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Presents

IIT-JEE 2009 ANSWER-KEY

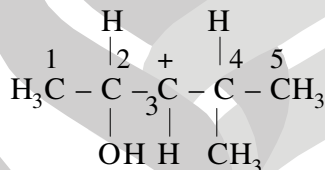## CHEMISTRY [PAPER – 2]

SECTION – I

Single Correct Choice Type

This section contains 4 multiple choice questions numbered 1 to 4. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONLY ONE is correct.

1. The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$ is
   (A) 0　　　　　(B) 2.84　　　　　(C) 4.90　　　　　(D) 5.92

Ans. A

2. In the following carbocation, H/CH_3 that is most likely to migrate to the positively charged carbon is
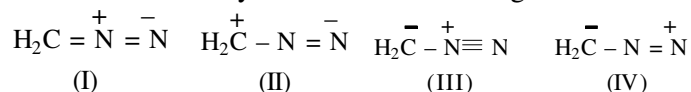
$$H_3C \overset{1}{-} \underset{\underset{OH}{|}}{\overset{H}{\underset{|}{C}}} \overset{}{-} \underset{\underset{H}{|}}{\overset{+}{\underset{3}{C}}} \overset{H}{-} \underset{\underset{CH_3}{|}}{\overset{4}{\underset{|}{C}}} \overset{5}{-} CH_3$$

   (A) CH_3 at C-4　　(B) H at C-4　　　(C) CH_3 at C-2　　(D) H at C-2

Ans. D

3. For a first order reaction $A \rightarrow P$, the temperature (T) dependent rate constant (k) was found to follow the equation $\log k = -(2000)\dfrac{1}{T} + 6.0$. The pre-exponential factor A and the activation energy E_a, respectively, are
   (A) $1.0 \times 10^6 \ s^{-1}$ and $9.2 \ kJ \ mol^{-1}$
   (B) $6.0 \times 10^6 \ s^{-1}$ and $16.6 \ kJ \ mol^{-1}$
   (C) $1.0 \times 10^6 \ s^{-1}$ and $16.6 \ kJ \ mol^{-1}$
   (D) $1.0 \times 10^6 \ s^{-1}$ and $38.3 \ kJ \ mol^{-1}$

Ans. D

4. The correct stability order of the following resonance structures is

$$H_2C = \overset{+}{N} = \overset{-}{N} \qquad H_2\overset{+}{C} - N = \overset{-}{N} \qquad H_2\overset{-}{C} - \overset{+}{N} \equiv N \qquad H_2\overset{-}{C} - N = \overset{+}{N}$$
$$\text{(I)} \qquad\qquad \text{(II)} \qquad\qquad \text{(III)} \qquad\qquad \text{(IV)}$$

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

Ans. B

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Multiple Correct Choice Type

> *This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONLY ONE is/are correct.*

5. In the reaction
$$2X + B_2H_6 \rightarrow [BH_2(X)_2]^+[BH_4]^-$$
The amine(s) X is (are)
(A) NH_3 (B) CH_3NH_2 (C) $(CH_3)_2NH$ (D) $(CH_3)_3N$
Ans. A,B,C

