

1. In the experiment to determine the speed of sound using a resonance column,
- (A) prongs of the tuning fork are kept in a vertical plane
 - (B) prongs of the tuning fork are kept in a horizontal plane
 - (C) in one of the two resonances observed, the length of the resonating air column is close to the wavelength of sound in air
 - (D) in one of the two resonances observed, the length of the resonating air column is close to half of the wavelength of sound in air

Answer
(A) (B) (C) (D)

2. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of ± 0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of ± 0.01 mm. Take $g = 9.8 \text{ m/s}^2$ (exact). The Young's modulus obtained from the reading is
- (A) $(2.0 \pm 0.3) \times 10^{11} \text{ N/m}^2$
 - (B) $(2.0 \pm 0.2) \times 10^{11} \text{ N/m}^2$
 - (C) $(2.0 \pm 0.1) \times 10^{11} \text{ N/m}^2$
 - (D) $(2.0 \pm 0.05) \times 10^{11} \text{ N/m}^2$

Answer
(A) (B) (C) (D)

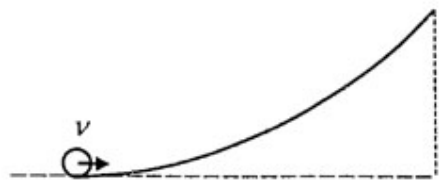
OR

(A) (B) (C) (D)

3. A particle moves in the X-Y plane under the influence of a force such that its linear momentum is $\vec{p}(t) = A [\hat{i} \cos(kt) - \hat{j} \sin(kt)]$, where A and k are constants. The angle between the force and the momentum is
- (A) 0°
 - (B) 30°
 - (C) 45°
 - (D) 90°

Answer
(A) (B) (C) (D)

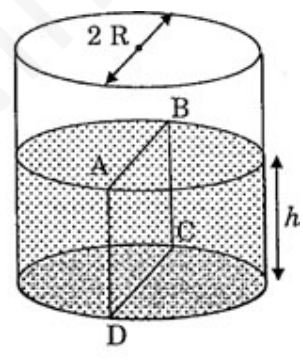
4. A small object of uniform density rolls up a curved surface with an initial velocity v . It reaches up to a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is



- (A) ring (B) solid sphere (C) hollow sphere (D) disc

Answer (A) (B) (C) (D)

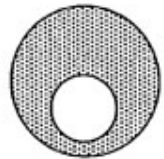
5. Water is filled up to a height h in a beaker of radius R as shown in the figure. The density of water is ρ , the surface tension of water is T and the atmospheric pressure is P_0 . Consider a vertical section ABCD of the water column through a diameter of the beaker. The force on water on one side of this section by water on the other side of this section has magnitude



- (A) $|2P_0Rh + \pi R^2 \rho gh - 2RT|$ (B) $|2P_0Rh + R \rho gh^2 - 2RT|$
 (C) $|P_0 \pi R^2 + R \rho gh^2 - 2RT|$ (D) $|P_0 \pi R^2 + R \rho gh^2 + 2RT|$

Answer (A) (B) (C) (D)

6. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in the figure. The electric field inside the emptied space is



- (A) zero everywhere
- (B) non-zero and uniform
- (C) non-uniform
- (D) zero only at its center

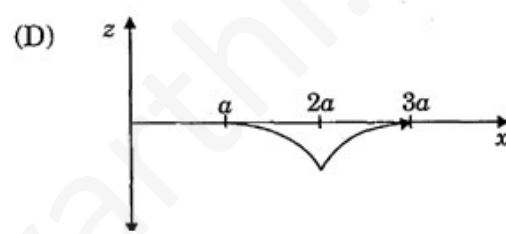
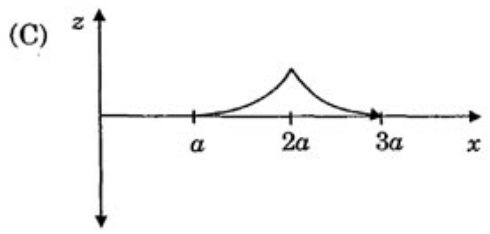
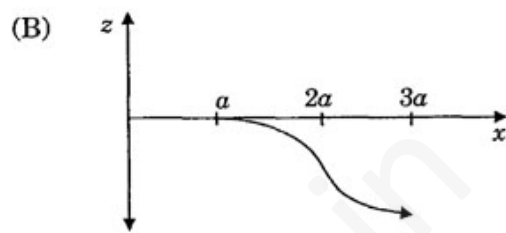
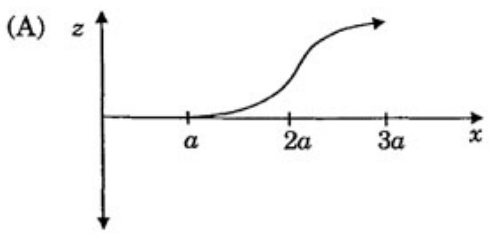
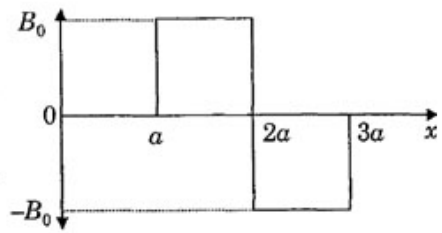
Answer (A) (B) (C) (D)

