JEE-2008
Paper I

1. Consider the two curves

$$C_1 : y^2 = 4x$$
$$C_2 : x^2 + y^2 - 6x + 1 = 0$$

Then,

(A) C_1 and C_2 touch each other only at one point

(B) C_1 and C_2 touch each other exactly at two points

(C) C_1 and C_2 intersect (but do not touch) at exactly two points

(D) C_1 and C_2 neither intersect nor touch each other

Answer ○ (A) ● (B) ○ (C) ○ (D)

2. If $0 < x < 1$, then

$$\sqrt{1+x^2}\ [\ \{x\cos(\cot^{-1}x) + \sin(\cot^{-1}x)\}^2 - 1\ ]^{\frac{1}{2}} =$$

(A) $\dfrac{x}{\sqrt{1+x^2}}$ (B) x (C) $x\sqrt{1+x^2}$ (D) $\sqrt{1+x^2}$

Answer ○ (A) ○ (B) ● (C) ○ (D)

3. The edges of a parallelopiped are of unit length and are parallel to non-coplanar unit vectors $\hat{a}, \hat{b}, \hat{c}$ such that

$$\hat{a}\cdot\hat{b} = \hat{b}\cdot\hat{c} = \hat{c}\cdot\hat{a} = \frac{1}{2}.$$

Then, the volume of the parallelopiped is

(A) $\dfrac{1}{\sqrt{2}}$ (B) $\dfrac{1}{2\sqrt{2}}$ (C) $\dfrac{\sqrt{3}}{2}$ (D) $\dfrac{1}{\sqrt{3}}$

Answer ● (A) ○ (B) ○ (C) ○ (D)

4. Let a and b be non-zero real numbers. Then, the equation

$$(ax^2 + by^2 + c)(x^2 - 5xy + 6y^2) = 0$$

represents

(A) four straight lines, when $c = 0$ and a, b are of the same sign

(B) two straight lines and a circle, when $a = b$, and c is of sign opposite to that of a

(C) two straight lines and a hyperbola, when a and b are of the same sign and c is of sign opposite to that of a

(D) a circle and an ellipse, when a and b are of the same sign and c is of sign opposite to that of a

Answer ○ (A) ● (B) ○ (C) ○ (D)

5. Let

$g(x)=\dfrac{(x-1)^n}{\log\cos^m(x-1)}$; $0<x<2$, m and n are integers, $m\neq 0$, $n>0$, and let p be the left hand derivative of $|x-1|$ at $x=1$.

If $\lim\limits_{x\to 1+} g(x)=p$, then

(A) $n=1, m=1$ (B) $n=1, m=-1$
(C) $n=2, m=2$ (D) $n>2, m=n$

Answer ○ ○ ● ○
(A) (B) (C) (D)

6. The total number of local maxima and local minima of the function

$$f(x)=\begin{cases}(2+x)^3, & -3<x\le -1\\ x^{2/3}, & -1<x<2\end{cases}$$

is

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

Answer ○ ○ ● ○
(A) (B) (C) (D)

7. A straight line through the vertex P of a triangle PQR intersects the side QR at the point S and the circumcircle of the triangle PQR at the point T. If S is not the centre of the circumcircle, then

(A) $\dfrac{1}{PS}+\dfrac{1}{ST}<\dfrac{2}{\sqrt{QS\times SR}}$

(B) $\dfrac{1}{PS}+\dfrac{1}{ST}>\dfrac{2}{\sqrt{QS\times SR}}$

(C) $\dfrac{1}{PS}+\dfrac{1}{ST}<\dfrac{4}{QR}$

(D) $\dfrac{1}{PS}+\dfrac{1}{ST}>\dfrac{4}{QR}$

Answer ○ ● ○ ●
(A) (B) (C) (D)

8. Let $P(x_1, y_1)$ and $Q(x_2, y_2)$, $y_1 < 0$, $y_2 < 0$, be the end points of the latus rectum of the ellipse $x^2 + 4y^2 = 4$. The equations of parabolas with latus rectum PQ are

(A) $x^2 + 2\sqrt{3}\, y = 3 + \sqrt{3}$

(B) $x^2 - 2\sqrt{3}\, y = 3 + \sqrt{3}$

(C) $x^2 + 2\sqrt{3}\, y = 3 - \sqrt{3}$

(D) $x^2 - 2\sqrt{3}\, y = 3 - \sqrt{3}$

Answer ○ ● ● ○
(A) (B) (C) (D)

9. Let

$$S_n = \sum_{k=1}^{n} \frac{n}{n^2 + kn + k^2} \quad \text{and} \quad T_n = \sum_{k=0}^{n-1} \frac{n}{n^2 + kn + k^2},$$

for $n = 1, 2, 3, \cdots$. Then,

(A) $S_n < \frac{\pi}{3\sqrt{3}}$ (B) $S_n > \frac{\pi}{3\sqrt{3}}$

(C) $T_n < \frac{\pi}{3\sqrt{3}}$ (D) $T_n > \frac{\pi}{3\sqrt{3}}$

Answer ● ○ ○ ●
(A) (B) (C) (D)

10. Let $f(x)$ be a non-constant twice differentiable function defined on $(-\infty, \infty)$ such that $f(x) = f(1-x)$ and $f'\left(\frac{1}{4}\right) = 0$. Then,

(A) $f''(x)$ vanishes at least twice on $[0, 1]$

(B) $f'\left(\frac{1}{2}\right) = 0$

(C) $\int_{-1/2}^{1/2} f\left(x + \frac{1}{2}\right) \sin x \, dx = 0$

(D) $\int_{0}^{1/2} f(t)\, e^{\sin \pi t}\, dt = \int_{1/2}^{1} f(1-t)\, e^{\sin \pi t}\, dt$

Answer ● ● ● ●
(A) (B) (C) (D)

11. Let f and g be real valued functions defined on interval $(-1, 1)$ such that $g''(x)$ is continuous, $g(0) \neq 0$, $g'(0) = 0$, $g''(0) \neq 0$, and $f(x) = g(x)\sin x$.

STATEMENT-1 : $\lim\limits_{x \to 0} [g(x)\cot x - g(0)\ \text{cosec}\ x] = f''(0)$.

and

STATEMENT-2 : $f'(0) = g(0)$.

(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)

12. Consider three planes

$P_1 : x - y + z = 1$

$P_2 : x + y - z = -1$

$P_3 : x - 3y + 3z = 2$.

Let L_1, L_2, L_3 be the lines of intersection of the planes P_2 and P_3, P_3 and P_1, and P_1 and P_2, respectively.

STATEMENT-1 : At least two of the lines L_1, L_2 and L_3 are non-parallel.

and

STATEMENT-2 : The three planes do not have a common point.

(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. Consider the system of equations

$$x-2y+3z=-1$$
$$-x+y-2z=k$$
$$x-3y+4z=1\,.$$

STATEMENT-1 : The system of equations has no solution for $k\neq 3$.

and

STATEMENT-2 : The determinant $\begin{vmatrix} 1 & 3 & -1 \\ -1 & -2 & k \\ 1 & 4 & 1 \end{vmatrix} \neq 0$, for $k \neq 3$.

(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. Consider the system of equations
$a\,x+b\,y=0$, $c\,x+d\,y=0$, where $a, b, c, d \in \{0, 1\}$.

STATEMENT-1 : The probability that the system of equations has a unique solution is $\frac{3}{8}$.

and

STATEMENT-2 : The probability that the system of equations has a solution is 1 .

(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)

Paragraph for Question Nos. 15 to 17

A circle C of radius 1 is inscribed in an equilateral triangle PQR. The points of contact of C with the sides PQ, QR, RP are D, E, F, respectively. The line PQ is given by the equation $\sqrt{3}\,x+y-6=0$ and the point D is $\left(\frac{3\sqrt{3}}{2}, \frac{3}{2}\right)$. Further, it is given that the origin and the centre of C are on the same side of the line PQ.

15. The equation of circle C is

(A) $(x-2\sqrt{3})^2+(y-1)^2=1$ (B) $(x-2\sqrt{3})^2+(y+\frac{1}{2})^2=1$

(C) $(x-\sqrt{3})^2+(y+1)^2=1$ (D) $(x-\sqrt{3})^2+(y-1)^2=1$

Answer ○ ○ ○ ● (A) (B) (C) (D)

16. Points E and F are given by

(A) $\left(\frac{\sqrt{3}}{2}, \frac{3}{2}\right), (\sqrt{3}, 0)$ (B) $\left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right), (\sqrt{3}, 0)$

(C) $\left(\frac{\sqrt{3}}{2}, \frac{3}{2}\right), \left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$ (D) $\left(\frac{3}{2}, \frac{\sqrt{3}}{2}\right), \left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$

Answer ● ○ ○ ○ (A) (B) (C) (D)

17. Equations of the sides QR, RP are

(A) $y=\frac{2}{\sqrt{3}}x+1,\ y=-\frac{2}{\sqrt{3}}x-1$ (B) $y=\frac{1}{\sqrt{3}}x,\ y=0$

(C) $y=\frac{\sqrt{3}}{2}x+1,\ y=-\frac{\sqrt{3}}{2}x-1$ (D) $y=\sqrt{3}\,x,\ y=0$

Answer ○ ○ ○ ● (A) (B) (C) (D)

Paragraph for Question Nos. 18 to 20

Consider the functions defined implicitly by the equation $y^3-3y+x=0$ on various intervals in the real line.

If $x\in(-\infty,-2)\cup(2,\infty)$, the equation implicitly defines a unique real valued differentiable function $y=f(x)$.

If $x\in(-2,2)$, the equation implicitly defines a unique real valued differentiable function $y=g(x)$ satisfying $g(0)=0$.