6. The nitrogen oxide(s) that contain(s) N-N bond(s) is(are)
(A) N_2O (B) N_2O_3 (C) N_2O_4 (D) N_2O_5
Ans. A,B,C

7. For the reduction of NO_3^- ion in an aqueous solution, E^0 is +0.96 V. Values of E^0 for some metal ions are given below
$$V^{2+}(aq) + 2e^- \rightarrow V \qquad E^0 = -1.19\,V$$
$$Fe^{3+}(aq) + 3e^- \rightarrow Fe \qquad E^0 = -0.04\,V$$
$$Au^{3+}(aq) + 3e^- \rightarrow Au \qquad E^0 = +1.40\,V$$
$$Hg^{2+}(aq) + 2e^- \rightarrow Hg \qquad E^0 = +0.86\,V$$
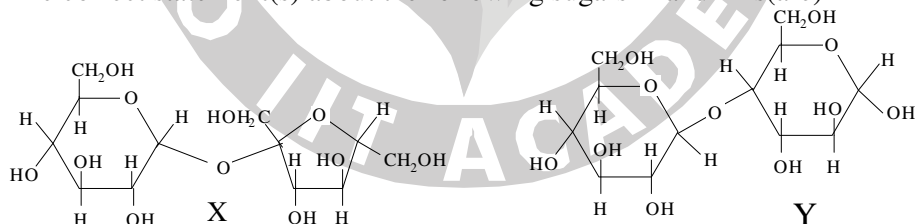The pair(s) of metals that is/are oxidized by NO_3^- in aqueous solution is (are)
(A) V and Hg   (B) Hg and Fe   (C) Fe and Au   (D) Fe and V
Ans. A,B,D

8. The correct statement(s) about the following sugars X and Y is(are)

(A) X is a reducing sugar and Y is a non-reducing sugar
(B) X is a non-reducing sugar and Y is a reducing sugar
(C) The glucosidic linkages in X and Y are α and β, respectively
(D) The glucosidic linkages in X and Y are β and α, respectively
Ans. B,C

9. Among the following, the state function(s) is(are)
(A) Internal energy   (B) Irreversible expansion work
(C) Reversible expansion work   (D) Molar enthalpy
Ans. A,B,D

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Section –III
Matrix-Match Type
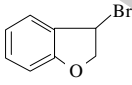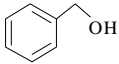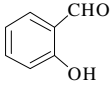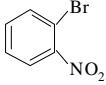
10. Match each of the reactions given in Column I with the corresponding product(s) given Column II

    (A) $Cu + dil. HNO_3$ (p) NO
    (B) $Cu + conc, HNO_3$ (q) NO_2
    (C) $Zn + dil HNO_3$ (r) N_2O
    (D) $Zn + conc HNO_3$ (s) $Cu(NO_3)_2$
                                            (t) $Zn(NO_3)_2$

Ans.   A-p,s B-q,s C – r,t D- q,t

11. Match each of the compounds given in Column I with the reaction(s), that they can undergo, given in Column II.

    Column I   Column II

    (A)   (p) Nucleophilic substitution

    (B)   (q) Elimination

    (C)   (r) Nucleophilic addition

    (D)   (s) Esterification with acetic anhydride

                                                     (t) Dehydrogenation

Ans.   A-q B-p, s,t C-r,s D-p

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SECTION – IV

Integer Answer Type

12. The number of water molecule(s) directly bonded to the metal centre in $CuSO_4 \cdot 5H_2O$ is

Ans. 4

13. The dissociation constant of a substituted benzoic acid at 25ºC is 1.0×10^{-4}. The pH of a 0.01 M solution of its sodium salt is

Ans. 8

14. The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is

Ans. 6

15. At 400K, the root mean square (rms) speed of a gas X (molecular weight = 40) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is

Ans. 4

16. The total number of cyclic structural as well as stereo isomers possible for a compound with the molecular formula C_5H_{10} is

Ans. 7

17. The coordination number of Al in the crystalline state of $AlCl_3$ is

Ans. 4

18. In a constant valume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in excess oxygen at 298.0 K. The temperature of the calorimeter was found to increase from 298.0 K to 298.45 K due to the combustion process. Given that the heat capacity of the calorimeter is 2.5 kJ K^{-1}, the numberical value for the enthalpy of combustion of the gas in kJ mol^{-1} is

Ans. 4

19. The total number of α and β particles emitted in the nuclear reaction
$^{238}_{92}U \rightarrow ^{214}_{82}Pb$ is

Ans. 8

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MATHEMATICS [PAPER – 2]

SECTION - I

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONLY ONE is correct.