7. Positive and negative point charges of equal magnitude are kept at $(0, 0, \frac{a}{2})$ and $(0, 0, -\frac{a}{2})$, respectively. The work done by the electric field when another positive point charge is moved from $(-a, 0, 0)$ to $(0, a, 0)$ is

- (A) positive
- (B) negative
- (C) zero
- (D) depends on the path connecting the initial and final positions

Answer (A) (B) (C) (D)

8. A magnetic field $\vec{B} = B_0\hat{j}$ exists in the region $a < x < 2a$ and $\vec{B} = -B_0\hat{j}$, in the region $2a < x < 3a$, where B_0 is a positive constant. A positive point charge moving with a velocity $\vec{v} = v_0\hat{i}$, where v_0 is a positive constant, enters the magnetic field at $x = a$. The trajectory of the charge in this region can be like,



Answer (A) (B) (C) (D)

9. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-rays is

- (A) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (B) $\lambda_0 = \frac{2h}{mc}$
 (C) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (D) $\lambda_0 = \lambda$

Answer (A) (B) (C) (D)

PREVIOUS STATEMENT-1

If there is no external torque on a body about its center of mass, then the velocity of the center of mass remains constant.

because

STATEMENT-2

The linear momentum of an isolated system remains constant.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is **NOT** a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

11. STATEMENT-1

A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.

because

STATEMENT-2

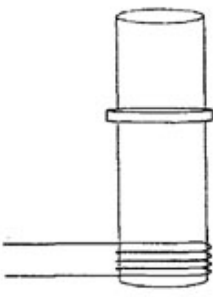
For every action there is an equal and opposite reaction.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is **NOT** a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

FR2. STATEMENT-1

A vertical iron rod has a coil of wire wound over it at the bottom end. An alternating current flows in the coil. The rod goes through a conducting ring as shown in the figure. The ring can float at a certain height above the coil.



because

STATEMENT-2

In the above situation, a current is induced in the ring which interacts with the horizontal component of the magnetic field to produce an average force in the upward direction.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is **NOT** a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

13. STATEMENT-1

The total translational kinetic energy of all the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume.

because

STATEMENT-2

The molecules of a gas collide with each other and the velocities of the molecules change due to the collision.

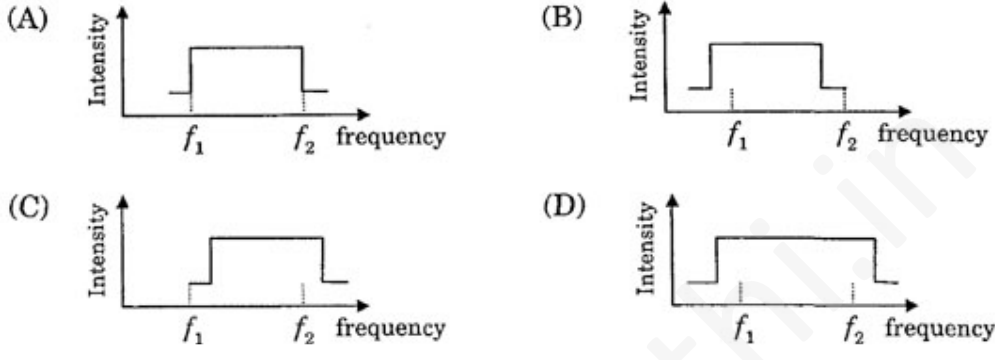
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is **NOT** a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