18. If $f(-10\sqrt{2})=2\sqrt{2}$, then $f''(-10\sqrt{2})=$

(A) $\frac{4\sqrt{2}}{7^3 3^2}$ (B) $-\frac{4\sqrt{2}}{7^3 3^2}$ (C) $\frac{4\sqrt{2}}{7^3 3}$ (D) $-\frac{4\sqrt{2}}{7^3 3}$

Answer ○ ● ○ ○ (A) (B) (C) (D)

19. The area of the region bounded by the curve $y = f(x)$, the x-axis, and the lines $x = a$ and $x = b$, where $-\infty < a < b < -2$, is

(A) $\int_a^b \frac{x}{3\left((f(x))^2 - 1\right)} dx + bf(b) - af(a)$

(B) $-\int_a^b \frac{x}{3\left((f(x))^2 - 1\right)} dx + bf(b) - af(a)$

(C) $\int_a^b \frac{x}{3\left((f(x))^2 - 1\right)} dx - bf(b) + af(a)$

(D) $-\int_a^b \frac{x}{3\left((f(x))^2 - 1\right)} dx - bf(b) + af(a)$

Answer ● ○ ○ ○
(A) (B) (C) (D)

20. $\int_{-1}^{1} g'(x)\, dx =$

(A) $2g(-1)$ (B) 0 (C) $-2g(1)$ (D) $2g(1)$

Answer ○ ○ ○ ●
(A) (B) (C) (D)

Paragraph for Question Nos. 21 to 23

Let A, B, C be three sets of complex numbers as defined below

$$A = \{z : \text{Im}\, z \geq 1\}$$
$$B = \{z : |z - 2 - i| = 3\}$$
$$C = \{z : \text{Re}((1 - i)z) = \sqrt{2}\}.$$

21. The number of elements in the set $A \cap B \cap C$ is

(A) 0 (B) 1 (C) 2 (D) ∞

Answer ○ ● ○ ○
(A) (B) (C) (D)

22. Let z be any point in $A \cap B \cap C$. Then, $|z + 1 - i|^2 + |z - 5 - i|^2$ lies between

(A) 25 and 29 (B) 30 and 34 (C) 35 and 39 (D) 40 and 44

Answer ○ ○ ● ○
(A) (B) (C) (D)

23. Let z be any point in $A \cap B \cap C$ and let w be any point satisfying $|w-2-i|<3$ Then, $|z|-|w|+3$ lies between

(A) -6 and 3 (B) -3 and 6 (C) -6 and 6 (D) -3 and 9

Answer

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

OR

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

OR

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

24. Students I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table.

Least count for length = 0.1 cm

Least count for time = 0.1 s

Student	Length of the pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_I, E_{II} and E_{III} are the percentage errors in g, i.e., $\left(\frac{\Delta g}{g} \times 100\right)$ for students I, II and III, respectively,

(A) $E_I = 0$ (B) E_I is minimum

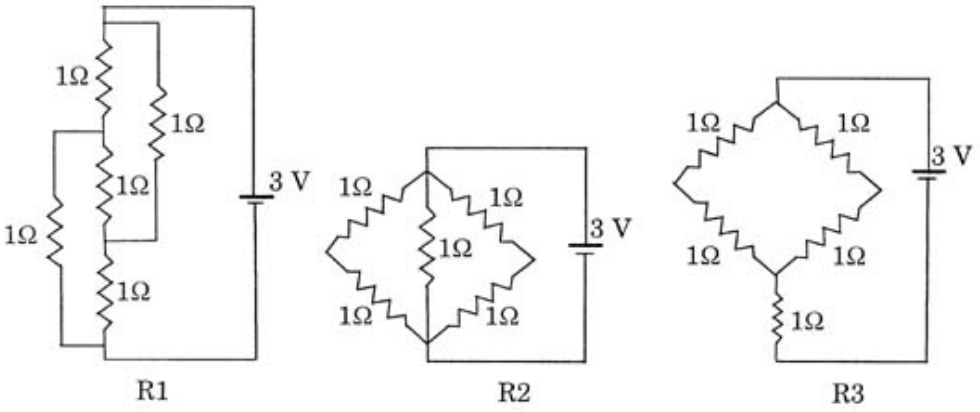
(C) $E_I = E_{II}$ (D) E_{II} is maximum

Answer

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

25. Figure shows three resistor configurations R1, R2 and R3 connected to 3 V battery. If the power dissipated by the configuration R1, R2 and R3 is P1, P2 and P3, respectively, then

Figure :



(A) P1 > P2 > P3
(B) P1 > P3 > P2
(C) P2 > P1 > P3
(D) P3 > P2 > P1

Answer ○ ○ ● ○
(A) (B) (C) (D)

26. Which one of the following statements is **WRONG** in the context of X-rays generated from a X-ray tube?

(A) Wavelength of characteristic X-rays decreases when the atomic number of the target increases

(B) Cut-off wavelength of the continuous X-rays depends on the atomic number of the target

(C) Intensity of the characteristic X-rays depends on the electrical power given to the X-ray tube

(D) Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in the X-ray tube

Answer ○ ● ○ ○
(A) (B) (C) (D)

27. Two beams of red and violet colours are made to pass separately through a prism (angle of the prism is 60°). In the position of minimum deviation, the angle of refraction will be

(A) 30° for both the colours
(B) greater for the violet colour
(C) greater for the red colour
(D) equal but not 30° for both the colours

Answer ● ○ ○ ○
(A) (B) (C) (D)

28. An ideal gas is expanding such that PT^2 = constant. The coefficient of volume expansion of the gas is

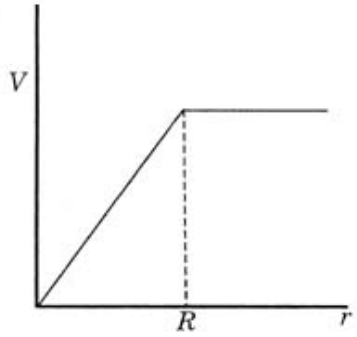
(A) $\frac{1}{T}$ (B) $\frac{2}{T}$ (C) $\frac{3}{T}$ (D) $\frac{4}{T}$

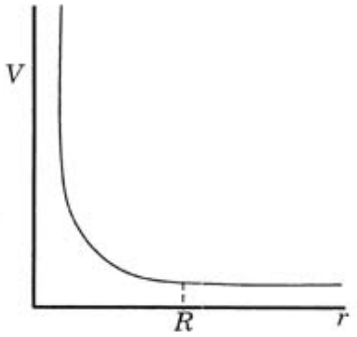
Answer ○ ○ ● ○
(A) (B) (C) (D)

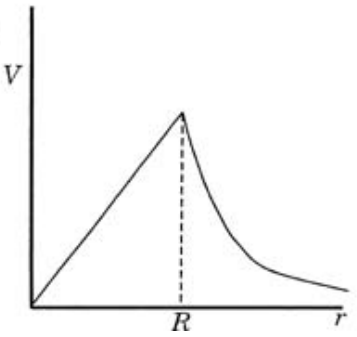
29. A spherically symmetric gravitational system of particles has a mass density

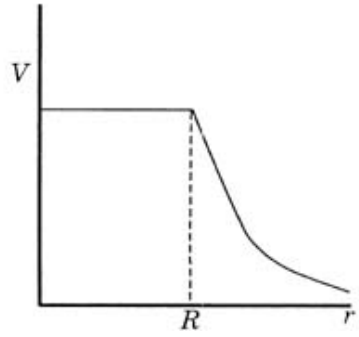
$$\rho = \begin{cases} \rho_0 & \text{for } r \le R \\ 0 & \text{for } r > R \end{cases}$$

where ρ_0 is a constant. A test mass can undergo circular motion under the influence of the gravitational field of particles. Its speed V as a function of distance r $(0 < r < \infty)$ from the centre of the system is represented by

(A)


(B)


(C)


(D)


Answer ○ ○ ● ○
(A) (B) (C) (D)

30. Two balls, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p}_1'$ and $\vec{p}_2'$ be their final momenta. The following option(s) is(are) **NOT ALLOWED** for any non-zero value of $p, a_1, a_2, b_1, b_2, c_1$ and c_2.

(A) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$
$\vec{p}_2' = a_2\hat{i} + b_2\hat{j}$

(B) $\vec{p}_1' = c_1\hat{k}$
$\vec{p}_2' = c_2\hat{k}$

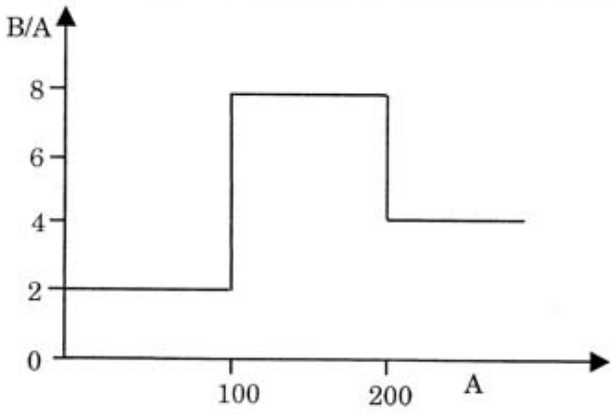
(C) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$
$\vec{p}_2' = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$

(D) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j}$
$\vec{p}_2' = a_2\hat{i} + b_1\hat{j}$

Answer ● ○ ○ ●
(A) (B) (C) (D)

31. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below.

Figure :



(A) Fusion of two nuclei with mass numbers lying in the range of $1 < A < 50$ will release energy

(B) Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy

(C) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragments

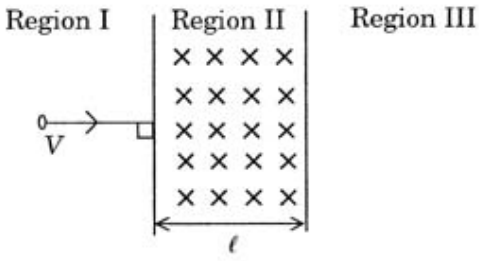
(D) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments

Answer ○ ● ○ ●

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

32. A particle of mass m and charge q, moving with velocity V enters Region II normal to the boundary as shown in the figure. Region II has a uniform magnetic field B perpendicular to the plane of the paper. The length of the Region II is ℓ. Choose the correct choice(s).

Figure :



(A) The particle enters Region III only if its velocity $V > \frac{q\ell B}{m}$

(B) The particle enters Region III only if its velocity $V < \frac{q\ell B}{m}$

(C) Path length of the particle in Region II is maximum when velocity $V = \frac{q\ell B}{m}$

(D) Time spent in Region II is same for any velocity V as long as the particle returns to Region I

Answer ● ○ ● ●

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

33. In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice(s).

(A) If $d = \lambda$, the screen will contain only one maximum

(B) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen

(C) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase

(D) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase

Answer

● ● ○ ○

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

34. STATEMENT-1

In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

and

STATEMENT-2

Resistance of a metal increases with increase in temperature.