20. A line with positive direction cosines passes through the point P(2, –1, 2) and makes equal angles with the co-ordinate axes. The line meets the plane

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

Ans.(C)

21. The normal at a point P on the ellipse $x^2 + 4y^2 = 16$ meets the x-axis at Q. If M is the mid point of the line segment PQ, the the locus of M intersects the latus rectums of the given ellipse at the point

(A) $\left(\pm \dfrac{3\sqrt{5}}{2}, \pm \dfrac{2}{7} \right)$ (B) $\left(\pm \dfrac{3\sqrt{5}}{2}, \pm \dfrac{\sqrt{19}}{4} \right)$ (C) $\left(\pm 2\sqrt{3}, \pm \dfrac{1}{7} \right)$ (D) $\left(\pm 2\sqrt{3}, \pm \dfrac{4\sqrt{3}}{7} \right)$

Ans.(C)

22. If the sum of first n terms of an A.P. is cn^2, then the sum of squares of these n terms is

(A) $\dfrac{n(4n^2 - 1)c^2}{6}$ (B) $\dfrac{n(4n^2 + 1)c^2}{3}$ (C) $\dfrac{n(4n^2 - 1)c^2}{3}$ (D) $\dfrac{n(4n^2 + 1)c^2}{6}$

Ans. (C)

23. The locus of the orthocenter of the triangle formed by the lines
$(1 + p)x – py + p(1 = p) = 0,$
$(1 + q)x – qy + q(1 + q) = 0,$
and y = 0, where p ≠ q, is

(A) a hyperbola   (B) a parabola   (C) an ellipse   (D) a straight line

Ans. (D)

SECTION - II

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONE OR MORE is/are correct.

24 For the function $f(x) = x \cos \dfrac{1}{x}$, $x \geq 1$

(A) for at least one x in the interval $[1, \infty)$, $f(x + 2) – f(x) < 2$ (B) $\lim\limits_{x \to \infty} f'(x) = 1$

(C) for all x in the interval $[1, \infty)$, $f(x + 2) – f(x) > 2$

(D) f`(x) is strictly decreasing in the interval $[1, \infty)$

Ans.(A,B,D)

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25. The tangent PT and the normal PN to the parabola $y^2 = 4ax$ at a point P on it meet its axis at point T and N, respectively. The locus of the centroid of the triangle PTN is a parabola whose

(A) vertex is $\left(\dfrac{2a}{3}, 0\right)$

(B) directrix is $x = 0$

(C) latus rectum is $\dfrac{2a}{3}$

(D) focus is (a, 0)

Ans.(A,D)

26. If $I_n \int\limits_{-\pi}^{\pi} \dfrac{\sin nx}{(1+\pi^x)\sin x} dx$, n = 0, 1, 2……, then

(A) $I_n = I_{n+2}$

(B) $\sum\limits_{m=1}^{10} I_{2m+1} = 10\pi$

(C) $\sum\limits_{m=1}^{10} I_{2m} = 0$

(D) $I_n = I_{n+1}$

Ans.(A,B,C)

27. For $0 < \theta < \dfrac{\pi}{2}$, the solution(s) of $\sum\limits_{m=1}^{6} \cos ec\left(\theta + \dfrac{(m-1)\pi}{4}\right)\cos ec\left(\theta + \dfrac{m\pi}{4}\right) = 4\sqrt{2}$ is (are)

(A) $\dfrac{\pi}{4}$

(B) $\dfrac{\pi}{6}$

(C) $\dfrac{\pi}{12}$

(D) $\dfrac{5\pi}{12}$

Ans. (C,D)

28. An ellipse intersects the hyperbola $2x^2 - 2y^2 = 1$ orthogonally. The eccentricity of the ellipse is reciprocal of that of the hyperbola. If the axes of the ellipse are along the co-ordinate axis, then

(A) Equation of ellipse is $x^2 + 2y^2 = 2$

(B) The foci of ellipse are $(\pm 1, 0)$

(C) Equation of ellipse is $x^2 + 2y^2 = 4$

(D) The foci of ellipse are $(\pm\sqrt{2}, 0)$

Ans.(A,B)