14. The speed of sound of the whistle is
- (A) 340 m/s for passengers in A and 310 m/s for passengers in B
 - (B) 360 m/s for passengers in A and 310 m/s for passengers in B
 - (C) 310 m/s for passengers in A and 360 m/s for passengers in B
 - (D) 340 m/s for passengers in both the trains

Answer (A) (B) (C) (D)

15. The distribution of the sound intensity of the whistle as observed by the passengers in train A is best represented by



Answer (A) (B) (C) (D)

16. The spread of frequency as observed by the passengers in train B is
- (A) 310 Hz
 - (B) 330 Hz
 - (C) 350 Hz
 - (D) 290 Hz

Answer (A) (B) (C) (D)

17. Light travels as a
- (A) parallel beam in each medium
 - (B) convergent beam in each medium
 - (C) divergent beam in each medium
 - (D) divergent beam in one medium and convergent beam in the other medium

Answer (A) (B) (C) (D)

18. The phases of the light wave at c , d , e and f are ϕ_c , ϕ_d , ϕ_e and ϕ_f respectively.

It is given that $\phi_c \neq \phi_f$.

- (A) ϕ_c cannot be equal to ϕ_d (B) ϕ_d can be equal to ϕ_e
(C) $(\phi_d - \phi_f)$ is equal to $(\phi_c - \phi_e)$ (D) $(\phi_d - \phi_c)$ is not equal to $(\phi_f - \phi_e)$

Answer
(A) (B) (C) (D)

19. Speed of light is

- (A) the same in medium-1 and medium-2
(B) larger in medium-1 than in medium-2
(C) larger in medium-2 than in medium-1
(D) different at b and d

Answer
(A) (B) (C) (D)

Q20. **Column I** describes some situations in which a small object moves. **Column II** describes some characteristics of these motions. Match the situations in **Column I** with the characteristics in **Column II** and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in the ORS.

- | Column I | Column II |
|--|--|
| <p>(A) The object moves on the x-axis under a conservative force in such a way that its "speed" and "position" satisfy $v = c_1\sqrt{c_2 - x^2}$, where c_1 and c_2 are positive constants.</p> <p>(B) The object moves on the x-axis in such a way that its velocity and its displacement from the origin satisfy $v = -kx$, where k is a positive constant.</p> <p>(C) The object is attached to one end of a mass-less spring of a given spring constant. The other end of the spring is attached to the ceiling of an elevator. Initially everything is at rest. The elevator starts going upwards with a constant acceleration a. The motion of the object is observed from the elevator during the period it maintains this acceleration.</p> <p>(D) The object is projected from the earth's surface vertically upwards with a speed $2\sqrt{GM_e/R_e}$, where, M_e is the mass of the earth and R_e is the radius of the earth. Neglect forces from objects other than the earth.</p> | <p>(p) The object executes a simple harmonic motion.</p> <p>(q) The object does not change its direction.</p> <p>(r) The kinetic energy of the object keeps on decreasing.</p> <p>(s) The object can change its direction only once.</p> |

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

OR

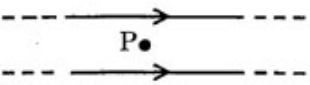
	p	q	r	s
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B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

FE21. Two wires each carrying a steady current I are shown in four configurations in **Column I**. Some of the resulting effects are described in **Column II**. Match the statements in **Column I** with the statements in **Column II** and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in the ORS.

Column I

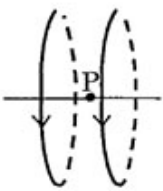
Column II

(A) Point P is situated midway between the wires.



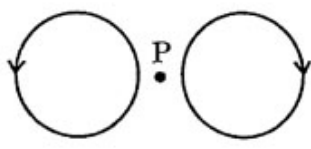
(p) The magnetic fields (B) at P due to the currents in the wires are in the same direction.

(B) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii.



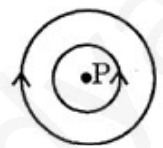
(q) The magnetic fields (B) at P due to the currents in the wires are in opposite directions.

(C) Point P is situated at the mid-point of the line joining the centers of the circular wires, which have same radii.



(r) There is no magnetic field at P.

(D) Point P is situated at the common center of the wires.



(s) The wires repel each other.

Answer

	p	q	r	s
A	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
B	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

OR

	p	q	r	s
A	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
B	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

22. **Column I** gives some devices and **Column II** gives some processes on which the functioning of these devices depend. Match the devices in **Column I** with the processes in **Column II** and indicate your answer by darkening appropriate bubbles in the 4×4 matrix given in the ORS.