(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

An astronaut in an orbiting space station above the Earth experiences weightlessness.

and

STATEMENT-2

An object moving around the Earth under the influence of Earth's gravitational force is in a state of 'free-fall'.

(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. STATEMENT-1

Two cylinders, one hollow (metal) and the other solid (wood) with the same mass and identical dimensions are simultaneously allowed to roll without slipping down an inclined plane from the same height. The hollow cylinder will reach the bottom of the inclined plane first.

and

STATEMENT-2

By the principle of conservation of energy, the total kinetic energies of both the cylinders are identical when they reach the bottom of the incline.

(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)

37. STATEMENT-1

The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

and

STATEMENT-2

In any steady flow of an incompressible fluid, the volume flow rate of the fluid 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

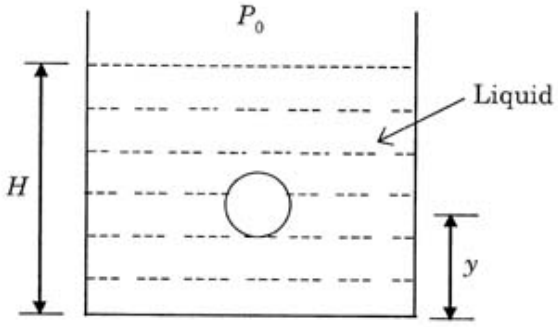
(D) STATEMENT-1 is False, STATEMENT-2 is True

Answer ● ○ ○ ○ (A) (B) (C) (D)

Paragraph for Question Nos. 38 to 40

A small spherical monoatomic ideal gas bubble $\left(\gamma = \frac{5}{3}\right)$ is trapped inside a liquid of density ρ_ℓ (see figure). Assume that the bubble does not exchange any heat with the liquid. The bubble contains n moles of gas. The temperature of the gas when the bubble is at the bottom is T_0, the height of the liquid is H and the atmospheric pressure is P_0 (Neglect surface tension).

Figure :



38. As the bubble moves upwards, besides the buoyancy force the following forces are acting on it

(A) Only the force of gravity

(B) The force due to gravity and the force due to the pressure of the liquid

(C) The force due to gravity, the force due to the pressure of the liquid and the force due to viscosity of the liquid

(D) The force due to gravity and the force due to viscosity of the liquid

Answer ○ (A) ○ (B) ○ (C) ● (D)

39. When the gas bubble is at a height y from the bottom, its temperature is

(A) $T_0\left(\frac{P_0 + \rho_\ell g H}{P_0 + \rho_\ell g y}\right)^{2/5}$

(B) $T_0\left(\frac{P_0 + \rho_\ell g (H - y)}{P_0 + \rho_\ell g H}\right)^{2/5}$

(C) $T_0\left(\frac{P_0 + \rho_\ell g H}{P_0 + \rho_\ell g y}\right)^{3/5}$

(D) $T_0\left(\frac{P_0 + \rho_\ell g (H - y)}{P_0 + \rho_\ell g H}\right)^{3/5}$

Answer ○ (A) ● (B) ○ (C) ○ (D)

40. The buoyancy force acting on the gas bubble is (Assume R is the universal gas constant)

(A) $\rho_\ell n R g T_0 \dfrac{(P_0 + \rho_\ell g H)^{2/5}}{(P_0 + \rho_\ell g y)^{7/5}}$

(B) $\dfrac{\rho_\ell n R g T_0}{(P_0 + \rho_\ell g H)^{2/5}[P_0 + \rho_\ell g (H - y)]^{3/5}}$

(C) $\rho_\ell n R g T_0 \dfrac{(P_0 + \rho_\ell g H)^{3/5}}{(P_0 + \rho_\ell g y)^{8/5}}$

(D) $\dfrac{\rho_\ell n R g T_0}{(P_0 + \rho_\ell g H)^{3/5}[P_0 + \rho_\ell g (H - y)]^{2/5}}$

Answer ○ ● ○ ○

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

Paragraph for Question Nos. 41 to 43

In a mixture of H – He^+ gas (He^+ is singly ionized He atom), H atoms and He^+ ions are excited to their respective first excited states. Subsequently, H atoms transfer their total excitation energy to He^+ ions (by collisions). Assume that the Bohr model of atom is exactly valid.

41. The quantum number n of the state finally populated in He^+ ions is

(A) 2 (B) 3 (C) 4 (D) 5

Answer ○ ○ ● ○

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

42. The wavelength of light emitted in the visible region by He^+ ions after collisions with H atoms is

(A) 6.5×10^{-7} m (B) 5.6×10^{-7} m

(C) 4.8×10^{-7} m (D) 4.0×10^{-7} m

Answer ○ ○ ● ○

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

43. The ratio of the kinetic energy of the $n = 2$ electron for the H atom to that of He^+ ion is

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) 1 (D) 2

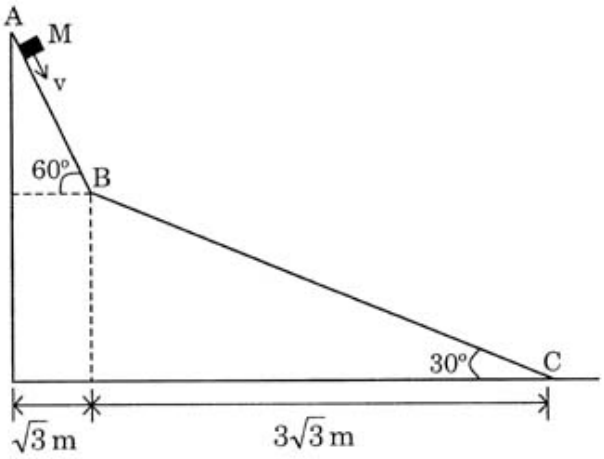
Answer ● ○ ○ ○

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

Paragraph for Question Nos. 44 to 46

A small block of mass M moves on a frictionless surface of an inclined plane, as shown in figure. The angle of the incline suddenly changes from 60° to 30° at point B. The block is initially at rest at A. Assume that collisions between the block and the incline are totally inelastic ($g = 10\ m/s^2$).

Figure :



44. The speed of the block at point B immediately after it strikes the second incline is

(A) $\sqrt{60}$ m/s (B) $\sqrt{45}$ m/s (C) $\sqrt{30}$ m/s (D) $\sqrt{15}$ m/s

Answer ○ ● ○ ○
(A) (B) (C) (D)

45. The speed of the block at point C, immediately before it leaves the second incline is

(A) $\sqrt{120}$ m/s (B) $\sqrt{105}$ m/s (C) $\sqrt{90}$ m/s (D) $\sqrt{75}$ m/s

Answer ○ ● ○ ○
(A) (B) (C) (D)

46. If collision between the block and the incline is completely elastic, then the vertical (upward) component of the velocity of the block at point B, immediately after it strikes the second incline is

(A) $\sqrt{30}$ m/s (B) $\sqrt{15}$ m/s (C) 0 (D) $-\sqrt{15}$ m/s

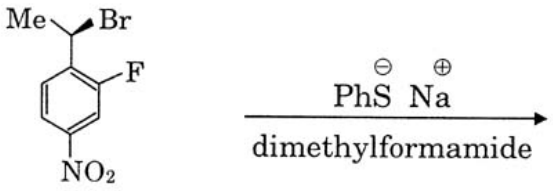
Answer ○ ○ ● ○
(A) (B) (C) (D)

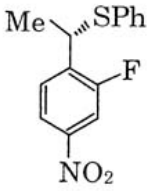
47. Hyperconjugation involves overlap of the following orbitals

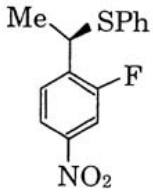
(A) $\sigma - \sigma$ (B) $\sigma - p$ (C) $p - p$ (D) $\pi - \pi$

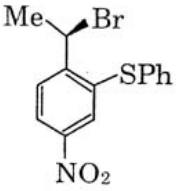
Answer ○ ● ○ ○
(A) (B) (C) (D)

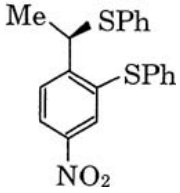
48. The major product of the following reaction is



(A) 

(B) 

(C) 

(D) 

Answer ● ○ ○ ○
(A) (B) (C) (D)

49. Aqueous solution of $Na_2S_2O_3$ on reaction with Cl_2 gives

(A) $Na_2S_4O_6$ (B) $NaHSO_4$ (C) NaCl (D) NaOH

Answer ○ ● ○ ○
(A) (B) (C) (D)

50. Native silver metal forms a water soluble complex with a dilute aqueous solution of NaCN in the presence of

(A) nitrogen (B) oxygen (C) carbon dioxide (D) argon

Answer ○ ● ○ ○
(A) (B) (C) (D)

51. Under the same reaction conditions, initial concentration of 1.386 mol dm^{-3} of a substance becomes half in 40 seconds and 20 seconds through first order and zero order kinetics, respectively. Ratio $\left(\frac{k_1}{k_0}\right)$ of the rate constants for first order (k_1) and zero order (k_0) of the reactions is

(A) 0.5 mol^{-1} dm^3 (B) 1.0 mol dm^{-3}

(C) 1.5 mol dm^{-3} (D) 2.0 mol^{-1} dm^3

Answer ● ○ ○ ○
(A) (B) (C) (D)

52. 2.5 mL of $\frac{2}{5}$ M weak monoacidic base ($K_b = 1 \times 10^{-12}$ at 25 °C) is titrated with $\frac{2}{15}$ M HCl in water at 25°C. The concentration of H^+ at equivalence point is ($K_w = 1 \times 10^{-14}$ at 25 °C)

(A) 3.7×10^{-13} M

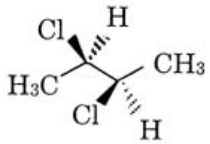
(B) 3.2×10^{-7} M

(C) 3.2×10^{-2} M

(D) 2.7×10^{-2} M

Answer ○ ○ ○ ● (A) (B) (C) (D)