Section –III
Matrix-Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in Column I are Labelled A, B, C and D, while the statements in Column II are labelled p, q, r, s and t. Any given statement in Column I can have correct matching with ONE Or MORE statement(s) in Column II . The appropriate bubbles correponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A-p,s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following,

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29. Match the statement/expressions given in **Column I** with the values given in **Column II**

Column I   **Column II**

(A) Root of the equation   (p) $\dfrac{\pi}{6}$

$2\sin^2\theta + \sin^2 2\theta = 2$

(B) Points of discontinuity of the function   (q) $\dfrac{\pi}{4}$

$f(x) = \left[\dfrac{6x}{\pi}\right]\cos\left[\dfrac{3x}{\pi}\right]$, where [y] denotes

the largest integer less than or equal to y

(C) Volume of the parallelepiped with its edges   (r) $\dfrac{\pi}{3}$

Represented by the vectors $\hat{i} + \hat{j}, \hat{i} + 2\hat{j}$

and $\hat{i} + \hat{j} + \pi\hat{k}$

(D) Angle between vectors $\vec{a}$ and $\vec{b}$ where   (s) $\dfrac{\pi}{2}$

$\vec{a}, \vec{b}$ and $\vec{c}$ are unit vectors satisfying

$\vec{a} + \vec{b} + \sqrt{3}\vec{c} = \vec{0}$ (t) π

Ans. A-q,s, B-p,r, C-t, D-r

30. Match the statement/expressions given in **Column I** with the values given in **Column II**

Column I   **Column II**

(A) The number of solutions of the equation   (p)   1

$x\,e^{\sin x} - \cos x = 0$ in the interval $\left(0, \dfrac{\pi}{2}\right)$

(B) Value(s) of k for which the planes   (q) 2
$kx + 4y + z = 0$, $4x + ky + 2z = 0$ and
$2x + 2y + z = 0$

(C) Value(s) of k for which   (r)   3
$|x - 1| + |x - 2| + |x + 1| + |x + 2| = 4k$
Has integer solution(s)

(D) If $y` = y + 1$ and $y(0) = 1$, then values of y (ln 2)   (s)   4

(t)   5

Ans. A-p, B-q,s, C-q,r,s,t, D-r

<div align="center">

Section –IV
Integer Answer Type

</div>

31. The centres of two circles C_1 and C_2 each of unit radius are at a distance of 6 units from each other. Let P be the mid point of the line segment joining the centres of C_1 and C_2 and C be a circle touching circles C_1 and C_2 externally. If a common tangent to C_1 and C passing through P is also a common tangent to C_2 and C, then the radius of the circle C is

Ans. 8

32. The Let ABC and ABC` be two non-congruent triangles with sides AB = 4, AC = AC` = $2\sqrt{2}$ and angle B = 30°. The absolute value of the difference between the areas of these triangle is

Ans. 4

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33. Let $f : R \to R$ be a continuous function which satisfies $f(x) = \int\limits_{0}^{x} f(t)dt.$ Then the value of $f(\ln 5)$ is

Ans. 0

34. Let (x, y, z) be points with integer co-ordinates satisfying the system homogeneous equations:

$$3x - y - z = 0,$$
$$-3x + z = 0,$$
$$-3x + 2y + z = 0$$

Then the number of such points for which $x^2 + y^2 + z^2 \leq 100$ is

Ans. 7

35. If the function $f(x) = x^3 + e^{\frac{x}{2}}$ and $g(x) = f^{-1}(x),$ then the value of $g`(1)$ is

Ans. 2

36. The smallest value of k, for which both the roots of the equation

$$X^2 - 8kx + 16 (k^2 - k + 1) = 0$$

Are real, distinct and have values at least 4, is

Ans. $k = 2$

37. The maximum value of the function $f(x) = 2x^3 - 15x^2 + 36x - 48$ on the set

$A = \{x \,|x^2 + 20 \leq 9x\}$ is

Ans. 7

38. Let $p(x)$ be a polynomial of degree 4 having extremum at $x = 1, 2$ and $\lim\limits_{x \to 0}\left(1 + \dfrac{p(x)}{x^2}\right) = 2$

Then the value of $p(2)$ is

Ans. 0

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PHYSICS [PAPER – II]

Single Correct Choice Type

This section contains 4 multiple choice questions numbered 1 to 4. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONLY ONE is correct.

39. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y-axis is

    (a) $\dfrac{a}{gk}$ (b) $\dfrac{a}{2gk}$ (c) $\dfrac{2a}{gk}$ (d) $\dfrac{a}{4gk}$
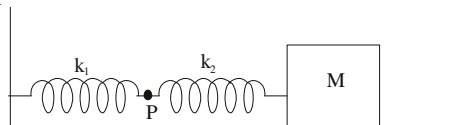
Ans. (b)

40. Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions $\phi_p = 2.0$ eV, $\phi_q = 2.5$ eV and $\phi_r = 3.0$ eV respectively. A light beam containing wavelengths of 550nm, 450nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is
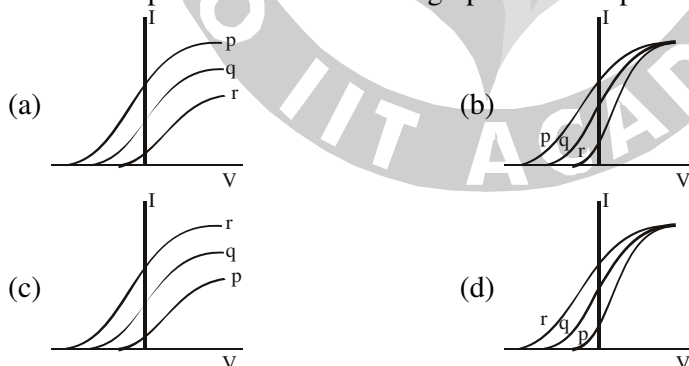
Ans. (A)

41. The mass M shown in the figure oscillates in simple harmonic motion with amplitude A. The amplitude of the point P is


    (a) $\dfrac{k_1 A}{k_2}$ (b) $\dfrac{k_2 A}{k_1}$ (c) $\dfrac{k_1 A}{k_1 + k_2}$ (d) $\dfrac{k_2 A}{k_1 + k_2}$

Ans. (d)

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42. A uniform rod of length L and mass M is pivoted at the centre. Its two ends are attached to two springs of equal spring constants k. The springs are fixed to rigid supports as shown in the figure, and the rod is free to oscillate in the horizontal plane. The rod is gently pushed through a small angle θ in one direction and released. The frequency of oscillations is
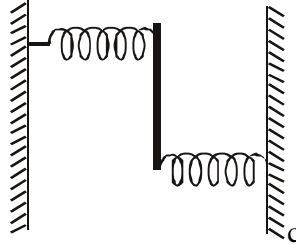
(a) $\dfrac{1}{2\pi}\sqrt{\dfrac{2k}{M}}$ (b) $\dfrac{1}{2\pi}\sqrt{\dfrac{k}{M}}$ (c) $\dfrac{1}{2\pi}\sqrt{\dfrac{6k}{M}}$ (d) $\dfrac{1}{2\pi}\sqrt{\dfrac{24k}{M}}$
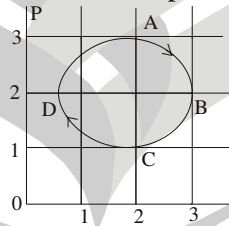
Ans. (c)

SECTION – II

Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), for its answer, out of which ONLY ONE is/are correct.