Column I	Column II
(A) Bimetallic strip	(p) Radiation from a hot body
(B) Steam engine	(q) Energy conversion
(C) Incandescent lamp	(r) Melting
(D) Electric fuse	(s) Thermal expansion of solids

Answer A – ‘s, q’ OR ‘s’ alone
 B – ‘q’
 C – ‘p, q’ OR ‘p’ alone
 D – ‘q, r’ OR ‘r’ alone

23. Consider a titration of potassium dichromate solution with acidified Mohr’s salt solution using diphenylamine as indicator. The number of moles of Mohr’s salt required per mole of dichromate is
 (A) 3 (B) 4 (C) 5 (D) 6

Answer (A) (B) (C) (D)

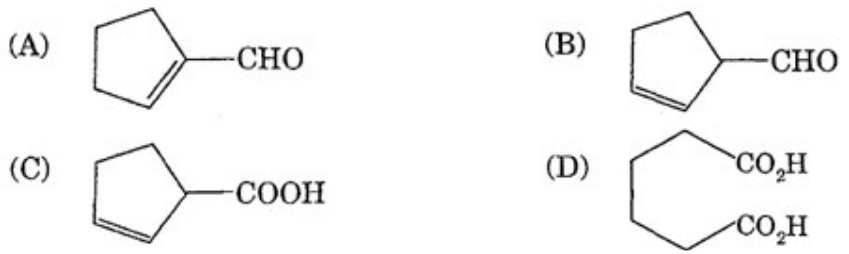
24. Among the following metal carbonyls, the C–O bond order is lowest in
 (A) $[\text{Mn}(\text{CO})_6]^+$ (B) $[\text{Fe}(\text{CO})_5]$ (C) $[\text{Cr}(\text{CO})_6]$ (D) $[\text{V}(\text{CO})_6]^-$

Answer (A) (B) (C) (D)

25. A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt(II) thiocyanate gives rise to a deep blue crystalline precipitate. The metal ion is
 (A) Pb^{2+} (B) Hg^{2+} (C) Cu^{2+} (D) Co^{2+}

Answer (A) (B) (C) (D)

26. Cyclohexene on ozonolysis followed by reaction with zinc dust and water gives compound E. Compound E on further treatment with aqueous KOH yields compound F. Compound F is



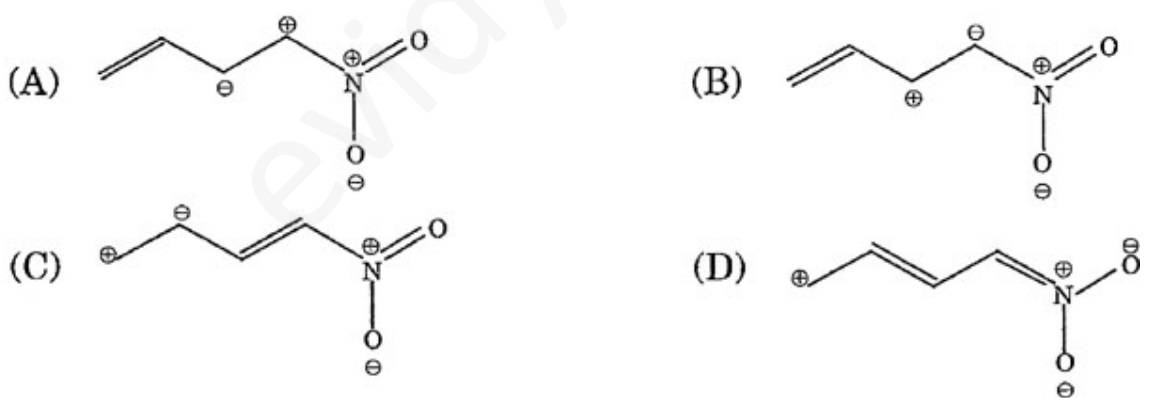
Answer
 (A) (B) (C) (D)

27. The number of stereoisomers obtained by bromination of *trans*-2-butene is

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

Answer
 (A) (B) (C) (D)

28. Among the following, the least stable resonance structure is



Answer
 (A) (B) (C) (D)

29. A positron is emitted from $^{23}_{11}\text{Na}$. The ratio of the atomic mass and atomic number of the resulting nuclide is