53. The correct statement(s) about the compound given below is (are)



(A) The compound is optically active

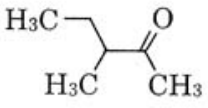
(B) The compound possesses centre of symmetry

(C) The compound possesses plane of symmetry

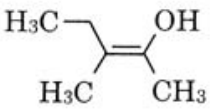
(D) The compound possesses axis of symmetry

Answer ● ○ ○ ● (A) (B) (C) (D)

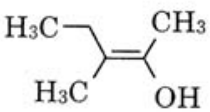
54. The correct statement(s) concerning the structures **E**, **F** and **G** is (are)



(**E**)



(**F**)



(**G**)

(A) **E**, **F** and **G** are resonance structures

(B) **E**, **F** and **E**, **G** are tautomers

(C) **F** and **G** are geometrical isomers

(D) **F** and **G** are diastereomers

Answer ○ ● ● ● (A) (B) (C) (D)

55. A solution of colourless salt **H** on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after sometime. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salt(s) **H** is (are)

(A) NH_4NO_3 (B) NH_4NO_2 (C) NH_4Cl (D) $(NH_4)_2SO_4$

Answer ● ● ○ ○
(A) (B) (C) (D)

56. A gas described by van der Waals equation

(A) behaves similar to an ideal gas in the limit of large molar volumes

(B) behaves similar to an ideal gas in the limit of large pressures

(C) is characterised by van der Waals coefficients that are dependent on the identity of the gas but are independent of the temperature

(D) has the pressure that is lower than the pressure exerted by the same gas behaving ideally

Answer
● ○ ● ○
(A) (B) (C) (D)
OR
● ○ ● ●
(A) (B) (C) (D)

57. STATEMENT-1 : Bromobenzene upon reaction with Br_2/Fe gives 1,4-dibromobenzene as the major product.

and

STATEMENT-2 : In bromobenzene, the inductive effect of the bromo group is more dominant than the mesomeric effect in directing the incoming electrophile.

(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. STATEMENT-1 : Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds.

and

STATEMENT-2 : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'.

(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)

59. STATEMENT-1 : The plot of atomic number (y-axis) versus number of neutrons (x-axis) for stable nuclei shows a curvature towards x-axis from the line of 45° slope as the atomic number is increased.

and

STATEMENT-2 : Proton-proton electrostatic repulsions begin to overcome attractive forces involving protons and neutrons in heavier nuclides.

(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)

60. STATEMENT-1 : For every chemical reaction at equilibrium, standard Gibbs energy of reaction is zero.

and

STATEMENT-2 : At constant temperature and pressure, chemical reactions are spontaneous in the direction of decreasing Gibbs energy.

(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

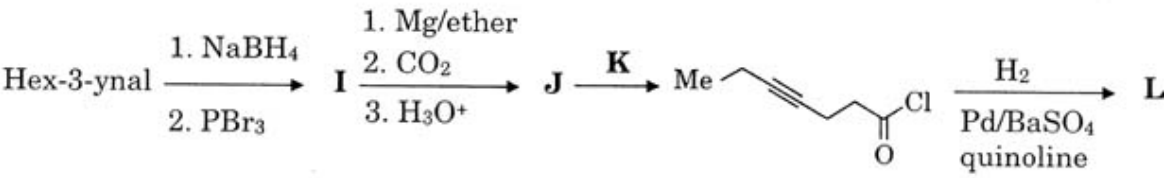
(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

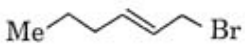
Answer ○ (A) ○ (B) ○ (C) ● (D)

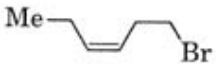
Paragraph for Question Nos. 61 to 63

In the following reaction sequence, products **I**, **J** and **L** are formed. **K** represents a reagent.



61. The structure of the product **I** is

(A) 

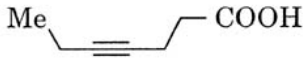
(B) 

(C) 

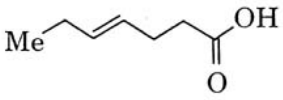
(D) 

Answer ○ ○ ○ ● (A) (B) (C) (D)

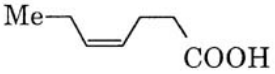
62. The structures of compounds **J** and **K**, respectively, are

(A) 

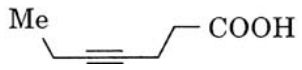
and $SOCl_2$

(B) 

and SO_2Cl_2

(C) 

and $SOCl_2$

(D) 

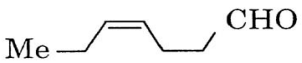
and CH_3SO_2Cl

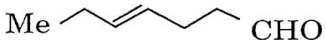
Answer ● ○ ○ ○ (A) (B) (C) (D)

63. The structure of product **L** is

(A) 

(B) 

(C) 

(D) 

Answer ○ ○ ● ○
(A) (B) (C) (D)

Paragraph for Question Nos. 64 to 66

There are some deposits of nitrates and phosphates in earth's crust. Nitrates are more soluble in water. Nitrates are difficult to reduce under the laboratory conditions but microbes do it easily. Ammonia forms large number of complexes with transition metal ions. Hybridization easily explains the ease of sigma donation capability of NH_3 and PH_3. Phosphine is a flammable gas and is prepared from white phosphorous.

64. Among the following, the correct statement is

(A) Phosphates have no biological significance in humans

(B) Between nitrates and phosphates, phosphates are less abundant in earth's crust

(C) Between nitrates and phosphates, nitrates are less abundant in earth's crust

(D) Oxidation of nitrates is possible in soil

Answer ○ ○ ● ○
(A) (B) (C) (D)

65. Among the following, the correct statement is

(A) Between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies spherical 's' orbital and is less directional

(B) Between NH_3 and PH_3, PH_3 is a better electron donor because the lone pair of electrons occupies sp^3 orbital and is more directional

(C) Between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies sp^3 orbital and is more directional

(D) Between NH_3 and PH_3, PH_3 is a better electron donor because the lone pair of electrons occupies spherical 's' orbital and is less directional

Answer ○ ○ ● ○
(A) (B) (C) (D)

66. White phosphorus on reaction with NaOH gives PH_3 as one of the products. This is a

(A) dimerization reaction
(B) disproportionation reaction
(C) condensation reaction
(D) precipitation reaction

Answer

○ (A) ● (B) ○ (C) ○ (D)

Paragraph for Question Nos. 67 to 69

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles

A solution **M** is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9

Given : Freezing point depression constant of water $\left(K_f^{water}\right) = 1.86$ K kg mol^{-1}
Freezing point depression constant of ethanol $\left(K_f^{ethanol}\right) = 2.0$ K kg mol^{-1}
Boiling point elevation constant of water $\left(K_b^{water}\right) = 0.52$ K kg mol^{-1}
Boiling point elevation constant of ethanol $\left(K_b^{ethanol}\right) = 1.2$ K kg mol^{-1}
Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mm Hg
Vapour pressure of pure ethanol = 40 mm Hg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

67. The freezing point of the solution **M** is

(A) 268.7 K (B) 268.5 K (C) 234.2 K (D) 150.9 K

Answer

○ (A) ○ (B) ○ (C) ● (D)

68. The vapour pressure of the solution **M** is

(A) 39.3 mm Hg (B) 36.0 mm Hg

(C) 29.5 mm Hg (D) 28.8 mm Hg

Answer ○ ● ○ ○

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

69. Water is added to the solution **M** such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is

(A) 380.4 K (B) 376.2 K (C) 375.5 K (D) 354.7 K

Answer ○ ● ○ ○

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

JEE-2008
Paper II

1. A particle P starts from the point $z_0 = 1+2i$, where $i=\sqrt{-1}$. It moves first horizontally away from origin by 5 units and then vertically away from origin by 3 units to reach a point z_1. From z_1 the particle moves $\sqrt{2}$ units in the direction of the vector $\hat{i}+\hat{j}$ and then it moves through an angle $\frac{\pi}{2}$ in anticlockwise direction on a circle with centre at origin, to reach a point z_2. The point z_2 is given by

(A) $6+7i$ (B) $-7+6i$ (C) $7+6i$ (D) $-6+7i$

Answer ○ (A) ○ (B) ○ (C) ● (D)

2. Let the function $g:(-\infty,\infty)\to\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ be given by $g(u)=2\tan^{-1}(e^u)-\frac{\pi}{2}$. Then, g is

(A) even and is strictly increasing in $(0, \infty)$
(B) odd and is strictly decreasing in $(-\infty, \infty)$
(C) odd and is strictly increasing in $(-\infty, \infty)$
(D) neither even nor odd, but is strictly increasing in $(-\infty, \infty)$

Answer ○ (A) ○ (B) ● (C) ○ (D)

3. Consider a branch of the hyperbola

$$x^2-2y^2-2\sqrt{2}x-4\sqrt{2}y-6=0$$

with vertex at the point A. Let B be one of the end points of its latus rectum. If C is the focus of the hyperbola nearest to the point A, then the area of the triangle ABC is

(A) $1-\sqrt{\frac{2}{3}}$ (B) $\sqrt{\frac{3}{2}}-1$ (C) $1+\sqrt{\frac{2}{3}}$ (D) $\sqrt{\frac{3}{2}}+1$

Answer ○ (A) ● (B) ○ (C) ○ (D)

4. The area of the region between the curves $y=\sqrt{\frac{1+\sin x}{\cos x}}$ and $y=\sqrt{\frac{1-\sin x}{\cos x}}$ bounded by the lines $x=0$ and $x=\frac{\pi}{4}$ is

(A) $\int_0^{\sqrt{2}-1}\frac{t}{(1+t^2)\sqrt{1-t^2}}\,dt$ (B) $\int_0^{\sqrt{2}-1}\frac{4t}{(1+t^2)\sqrt{1-t^2}}\,dt$

(C) $\int_0^{\sqrt{2}+1}\frac{4t}{(1+t^2)\sqrt{1-t^2}}\,dt$ (D) $\int_0^{\sqrt{2}+1}\frac{t}{(1+t^2)\sqrt{1-t^2}}\,dt$

Answer ○ (A) ● (B) ○ (C) ○ (D)