43. The figure shows the P-V plot of an ideal gas taken through a cycle ABCDA. The part ABC is semi-circle and CDA is half of an ellipse. Then,

(a) the process during the path A → B is isothermal
(b) heat flows out of the gas during the path B →C →D
(c) work done during the path A → B → C is zero
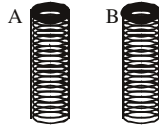(d) positive work is done by the gas is the cycle ABCDA

Ans. (b), (d)

44. Under the influence of the coulomb field of charge +Q, a charge –q is moving around it in an elliptical orbit. Find out the correct statement (s).
(a) The angular momentum of the charge –q is constant
(b) The linear momentum of the charge –q is constant
(c) The angular velocity of the charge –q is constant
(d) The linear speed of the charge –q is constant

Ans. (a)

45. Two metallic rings A and B, identical is shape and size but having different resistivities ρ_A and ρ_B, are kept on top of two identical solenoids as shown in the figure. When current I is switched on in both the solenoids in identical manner, the rings A and B jump to heights h_A and h_B, respectively, with $h_A > h_B$. The possible relation (s) between their resistivities and their masses m_A and m_B is (are)

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(a) $\rho_A > \rho_B$ and $m_A = m_B$ (b) $\rho_A < \rho_B$ and $m_A = m_B$

(c) $\rho_A > \rho_B$ and $m_A > m_B$ (d) $\rho_A < \rho_B$ and $m_A < m_B$

Ans.   (b), (d)

46.   A sphere is rolling without slipping on a fixed horizontal plane surface. In the figure, A is the point of contract, B is the centre of the sphere and C is its topmost point, Then.
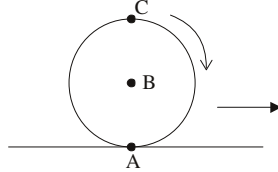
(a) $\vec{V}_C - \vec{V}_A = 2\left(\vec{V}_B - \vec{V}_C\right)$ (b) $\vec{V}_C - \vec{V}_B = \vec{V}_B - \vec{V}_A$

(c) $|\vec{V}_C - \vec{V}_A| = 2|\vec{V}_B - \vec{V}_C|$ (d) $|\vec{V}_C - \vec{V}_A| = 4|\vec{V}_B|$

Ans.   (b), (c)

47.   A student perfumed the experiment to measure the speed of sound in air using resonance air-column method. Two resonances in the air-column were obtained by lowering the water level. The resonance with the shorter air-column is the first resonance and that with the longer air-column is the second resonance. Then,

(a) the intensity of the sound heard at the first resonance was more than that at the second resonance

(b) the prongs of the tuning fork were kept in a horizontal plane above the resonance tube

(c) the amplitude of vibration of the ends of the prongs is typically around 1cm

(d) the length of the air-column at the first resonance was somewhat shorter than 1/4th of the wavelength of the sound in air.

Ans.   (a), (c), (d)

Section –III
Matrix-Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in Column I are Labelled A, B, C and D, while the statements in Column II are labelled p, q, r, s and t. Any given statement in Column I can have correct matching with ONE Or MORE statement(s) in Column II . The appropriate bubbles correpponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A-p,s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following,

48.   Column-II gives certain systems undergoing a process. Column I suggests changes in some of the parameters related to the system. Match the statements is Column I to the appropriate process(es) from column II.

Column – I		Column – II
(A) The energy of the system is increased	(p)	System : A capacitor, initially uncharged Process : It is connected to a battery
(B) Mechanical energy is provided to the system, which is converted into energy of random motion of its parts	(q)	System : A gas in an adiabatic container filleted with an adiabatic piston Process : The gas is compressed by pushing the piston
(c) Internal energy of the system is converted into its mechanical energy	(r)	System : A gas is rigid container Process : The gas gets cooled due to colder atmosphere surrounding it
(d) Mass of the system is decreased.	(s)	System : A heavy nucleus, initially at rest Process : The nucleus fissions into two fragments of nearly equal masses and some neutrons are emitted
	(t)	System : A resistive wire loop Process: The loop is placed in a time varying magnetic field perpendicularly to its plane