- (A) 22/10 (B) 22/11
(C) 23/10 (D) 23/12

Answer (A) (B) (C) (D)

30. For the process $\text{H}_2\text{O}(l)$ (1 bar, 373 K) \rightarrow $\text{H}_2\text{O}(g)$ (1 bar, 373 K), the correct set of thermodynamic parameters is

- (A) $\Delta G = 0, \Delta S = +ve$ (B) $\Delta G = 0, \Delta S = -ve$
(C) $\Delta G = +ve, \Delta S = 0$ (D) $\Delta G = -ve, \Delta S = +ve$

Answer (A) (B) (C) (D)

31. Consider a reaction $a\text{G} + b\text{H} \rightarrow \text{Products}$. When concentration of both the reactants G and H is doubled, the rate increases by eight times. However, when concentration of G is doubled keeping the concentration of H fixed, the rate is doubled. The overall order of the reaction is

- (A) 0 (B) 1 (C) 2 (D) 3

Answer (A) (B) (C) (D)

32. STATEMENT-1 : Alkali metals dissolve in liquid ammonia to give blue solutions.

because

STATEMENT-2 : Alkali metals in liquid ammonia give solvated species of the type $[M(NH_3)_n]^+$ (M = alkali metals).

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True; Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer
(A) (B) (C) (D)

33. STATEMENT-1 : Glucose gives a reddish-brown precipitate with Fehling's solution.

because

STATEMENT-2 : Reaction of glucose with Fehling's solution gives CuO and gluconic acid.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer
(A) (B) (C) (D)

34. STATEMENT-1 : Molecules that are not superimposable on their mirror images are chiral.

because

STATEMENT-2 : All chiral molecules have chiral centres.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

35. STATEMENT-1 : Band gap in germanium is small.

because

STATEMENT-2 : The energy spread of each germanium atomic energy level is infinitesimally small.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

36. Among the following, identify the correct statement.

- (A) Chloride ion is oxidised by O_2 (B) Fe^{2+} is oxidised by iodine
 (C) Iodide ion is oxidised by chlorine (D) Mn^{2+} is oxidised by chlorine

Answer
 (A) (B) (C) (D)

37. While Fe^{3+} is stable, Mn^{3+} is not stable in acid solution because

- (A) O_2 oxidises Mn^{2+} to Mn^{3+}
 (B) O_2 oxidises both Mn^{2+} to Mn^{3+} and Fe^{2+} to Fe^{3+}
 (C) Fe^{3+} oxidises H_2O to O_2
 (D) Mn^{3+} oxidises H_2O to O_2

Answer
 (A) (B) (C) (D)

38. Sodium fusion extract, obtained from aniline, on treatment with iron(II) sulphate and H_2SO_4 in presence of air gives a Prussian blue precipitate. The blue colour is due to the formation of

- (A) $Fe_4[Fe(CN)_6]_3$ (B) $Fe_3[Fe(CN)_6]_2$
 (C) $Fe_4[Fe(CN)_6]_2$ (D) $Fe_3[Fe(CN)_6]_3$

Answer
 (A) (B) (C) (D)

39. Which one of the following reagents is used in the above reaction?

- (A) aq. NaOH + CH_3Cl (B) aq. NaOH + CH_2Cl_2
 (C) aq. NaOH + $CHCl_3$ (D) aq. NaOH + CCl_4