5. Consider three points $P = (-\sin(\beta-\alpha), -\cos\beta)$, $Q = (\cos(\beta-\alpha), \sin\beta)$ and $R = (\cos(\beta-\alpha+\theta), \sin(\beta-\theta))$, where $0 < \alpha, \beta, \theta < \frac{\pi}{4}$. Then,

(A) P lies on the line segment RQ

(B) Q lies on the line segment PR

(C) R lies on the line segment QP

(D) P, Q, R are non-collinear

Answer ○ ○ ○ ● (A) (B) (C) (D)

6. An experiment has 10 equally likely outcomes. Let A and B be two non-empty events of the experiment. If A consists of 4 outcomes, the number of outcomes that B must have so that A and B are independent, is

(A) 2, 4 or 8 (B) 3, 6 or 9 (C) 4 or 8 (D) 5 or 10

Answer ○ ○ ○ ● (A) (B) (C) (D)

7. Let two non-collinear unit vectors $\hat{a}$ and $\hat{b}$ form an acute angle. A point P moves so that at any time t the position vector $\vec{OP}$ (where O is the origin) is given by $\hat{a}\cos t + \hat{b}\sin t$. When P is farthest from origin O, let M be the length of $\vec{OP}$ and $\hat{u}$ be the unit vector along $\vec{OP}$. Then,

(A) $\hat{u} = \dfrac{\hat{a}+\hat{b}}{|\hat{a}+\hat{b}|}$ and $M = (1+\hat{a}\cdot\hat{b})^{\frac{1}{2}}$ (B) $\hat{u} = \dfrac{\hat{a}-\hat{b}}{|\hat{a}-\hat{b}|}$ and $M = (1+\hat{a}\cdot\hat{b})^{\frac{1}{2}}$

(C) $\hat{u} = \dfrac{\hat{a}+\hat{b}}{|\hat{a}+\hat{b}|}$ and $M = (1+2\hat{a}\cdot\hat{b})^{\frac{1}{2}}$ (D) $\hat{u} = \dfrac{\hat{a}-\hat{b}}{|\hat{a}-\hat{b}|}$ and $M = (1+2\hat{a}\cdot\hat{b})^{\frac{1}{2}}$

Answer ● ○ ○ ○ (A) (B) (C) (D)

8. Let

$$I = \int \frac{e^x}{e^{4x}+e^{2x}+1}\,dx, \quad J = \int \frac{e^{-x}}{e^{-4x}+e^{-2x}+1}\,dx.$$

Then, for an arbitrary constant C, the value of $J - I$ equals

(A) $\dfrac{1}{2}\log\left(\dfrac{e^{4x}-e^{2x}+1}{e^{4x}+e^{2x}+1}\right)+C$ (B) $\dfrac{1}{2}\log\left(\dfrac{e^{2x}+e^{x}+1}{e^{2x}-e^{x}+1}\right)+C$

(C) $\dfrac{1}{2}\log\left(\dfrac{e^{2x}-e^{x}+1}{e^{2x}+e^{x}+1}\right)+C$ (D) $\dfrac{1}{2}\log\left(\dfrac{e^{4x}+e^{2x}+1}{e^{4x}-e^{2x}+1}\right)+C$

Answer ○ ○ ● ○ (A) (B) (C) (D)

9. Let $g(x) = \log f(x)$ where $f(x)$ is a twice differentiable positive function on $(0, \infty)$ such that $f(x+1) = x\, f(x)$. Then, for $N = 1, 2, 3, \ldots$,

$$g''\left(N + \frac{1}{2}\right) - g''\left(\frac{1}{2}\right) =$$

(A) $-4\left\{1 + \frac{1}{9} + \frac{1}{25} + \cdots + \frac{1}{(2N-1)^2}\right\}$ (B) $4\left\{1 + \frac{1}{9} + \frac{1}{25} + \cdots + \frac{1}{(2N-1)^2}\right\}$

(C) $-4\left\{1 + \frac{1}{9} + \frac{1}{25} + \cdots + \frac{1}{(2N+1)^2}\right\}$ (D) $4\left\{1 + \frac{1}{9} + \frac{1}{25} + \cdots + \frac{1}{(2N+1)^2}\right\}$

Answer ● ○ ○ ○

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

10. Suppose four distinct positive numbers a_1, a_2, a_3, a_4 are in G.P. Let $b_1 = a_1$, $b_2 = b_1 + a_2$, $b_3 = b_2 + a_3$ and $b_4 = b_3 + a_4$.

STATEMENT-1 : The numbers b_1, b_2, b_3, b_4 are neither in A.P. nor in G.P.

and

STATEMENT-2 : The numbers b_1, b_2, b_3, b_4 are in H.P.

(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. Let a, b, c, p, q be real numbers. Suppose α, β are the roots of the equation $x^2 + 2px + q = 0$ and $\alpha, \frac{1}{\beta}$ are the roots of the equation $ax^2 + 2bx + c = 0$, where $\beta^2 \notin \{-1, 0, 1\}$.

STATEMENT-1 : $\left(p^2 - q\right)\left(b^2 - ac\right) \geq 0$

and

STATEMENT-2 : $b \neq pa$ or $c \neq qa$

(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)

12. Consider

$L_1 : 2x + 3y + p - 3 = 0$

$L_2 : 2x + 3y + p + 3 = 0,$

where p is a real number, and $C : x^2 + y^2 + 6x - 10y + 30 = 0$.

STATEMENT-1 : If line L_1 is a chord of circle C, then line L_2 is not always a diameter of circle C.

and

STATEMENT-2 : If line L_1 is a diameter of circle C, then line L_2 is not a chord of circle C.

(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. Let a solution $y = y(x)$ of the differential equation

$$x\sqrt{x^2 - 1}\ dy - y\sqrt{y^2 - 1}\ dx = 0$$

satisfy $y(2) = \frac{2}{\sqrt{3}}$.

STATEMENT-1 : $y(x) = \sec\left(\sec^{-1} x - \frac{\pi}{6}\right)$

and

STATEMENT-2 : $y(x)$ is given by

$$\frac{1}{y} = \frac{2\sqrt{3}}{x} - \sqrt{1 - \frac{1}{x^2}}$$

(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)

Paragraph for Question Nos. 14 to 16

Consider the function $f:(-\infty,\infty)\to(-\infty,\infty)$ defined by

$$f(x)=\frac{x^2-ax+1}{x^2+ax+1},\ 0<a<2.$$

14. Which of the following is true?

(A) $(2+a)^2 f''(1)+(2-a)^2 f''(-1)=0$ (B) $(2-a)^2 f''(1)-(2+a)^2 f''(-1)=0$

(C) $f'(1)f'(-1)=(2-a)^2$ (D) $f'(1)\,f'(-1)=-(2+a)^2$

Answer ● ○ ○ ○

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

15. Which of the following is true?

(A) $f(x)$ is decreasing on $(-1,1)$ and has a local minimum at $x=1$

(B) $f(x)$ is increasing on $(-1,1)$ and has a local maximum at $x=1$

(C) $f(x)$ is increasing on $(-1,1)$ but has neither a local maximum nor a local minimum at $x=1$

(D) $f(x)$ is decreasing on $(-1,1)$ but has neither a local maximum nor a local minimum at $x=1$

Answer ● ○ ○ ○

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

16. Let

$$g(x)=\int_0^{e^x}\frac{f'(t)}{1+t^2}\,dt.$$

Which of the following is true?

(A) $g'(x)$ is positive on $(-\infty,0)$ and negative on $(0,\infty)$

(B) $g'(x)$ is negative on $(-\infty,0)$ and positive on $(0,\infty)$

(C) $g'(x)$ changes sign on both $(-\infty,0)$ and $(0,\infty)$

(D) $g'(x)$ does not change sign on $(-\infty,\infty)$

Answer ○ ● ○ ○

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

Paragraph for Question Nos. 17 to 19

Consider the lines

$$L_1 : \frac{x+1}{3} = \frac{y+2}{1} = \frac{z+1}{2}$$

$$L_2 : \frac{x-2}{1} = \frac{y+2}{2} = \frac{z-3}{3}$$

17. The unit vector perpendicular to both L_1 and L_2 is

(A) $\frac{-\hat{i}+7\hat{j}+7\hat{k}}{\sqrt{99}}$ (B) $\frac{-\hat{i}-7\hat{j}+5\hat{k}}{5\sqrt{3}}$

(C) $\frac{-\hat{i}+7\hat{j}+5\hat{k}}{5\sqrt{3}}$ (D) $\frac{7\hat{i}-7\hat{j}-\hat{k}}{\sqrt{99}}$

Answer ○ ● ○ ○

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

18. The shortest distance between L_1 and L_2 is

(A) 0 (B) $\frac{17}{\sqrt{3}}$ (C) $\frac{41}{5\sqrt{3}}$ (D) $\frac{17}{5\sqrt{3}}$

Answer ○ ○ ○ ●

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

19. The distance of the point (1, 1, 1) from the plane passing through the point (−1, −2, −1) and whose normal is perpendicular to both the lines L_1 and L_2 is

(A) $\frac{2}{\sqrt{75}}$ (B) $\frac{7}{\sqrt{75}}$ (C) $\frac{13}{\sqrt{75}}$ (D) $\frac{23}{\sqrt{75}}$

Answer ○ ○ ● ○

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

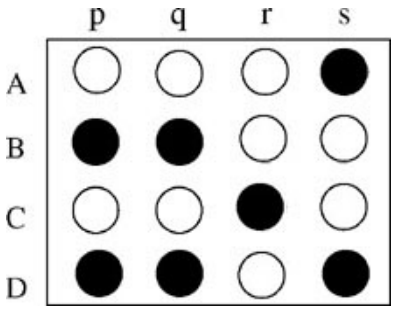
20. Consider the lines given by

$$L_1 : x+3y-5=0$$
$$L_2 : 3x-ky-1=0$$
$$L_3 : 5x+2y-12=0$$

Match the Statements / Expressions in **Column I** with the Statements / Expressions 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) L_1, L_2, L_3 are concurrent, if	(p) $k=-9$
(B) One of L_1, L_2, L_3 is parallel to at least one of the other two, if	(q) $k=-\frac{6}{5}$
(C) L_1, L_2, L_3 form a triangle, if	(r) $k=\frac{5}{6}$
(D) L_1, L_2, L_3 do not form a triangle, if	(s) $k=5$

