\frac{22}{21}$ (c) $\frac{32}{21}$ (d) $-\frac{44}{21}$

150. If (α, β) and (γ, δ) where $\alpha < \gamma$, are the turning points of $f(x) = 2x^3 - 15x^2 + 36x - 8$, then $\alpha - \gamma - \beta + \delta =$

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

151. The height of a cylinder of the greatest volume that can be inscribed in a sphere of radius 3 is

(a) $3\sqrt{3}$ (b) $2\sqrt{3}$

(c) $\sqrt{3}$ (d) $\sqrt{2}$

152. $\int \frac{dx}{(e^x+e^{-x})^2} =$

(a) $\frac{1}{2(e^{2x}+1)}+c$ (b) $-\frac{1}{2(e^{2x}+1)}+c$

(c) $\frac{1}{3(e^{2x}+1)}+c$ (d) $-\frac{1}{(e^{2x}+1)}+c$

153. $\int_0^{\pi/2} \frac{dx}{1+(\tan x)^{\sqrt{2018}}} =$

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

154. If $\int \frac{x}{(x^2+1)(x-1)}dx = A\log|x^2+1| + B\tan^{-1}x + C\log|x-1| + d$, then $A+B+C=$

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

155. $\int_0^{\pi/2} \frac{\cos^3 x}{\sin x+\cos x}dx =$

(a) $\frac{\pi-1}{2}$ (b) $\frac{\pi-1}{4}$

(c) $\frac{1+\pi}{4}$ (d) $\frac{\pi-3}{4}$

156. $\int_0^3 (2+x^2)dx =$

(a) $\lim_{n\to\infty}\frac{1}{n}\left[2n+\frac{1^2+2^2+\cdots+(3n)^2}{n^2}\right]$

(b) $\lim_{n\to\infty}\frac{1}{n}\left[3n+\frac{1^2+2^2+\cdots+6n^2}{n^2}\right]$

(c) $\lim_{n\to\infty}\frac{1}{n}\left[6n+\frac{1^2+2^2+\cdots+9n^2}{n^2}\right]$

(d) $\lim_{n\to\infty}\frac{1}{n}\left[3n+\frac{1^2+2^2+\cdots+3n^2}{n^2}\right]$

157. The area enclosed (in square units) by the curve $y = x^4 - x^2$, the X-axis and the vertical lines passing through the two minimum points of the curve is

(a) $\frac{48\sqrt{2}}{5}$ (b) $\frac{5}{48\sqrt{2}}$

(c) $\frac{7}{60\sqrt{2}}$ (d) $\frac{7}{30\sqrt{2}}$

158. The differential equation corresponding to the family of circles having centres on X-axis and passing through the origin is

(a) $y^2+x^2+\frac{dy}{dx}=0$

(b) $y^2-x^2+\frac{dy}{dx}=0$

(c) $y^2+x^2+2xy\frac{dy}{dx}=0$

(d) $y^2-x^2-2xy\frac{dy}{dx}=0$

159. The general solution of the differential equation $(x^2+xy)y' = y^2$ is

(a) $e^{\frac{y}{x}} = cx$ (b) $e^{-\frac{y}{x}} = cy$

(c) $e^{-\frac{y}{x}} = cxy$ (d)$(e^{\frac{-2y}{x}} = cy$

160. At any point on a curve, the slope of the tangent is equal to the sum of abscissa and the product of ordinate and abscissa of that point. If the curve passes through $(0,1)$, then the equation of the curve is

(a) $y = 2e^{\frac{x^2}{2}} - 1$ (b) $y = 2e^{x^2}$

(c) $y = e^{-x^2}$ (d) $y = 2e^{-x^2} - 1$