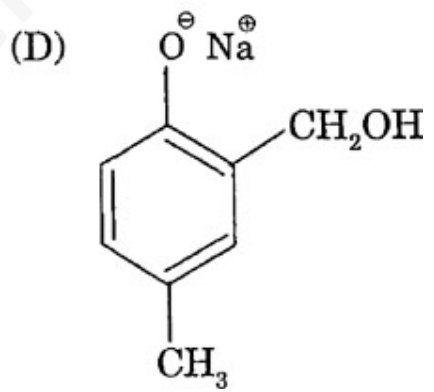
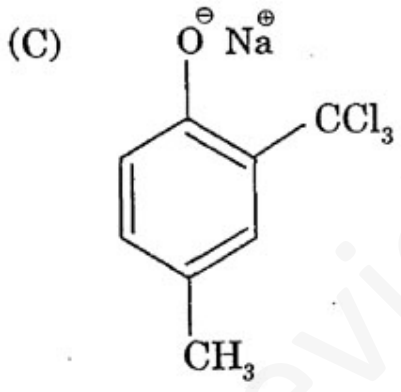
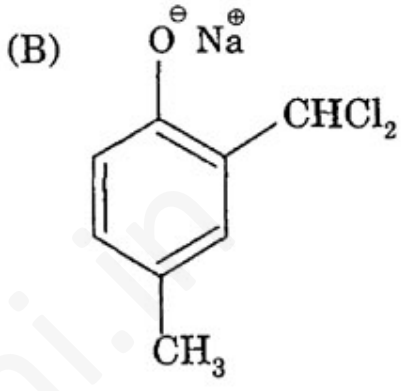
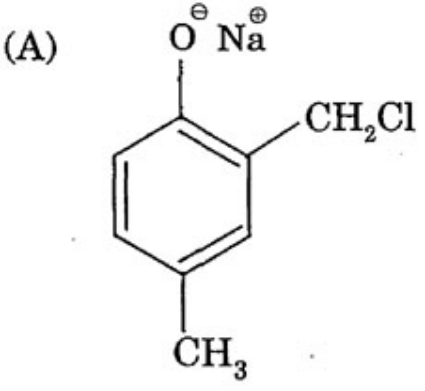
Answer
 (A) (B) (C) (D)

10. The electrophile in this reaction is

- (A) :CHCl (B) +CHCl_2 (C) :CCl_2 (D) -CCl_3

Answer (A) (B) (C) (D)

41. The structure of the intermediate I is



Answer (A) (B) (C) (D)

42. Match the reactions in **Column I** with nature of the reactions/type of the products in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	Column II
(A) $O_2^- \rightarrow O_2 + O_2^{2-}$	(p) redox reaction
(B) $CrO_4^{2-} + H^+ \rightarrow$	(q) one of the products has trigonal planar structure
(C) $MnO_4^- + NO_2^- + H^+ \rightarrow$	(r) dimeric bridged tetrahedral metal ion
(D) $NO_3^- + H_2SO_4 + Fe^{2+} \rightarrow$	(s) disproportionation

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

43. Match the compounds/ions in **Column I** with their properties/reactions in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	Column II
(A) C_6H_5CHO	(p) gives precipitate with 2,4-dinitrophenylhydrazine
(B) $CH_3C \equiv CH$	(q) gives precipitate with $AgNO_3$
(C) CN^-	(r) is a nucleophile
(D) I^-	(s) is involved in cyanohydrin formation

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

44. Match the crystal system/unit cells mentioned in **Column I** with their characteristic features mentioned in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	Column II
(A) simple cubic and face-centred cubic	(p) have these cell parameters $a=b=c$ and $\alpha = \beta = \gamma$
(B) cubic and rhombohedral	(q) are two crystal systems
(C) cubic and tetragonal	(r) have only two crystallographic angles of 90°
(D) hexagonal and monoclinic	(s) belong to same crystal system

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
B	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>

45. Let $O(0, 0)$, $P(3, 4)$, $Q(6, 0)$ be the vertices of the triangle OPQ . The point R inside the triangle OPQ is such that the triangles OPR , PQR , OQR are of equal area. The coordinates of R are

- | | |
|-----------------------------------|---|
| (A) $\left(\frac{4}{3}, 3\right)$ | (B) $\left(3, \frac{2}{3}\right)$ |
| (C) $\left(3, \frac{4}{3}\right)$ | (D) $\left(\frac{4}{3}, \frac{2}{3}\right)$ |

Answer (A) (B) (C) (D)

46. If $|z|=1$ and $z \neq \pm 1$, then all the values of $\frac{z}{1-z^2}$ lie on

- (A) a line not passing through the origin
- (B) $|z| = \sqrt{2}$
- (C) the x -axis
- (D) the y -axis

Answer (A) (B) (C) (D)

47. Let E^c denote the complement of an event E . Let E, F, G be pairwise independent events with $P(G) > 0$ and $P(E \cap F \cap G) = 0$. Then $P(E^c \cap F^c | G)$ equals

- (A) $P(E^c) + P(F^c)$
- (B) $P(E^c) - P(F^c)$
- (C) $P(E^c) - P(F)$
- (D) $P(E) - P(F^c)$

Answer (A) (B) (C) (D)