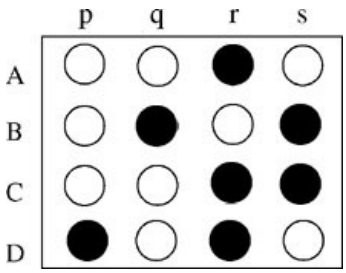
Answer



21. Match the Statements / Expressions in **Column I** with the Statements / Expressions 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) The minimum value of $\frac{x^2+2x+4}{x+2}$ is	(p) 0
(B) Let A and B be 3×3 matrices of real numbers, where A is symmetric, B is skew-symmetric, and $(A+B)(A-B)=(A-B)(A+B)$. If $(AB)^t=(-1)^k AB$, where $(AB)^t$ is the transpose of the matrix AB, then the possible values of k are	(q) 1
(C) Let $a=\log_3 \log_3 2$. An integer k satisfying $1<2^{(-k+3^{-a})}<2$, must be less than	(r) 2
(D) If $\sin\theta=\cos\varphi$, then the possible values of $\frac{1}{\pi}(\theta \pm \varphi - \frac{\pi}{2})$ are	(s) 3

Answer

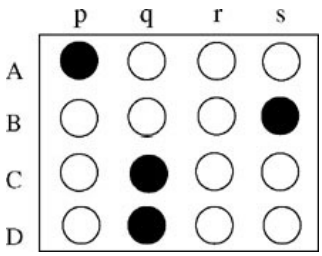


22. Consider all possible permutations of the letters of the word ENDEANOEL.

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

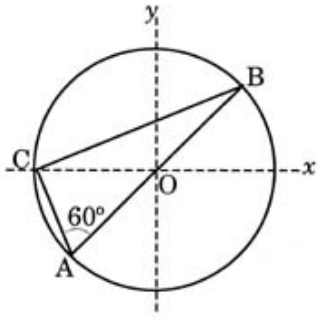
	Column I	**Column II**
(A)	The number of permutations containing the word ENDEA is	(p) $5!$
(B)	The number of permutations in which the letter E occurs in the first and the last positions is	(q) $2 \times 5!$
(C)	The number of permutations in which none of the letters D, L, N occurs in the last five positions is	(r) $7 \times 5!$
(D)	The number of permutations in which the letters A, E, O occur only in odd positions is	(s) $21 \times 5!$

Answer



23. Consider a system of three charges $\frac{q}{3}, \frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60°

Figure :



(A) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x-axis

(B) The potential energy of the system is zero

(C) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$

(D) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$

Answer

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

24. A radioactive sample S1 having an activity of $5\,\mu$Ci has twice the number of nuclei as another sample S2 which has an activity of $10\,\mu$Ci. The half lives of S1 and S2 can be

(A) 20 years and 5 years, respectively

(B) 20 years and 10 years, respectively

(C) 10 years each

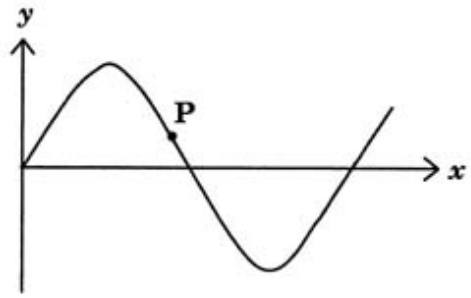
(D) 5 years each

Answer ● ○ ○ ○

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

25. A transverse sinusoidal wave moves along a string in the positive x–direction at a speed of 10 cm/s. The wavelength of the wave is 0.5 m and its amplitude is 10 cm. At a particular time t, the snap-shot of the wave is shown in figure. The velocity of point P when its displacement is 5 cm is

Figure :



(A) $\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s

(B) $-\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s

(C) $\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s

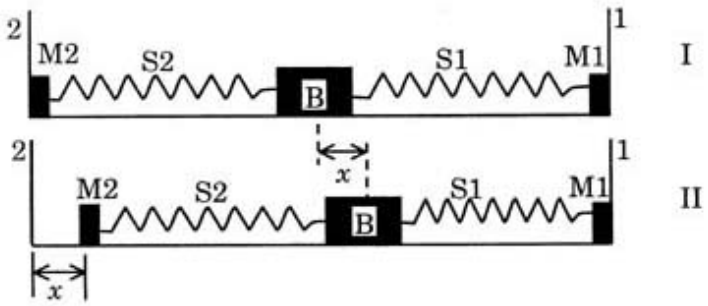
(D) $-\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s

Answer ● ○ ○ ○

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

26. A block (B) is attached to two unstretched springs S1 and S2 with spring constants k and $4k$, respectively (see figure I). The other ends are attached to identical supports M1 and M2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall 1 by a small distance x (figure II) and released. The block returns and moves a maximum distance y towards wall 2. Displacements x and y are measured with respect to the equilibrium position of the block B. The ratio $\frac{y}{x}$ is

Figure :



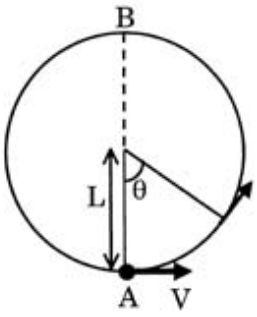
(A) 4 (B) 2 (C) $\frac{1}{2}$ (D) $\frac{1}{4}$

Answer ○ ○ ● ○

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

27. A bob of mass M is suspended by a massless string of length L. The horizontal velocity V at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies

Figure :



(A) $\theta = \frac{\pi}{4}$ (B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

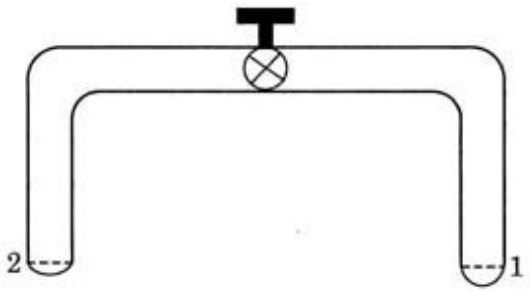
(C) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ (D) $\frac{3\pi}{4} < \theta < \pi$

Answer ○ ○ ○ ●

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

28. A glass tube of uniform internal radius (r) has a valve separating the two identical ends. Initially, the valve is in a tightly closed position. End 1 has a hemispherical soap bubble of radius r. End 2 has sub-hemispherical soap bubble as shown in figure. Just after opening the valve,

Figure :



(A) air from end 1 flows towards end 2. No change in the volume of the soap bubbles

(B) air from end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases

(C) no change occurs

(D) air from end 2 flows towards end 1. Volume of the soap bubble at end 1 increases

Answer ○ ● ○ ○

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

29. A vibrating string of certain length ℓ under a tension T resonates with a mode corresponding to the first overtone (third harmonic) of an air column of length 75 cm inside a tube closed at one end. The string also generates 4 beats per second when excited along with a tuning fork of frequency n. Now when the tension of the string is slightly increased the number of beats reduces to 2 per second. Assuming the velocity of sound in air to be 340 m/s, the frequency n of the tuning fork in Hz is

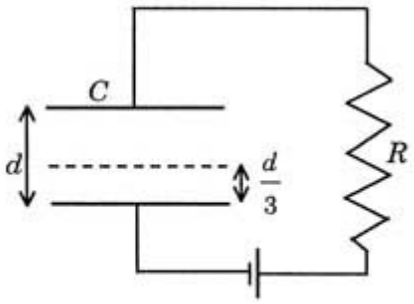
(A) 344 (B) 336 (C) 117.3 (D) 109.3

Answer ● ○ ○ ○

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

30. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $K = 2$. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time t is

Figure :



(A) $\frac{6\varepsilon_0 R}{5d+3Vt}$ (B) $\frac{(15d+9Vt)\varepsilon_0 R}{2d^2-3dVt-9V^2t^2}$

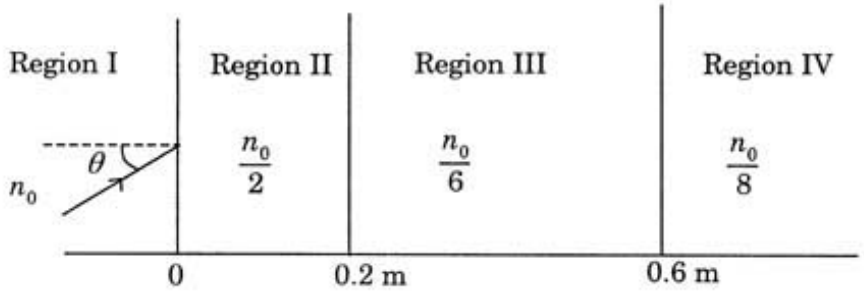
(C) $\frac{6\varepsilon_0 R}{5d-3Vt}$ (D) $\frac{(15d-9Vt)\varepsilon_0 R}{2d^2+3dVt-9V^2t^2}$

Answer ● ○ ○ ○

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

31. A light beam is traveling from Region I to Region IV (Refer Figure). The refractive index in Regions I, II, III and IV are $n_0, \frac{n_0}{2}, \frac{n_0}{6}$ and $\frac{n_0}{8}$, respectively. The angle of incidence θ for which the beam just misses entering Region IV is

Figure :



(A) $\sin^{-1}\left(\frac{3}{4}\right)$ (B) $\sin^{-1}\left(\frac{1}{8}\right)$ (C) $\sin^{-1}\left(\frac{1}{4}\right)$ (D) $\sin^{-1}\left(\frac{1}{3}\right)$

Answer ○ ● ○ ○

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

32. STATEMENT-1

For an observer looking out through the window of a fast moving train, the nearby objects appear to move in the opposite direction to the train, while the distant objects appear to be stationary.

and

STATEMENT-2

If the observer and the object are moving at velocities $\vec{V}_1$ and $\vec{V}_2$ respectively with reference to a laboratory frame, the velocity of the object with respect to the observer is $\vec{V}_2 - \vec{V}_1$.

(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

It is easier to pull a heavy object than to push it on a level ground.

and

STATEMENT-2

The magnitude of frictional force depends on the nature of the two surfaces in contact.

(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

For practical purposes, the earth is used as a reference at zero potential in electrical circuits.

and

STATEMENT-2

The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$.