Ans.   A-pqt, B-q, C-s, D-s

49.   Column I shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/3$, where λ is the wavelengths of the light used. In the cases B, C and D, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thickness of the sheets are different in different cases. The phase difference between the light waves reaching a point P on the screen from the two slits is denoted by $\delta(P)$ and the intensity by $I(P)$. Match each situation given in Column I with the statements (s) in Column II valid for that situation.
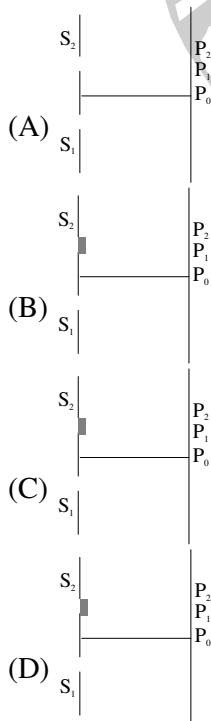
Column-I   **Column-II**

(A)   (p) $\delta(P_0) = 0$

(B) $(\mu - 1) t = \lambda/4$ (q) $\delta(P_1) = 0$

(C) $(\mu - 1) t = \lambda/2$ (r) $I(P_1) = 0$

(D) $(\mu - 1) t = 3\lambda/4$ (s) $I(P_0) > I(P_1)$

                                                                            (t) $I(P_2) > I(P_1)$

Ans.   A-ps, B-q, C-t, D-rst

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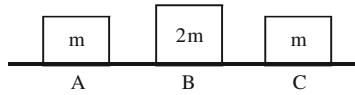e-mail : contact@raoiitacademy.com, website : www.raoiitacademy.com

Integer Answer Type

> This section contains 8 questions. The answer to each of the question is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question number in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:

50. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking $g = 10$ m/s^2 , find the work done (in joules) by the string on the block of mass 0.36kg during the first second after the system is released from rest.

Ans.   8

51. Two soap bubbles A and B are kept in a closed chamber where the air is maintained at pressure 8 N/m^2. The radii of bubbles A and B are 2cm and 4cm, respectively. Surface tension of the soap-water used to make bubbles is 0.04 N/m. Find the ratio n_B/n_A, where n_A and n_B are the number of moles of air in bubbles A and B, respectively. Neglect the effect of gravity.

Ans.   6

52. A steady current I goes through a wire loop PQR having shape of a right angle triangle with PQ = 3x, PR = 4x and QR = 5x. If the magnitude of the magnetic field at P due to this loop is k $\left(\dfrac{\mu_0 I}{48\pi x} \right)$, find the value of k.

Ans.   7

53. A cylindrical vessel of height 500 mm has an orifice (small hole) at its bottom. The orifice is initially closed and water is filled in it up to height H. Now the top is completely sealed with a cap and the orifice at the bottom is opened. Some water comes out form the orifice and the water level in the vessel becomes steady with height of water column being 200mm. Find the fall in height (in mm) of water level due to opening of the orifice.
[Take atmospheric pressure = 1.0×10^5 N/m^2, density of water = 1000kg/m^3 and $g = 10$m/s^2. Neglect any effect of surface tension.]

Ans.   6

54. A 20cm long string, having a mass of 1.0g, is fixed at both the ends. The tension in the string is 0.5N. The string is set into vibrations using an external vibrator of frequency 100Hz. Find the separation (in cm) between the successive nodes on the string.

Ans.   5

55. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, where k and a are constants and r is the distance from its centre. If the electric field at r = $\dfrac{R}{2}$ is $\dfrac{1}{8}$ times that at r = R, find the value of a.

Ans.   2

56. A metal rod AB of length 10x has its one end A is ice at 0ºC and the other end B in water at 100ºC. If a point P on the rod is maintained at 400ºC, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ.
[Neglect any heat loss to the surrounding.]

Ans.   9

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57. Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. These have masses m, 2m and m, respectively. The object A moves towards B with a speed 9m/s makes an elastic collision with it. Thereafter, B makes completely inelastic collision with C. All motions occur on the same straight line. Find the final speed (in m/s) of the object C.

m	2m	m
A	B	C

Ans. 4

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