48. $\frac{d^2x}{dy^2}$ equals

- (A) $\left(\frac{d^2y}{dx^2}\right)^{-1}$
- (B) $-\left(\frac{d^2y}{dx^2}\right)^{-1} \left(\frac{dy}{dx}\right)^{-3}$
- (C) $\left(\frac{d^2y}{dx^2}\right) \left(\frac{dy}{dx}\right)^{-2}$
- (D) $-\left(\frac{d^2y}{dx^2}\right) \left(\frac{dy}{dx}\right)^{-3}$

Answer (A) (B) (C) (D)

49. The differential equation $\frac{dy}{dx} = \frac{\sqrt{1-y^2}}{y}$ determines a family of circles with
- (A) variable radii and a fixed centre at (0, 1)
 - (B) variable radii and a fixed centre at (0, -1)
 - (C) fixed radius 1 and variable centres along the x-axis
 - (D) fixed radius 1 and variable centres along the y-axis

Answer (A) (B) (C) (D)

50. Let $\vec{a}, \vec{b}, \vec{c}$ be unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$. Which one of the following is correct?
- (A) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} = \vec{0}$
 - (B) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} \neq \vec{0}$
 - (C) $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{a} \times \vec{c} \neq \vec{0}$
 - (D) $\vec{a} \times \vec{b}, \vec{b} \times \vec{c}, \vec{c} \times \vec{a}$ are mutually perpendicular

Answer (A) (B) (C) (D)

51. Let $ABCD$ be a quadrilateral with area 18, with side AB parallel to the side CD and $AB = 2CD$. Let AD be perpendicular to AB and CD . If a circle is drawn inside the quadrilateral $ABCD$ touching all the sides, then its radius is
- (A) 3
 - (B) 2
 - (C) $\frac{3}{2}$
 - (D) 1

Answer (A) (B) (C) (D)

52. Let $f(x) = \frac{x}{(1+x^n)^{1/n}}$ for $n \geq 2$ and $g(x) = \underbrace{(f \circ f \circ \dots \circ f)}_{f \text{ occurs } n \text{ times}}(x)$. Then $\int x^{n-2}g(x) dx$ equals

- (A) $\frac{1}{n(n-1)}(1+nx^n)^{1-\frac{1}{n}} + K$ (B) $\frac{1}{n-1}(1+nx^n)^{1-\frac{1}{n}} + K$
 (C) $\frac{1}{n(n+1)}(1+nx^n)^{1+\frac{1}{n}} + K$ (D) $\frac{1}{n+1}(1+nx^n)^{1+\frac{1}{n}} + K$

Answer (A) (B) (C) (D)

53. The letters of the word **COCHIN** are permuted and all the permutations are arranged in an alphabetical order as in an English dictionary. The number of words that appear before the word **COCHIN** is
 (A) 360 (B) 192 (C) 96 (D) 48

Answer (A) (B) (C) (D)

54. Consider the planes $3x - 6y - 2z = 15$ and $2x + y - 2z = 5$.
 STATEMENT-1 : The parametric equations of the line of intersection of the given planes are $x = 3 + 14t, y = 1 + 2t, z = 15t$.
because
 STATEMENT-2 : The vector $14\hat{i} + 2\hat{j} + 15\hat{k}$ is parallel to the line of intersection of given planes.
 (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is **NOT** a correct explanation for Statement-1
 (C) Statement-1 is True, Statement-2 is False
 (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

55. STATEMENT-1 : The curve $y = \frac{-x^2}{2} + x + 1$ is symmetric with respect to the line $x = 1$.

because

STATEMENT-2 : A parabola is symmetric about its axis.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

56. Let $f(x) = 2 + \cos x$ for all real x .

STATEMENT-1 : For each real t , there exists a point c in $[t, t + \pi]$ such that $f'(c) = 0$.

because

STATEMENT-2 : $f(t) = f(t + 2\pi)$ for each real t .

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

57. Lines $L_1 : y - x = 0$ and $L_2 : 2x + y = 0$ intersect the line $L_3 : y + 2 = 0$ at P and Q , respectively. The bisector of the acute angle between L_1 and L_2 intersects L_3 at R .

STATEMENT-1 : The ratio $PR : RQ$ equals $2\sqrt{2} : \sqrt{5}$.

because

STATEMENT-2 : In any triangle, bisector of an angle divides the triangle into two similar triangles.

- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
- (C) Statement-1 is True, Statement-2 is False
- (D) Statement-1 is False, Statement-2 is True

Answer (A) (B) (C) (D)

58. Which one of the following statements is correct?
- (A) $G_1 > G_2 > G_3 > \dots$
 - (B) $G_1 < G_2 < G_3 < \dots$
 - (C) $G_1 = G_2 = G_3 = \dots$
 - (D) $G_1 < G_3 < G_5 < \dots$ and $G_2 > G_4 > G_6 > \dots$

Answer (A) (B) (C) (D)

59. Which one of the following statements is correct?
- (A) $A_1 > A_2 > A_3 > \dots$
 - (B) $A_1 < A_2 < A_3 < \dots$
 - (C) $A_1 > A_3 > A_5 > \dots$ and $A_2 < A_4 < A_6 < \dots$
 - (D) $A_1 < A_3 < A_5 < \dots$ and $A_2 > A_4 > A_6 > \dots$

Answer (A) (B) (C) (D)

60. Which one of the following statements is correct?

- (A) $H_1 > H_2 > H_3 > \dots$
- (B) $H_1 < H_2 < H_3 < \dots$
- (C) $H_1 > H_3 > H_5 > \dots$ and $H_2 < H_4 < H_6 < \dots$
- (D) $H_1 < H_3 < H_5 < \dots$ and $H_2 > H_4 > H_6 > \dots$

M61-63: Paragraph for Question Nos. 61 to 63

If a continuous function f defined on the real line \mathbf{R} , assumes positive and negative values in \mathbf{R} then the equation $f(x) = 0$ has a root in \mathbf{R} . For example, if it is known that a continuous function f on \mathbf{R} is positive at some point and its minimum value is negative then the equation $f(x) = 0$ has a root in \mathbf{R} .

Consider $f(x) = ke^x - x$ for all real x where k is a real constant.

Answer
 (A) (B) (C) (D)

61. The line $y = x$ meets $y = ke^x$ for $k \leq 0$ at
 (A) no point (B) one point
 (C) two points (D) more than two points

Answer
 (A) (B) (C) (D)

62. The positive value of k for which $ke^x - x = 0$ has only one root is
 (A) $\frac{1}{e}$ (B) 1 (C) e (D) $\log_e 2$

Answer
 (A) (B) (C) (D)

63. For $k > 0$, the set of all values of k for which $ke^x - x = 0$ has two distinct roots is
 (A) $(0, \frac{1}{e})$ (B) $(\frac{1}{e}, 1)$ (C) $(\frac{1}{e}, \infty)$ (D) $(0, 1)$

Answer
 (A) (B) (C) (D)

64. Let $f(x) = \frac{x^2 - 6x + 5}{x^2 - 5x + 6}$.

Match the expressions/statements in **Column I** with expressions/statements in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4×4 matrix given in the ORS.

Column I

Column II

- | | |
|---|--------------------|
| (A) If $-1 < x < 1$, then $f(x)$ satisfies | (p) $0 < f(x) < 1$ |
| (B) If $1 < x < 2$, then $f(x)$ satisfies | (q) $f(x) < 0$ |
| (C) If $3 < x < 5$, then $f(x)$ satisfies | (r) $f(x) > 0$ |
| (D) If $x > 5$, then $f(x)$ satisfies | (s) $f(x) < 1$ |

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
D	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>

65. Let (x, y) be such that

$$\sin^{-1}(ax) + \cos^{-1}(y) + \cos^{-1}(bxy) = \frac{\pi}{2}.$$

Match the statements in **Column I** with statements in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4×4 matrix given in the ORS.

Column I

Column II

- (A) If $a = 1$ and $b = 0$, then (x, y)
- (B) If $a = 1$ and $b = 1$, then (x, y)
- (C) If $a = 1$ and $b = 2$, then (x, y)
- (D) If $a = 2$ and $b = 2$, then (x, y)

- (p) lies on the circle $x^2 + y^2 = 1$
- (q) lies on $(x^2 - 1)(y^2 - 1) = 0$
- (r) lies on $y = x$
- (s) lies on $(4x^2 - 1)(y^2 - 1) = 0$

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

66. Match the statements in **Column I** with the properties in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4×4 matrix given in the ORS.

Column I

Column II

- | | |
|--|----------------------------------|
| (A) Two intersecting circles | (p) have a common tangent |
| (B) Two mutually external circles | (q) have a common normal |
| (C) Two circles, one strictly inside the other | (r) do not have a common tangent |
| (D) Two branches of a hyperbola | (s) do not have a common normal |

Answer

	p	q	r	s
A	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
B	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>