(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

The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.

and

STATEMENT-2

Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

(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

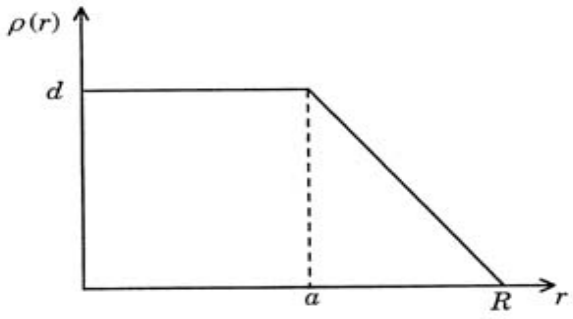
Answer ○ ○ ● ○

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

Paragraph for Question Nos. 36 to 38

The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density $\rho(r)$ [charge per unit volume] is dependent only on the radial distance r from the centre of the nucleus as shown in figure. The electric field is only along the radial direction.

Figure :



36. The electric field at $r = R$ is

(A) independent of a (B) directly proportional to a

(C) directly proportional to a^2 (D) inversely proportional to a

Answer ● ○ ○ ○

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

37. For $a = 0$, the value of d (maximum value of ρ as shown in the figure) is

(A) $\frac{3Ze}{4\pi R^3}$ (B) $\frac{3Ze}{\pi R^3}$ (C) $\frac{4Ze}{3\pi R^3}$ (D) $\frac{Ze}{3\pi R^3}$

Answer ○ ● ○ ○

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

38. The electric field within the nucleus is generally observed to be linearly dependent on r. This implies

(A) $a = 0$ (B) $a = \frac{R}{2}$ (C) $a = R$ (D) $a = \frac{2R}{3}$

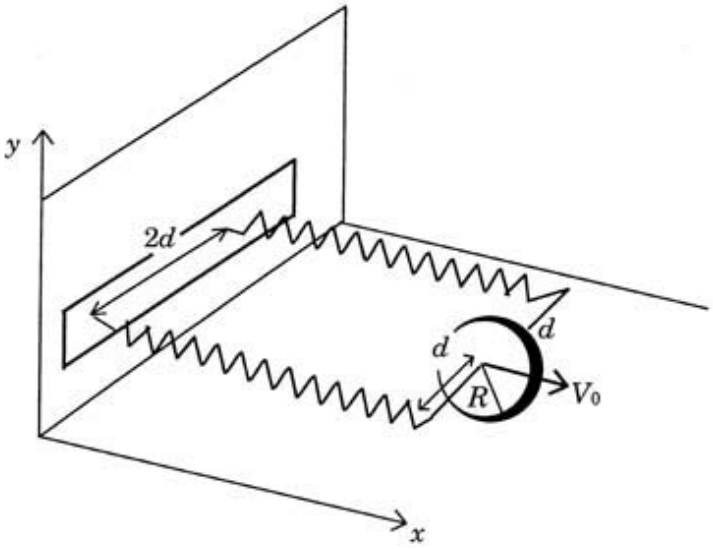
Answer ○ ○ ● ○

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

Paragraph for Question Nos. 39 to 41

A uniform thin cylindrical disk of mass M and radius R is attached to two identical massless springs of spring constant k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in a horizontal plane. The unstretched length of each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\vec{V}_0 = V_0 \hat{i}$. The coefficient of friction is μ.

Figure :



39. The net external force acting on the disk when its centre of mass is at displacement x with respect to its equilibrium position is

(A) $-kx$ (B) $-2kx$ (C) $-\frac{2kx}{3}$ (D) $-\frac{4kx}{3}$

Answer ○ ○ ○ ● (A) (B) (C) (D)

40. The centre of mass of the disk undergoes simple harmonic motion with angular frequency ω equal to

(A) $\sqrt{\frac{k}{M}}$ (B) $\sqrt{\frac{2k}{M}}$ (C) $\sqrt{\frac{2k}{3M}}$ (D) $\sqrt{\frac{4k}{3M}}$

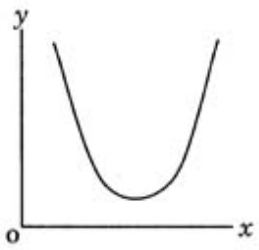
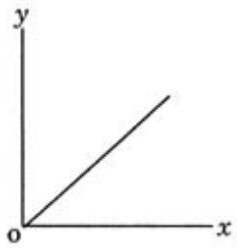
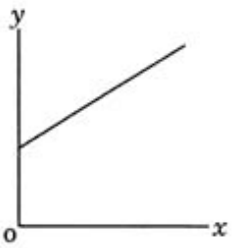
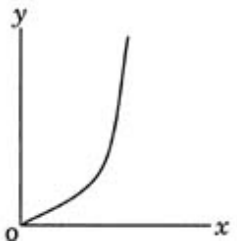
Answer ○ ○ ○ ● (A) (B) (C) (D)

41. The maximum value of V_0 for which the disk will roll without slipping is

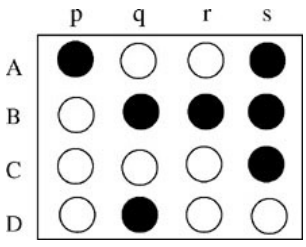
(A) $\mu g\sqrt{\frac{M}{k}}$ (B) $\mu g\sqrt{\frac{M}{2k}}$ (C) $\mu g\sqrt{\frac{3M}{k}}$ (D) $\mu g\sqrt{\frac{5M}{2k}}$

Answer ○ ○ ● ○ (A) (B) (C) (D)

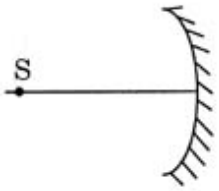
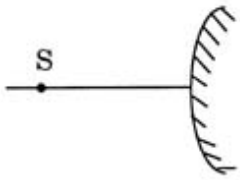
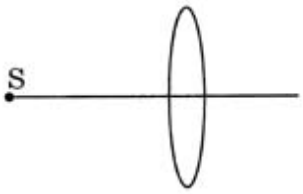
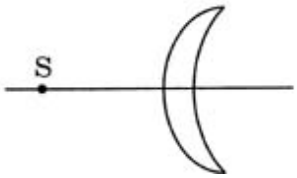
42. **Column I** gives a list of possible set of parameters measured in some experiments. The variations of the parameters in the form of graphs are shown in **Column II.** Match the set of parameters given in **Column I** with the graphs given in **Column II.** Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	**Column II**
(A) Potential energy of a simple pendulum (y axis) as a function of displacement (x axis)	(p) 
(B) Displacement (y axis) as a function of time (x axis) for a one dimensional motion at zero or constant acceleration when the body is moving along the positive x-direction	(q) 
(C) Range of a projectile (y axis) as a function of its velocity (x axis) when projected at a fixed angle	(r) 
(D) The square of the time period (y axis) of a simple pendulum as a function of its length (x axis)	(s) 

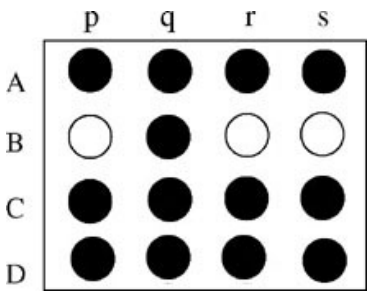
Answer



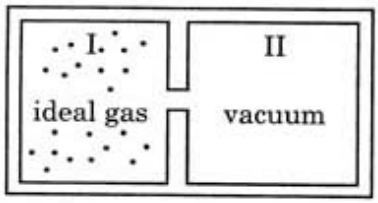
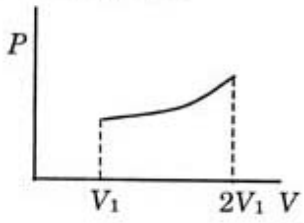
43. An optical component and an object S placed along its optic axis are given in **Column I**. The distance between the object and the component can be varied. The properties of images are given in **Column II**. Match all the properties of images from **Column II** with the appropriate components given in **Column I**. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I		**Column II**
(A)		(p) Real image
(B)		(q) Virtual image
(C)		(r) Magnified image
(D)		(s) Image at infinity

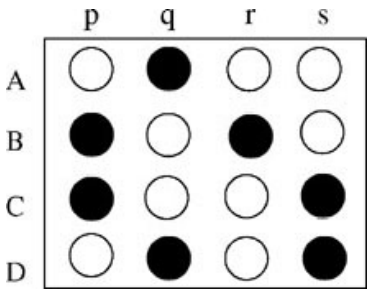
Answer



44. **Column I** contains a list of processes involving expansion of an ideal gas. Match this with **Column II** describing the thermodynamic change during this process. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and the Chamber II has vacuum. The valve is opened. 	(p) The temperature of the gas decreases
(B) An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$, where V is the volume of the gas	(q) The temperature of the gas increases or remains constant
(C) An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$, where V is its volume	(r) The gas loses heat
(D) An ideal monoatomic gas expands such that its pressure P and volume V follows the behaviour shown in the graph 	(s) The gas gains heat

Answer



45. The correct stability order for the following species is

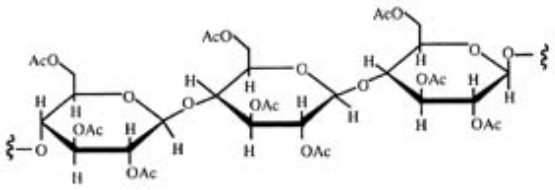
(I) (II) (III) (IV)

(A) (II) > (IV) > (I) > (III)
(B) (I) > (II) > (III) > (IV)
(C) (II) > (I) > (IV) > (III)
(D) (I) > (III) > (II) > (IV)

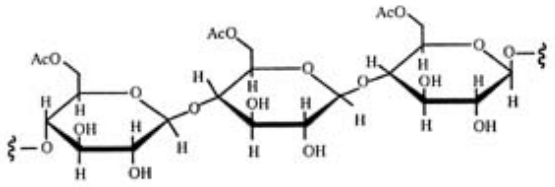
Answer ○ ○ ○ ● (A) (B) (C) (D)

46. Cellulose upon acetylation with excess acetic anhydride/H_2SO_4 (catalytic) gives cellulose triacetate whose structure is

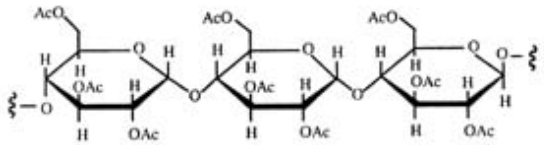
(A)



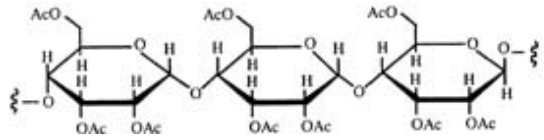
(B)



(C)

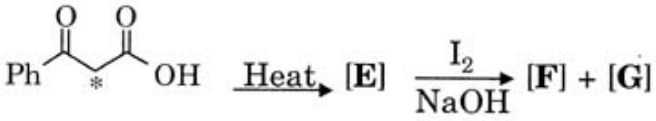


(D)

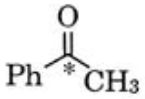
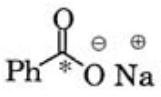


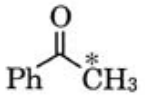
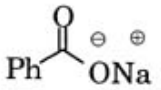
Answer ● ○ ○ ○ (A) (B) (C) (D)

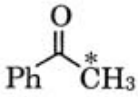
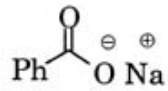
47. In the following reaction sequence, the correct structures of **E**, **F** and **G** are

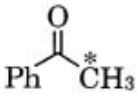
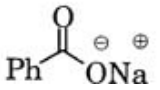


(* implies ^{13}C labelled carbon)

(A) **E** =  **F** =  **G** = CHI_3

(B) **E** =  **F** =  **G** = CHI_3

(C) **E** =  **F** =  **G** = $\overset{*}{C}HI_3$

(D) **E** =  **F** =  **G** = $\overset{*}{C}H_3I$

Answer ○ (A) ○ (B) ● (C) ○ (D)

48. Among the following, the coloured compound is

(A) CuCl (B) $K_3[Cu(CN)_4]$

(C) CuF_2 (D) $[Cu(CH_3CN)_4]BF_4$

Answer ○ (A) ○ (B) ● (C) ○ (D)

49. Both $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. The hybridisations of nickel in these complexes, respectively, are

(A) sp^3, sp^3 (B) sp^3, dsp^2 (C) dsp^2, sp^3 (D) dsp^2, dsp^2

Answer ○ (A) ● (B) ○ (C) ○ (D)

50. The IUPAC name of $[Ni(NH_3)_4][NiCl_4]$ is

(A) Tetrachloronickel (II) - tetraamminenickel (II)

(B) Tetraamminenickel (II) - tetrachloronickel (II)

(C) Tetraamminenickel (II) - tetrachloronickelate (II)

(D) Tetrachloronickel (II) - tetraamminenickelate (0)

Answer ○ ○ ● ○

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

51. Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of H_2 gas at the cathode is (1 Faraday = 96500 C mol^{-1})

(A) 9.65×10^4 sec (B) 19.3×10^4 sec

(C) 28.95×10^4 sec (D) 38.6×10^4 sec

Answer ○ ● ○ ○

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

52. Among the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambient conditions is

(A) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$ (B) $CH_3(CH_2)_{11}OSO_3^-Na^+$

(C) $CH_3(CH_2)_6COO^-Na^+$ (D) $CH_3(CH_2)_{11}N^+(CH_3)_3Br^-$

Answer ● ○ ○ ○

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

53. Solubility product constants (K_{sp}) of salts of types MX, MX_2 and M_3X at temperature 'T' are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities ($mol\,dm^{-3}$) of the salts at temperature 'T' are in the order

(A) $MX > MX_2 > M_3X$ (B) $M_3X > MX_2 > MX$

(C) $MX_2 > M_3X > MX$ (D) $MX > M_3X > MX_2$

Answer ○ ○ ○ ●

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

54. STATEMENT-1 : Aniline on reaction with $NaNO_2$/HCl at 0 °C followed by coupling with β–naphthol gives a dark blue coloured precipitate.

and

STATEMENT-2 : The colour of the compound formed in the reaction of aniline with $NaNO_2$/HCl at 0 °C followed by coupling with β–naphthol is due to the extended conjugation.

(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 : $[Fe(H_2O)_5NO]SO_4$ is paramagnetic.

and

STATEMENT-2 : The Fe in $[Fe(H_2O)_5\ NO]SO_4$ has three unpaired electrons.

(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. STATEMENT-1 : The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ are optically inactive.

and

STATEMENT-2 : Both geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ possess axis of symmetry.

(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. STATEMENT-1 : There is a natural asymmetry between converting work to heat and converting heat to work.

and

STATEMENT-2 : No process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work.

(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

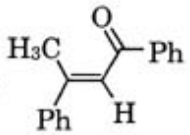
(D) STATEMENT-1 is False, STATEMENT-2 is True

Answer ● ○ ○ ○

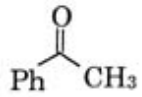
(A) (B) (C) (D)

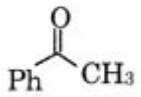
Paragraph for Question Nos. 58 to 60

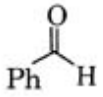
A tertiary alcohol **H** upon acid catalysed dehydration gives a product **I**. Ozonolysis of **I** leads to compounds **J** and **K**. Compound **J** upon reaction with KOH gives benzyl alcohol and a compound **L**, whereas **K** on reaction with KOH gives only **M**.

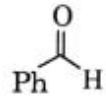
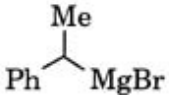
M = 

58. Compound **H** is formed by the reaction of

(A)  + PhMgBr

(B)  + $PhCH_2MgBr$

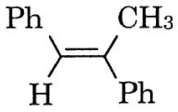
(C)  + $PhCH_2MgBr$

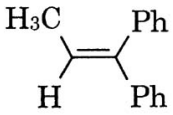
(D)  + 

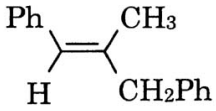
Answer ○ ● ○ ○

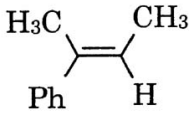
(A) (B) (C) (D)

59. The structure of compound **I** is

(A) 

(B) 

(C) 

(D) 

Answer

60. The structures of compounds **J**, **K** and **L**, respectively, are

(A) $PhCOCH_3$, $PhCH_2COCH_3$ and $PhCH_2COO^-K^+$

(B) $PhCHO$, $PhCH_2CHO$ and $PhCOO^-K^+$

(C) $PhCOCH_3$, $PhCH_2CHO$ and $CH_3COO^-K^+$

(D) $PhCHO$, $PhCOCH_3$ and $PhCOO^-K^+$

Answer

Paragraph for Question Nos. 61 to 63

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'.

61. The number of atoms in this HCP unit cell is

(A) 4 (B) 6 (C) 12 (D) 17

Answer ○ ● ○ ○
(A) (B) (C) (D)

62. The volume of this HCP unit cell is

(A) $24\sqrt{2}\,r^3$ (B) $16\sqrt{2}\,r^3$ (C) $12\sqrt{2}\,r^3$ (D) $\frac{64}{3\sqrt{3}}r^3$

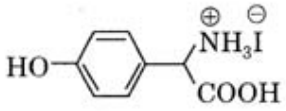
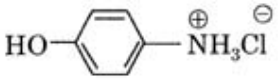
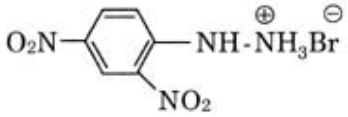
Answer ● ○ ○ ○
(A) (B) (C) (D)

63. The empty space in this HCP unit cell is

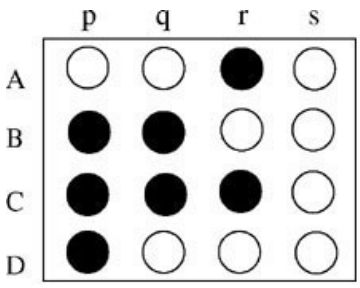
(A) 74% (B) 47.6% (C) 32% (D) 26%

Answer ○ ○ ○ ●
(A) (B) (C) (D)

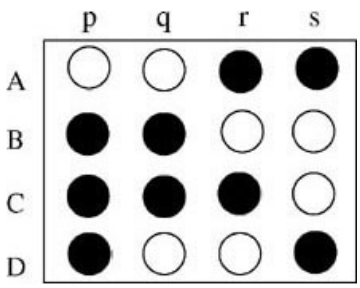
64. Match the compounds in **Column I** with their characteristic test(s)/reaction(s) given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	**Column II**
(A) $H_2N - \overset{\oplus}{N}H_3\overset{\ominus}{Cl}$	(p) sodium fusion extract of the compound gives Prussian blue colour with $FeSO_4$
(B) 	(q) gives positive $FeCl_3$ test
(C) 	(r) gives white precipitate with $AgNO_3$
(D) 	(s) reacts with aldehydes to form the corresponding hydrazone derivative

Answer



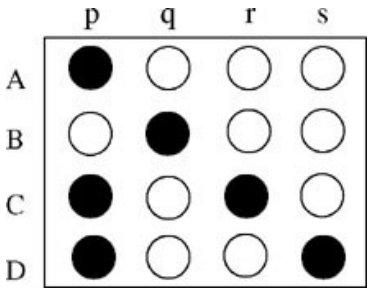
OR



65. Match the conversions in **Column I** with the type(s) of reaction(s) given 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) $PbS \rightarrow PbO$	(p) roasting
(B) $CaCO_3 \rightarrow CaO$	(q) calcination
(C) $ZnS \rightarrow Zn$	(r) carbon reduction
(D) $Cu_2S \rightarrow Cu$	(s) self reduction

Answer



66. Match the entries in **Column I** with the correctly related quantum number(s) 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) Orbital angular momentum of the electron in a hydrogen-like atomic orbital	(p) Principal quantum number
(B) A hydrogen-like one-electron wave function obeying Pauli principle	(q) Azimuthal quantum number
(C) Shape, size and orientation of hydrogen-like atomic orbitals	(r) Magnetic quantum number
(D) Probability density of electron at the nucleus in hydrogen-like atom	(s) Electron spin quantum number

Answer