

# PART-I: CHEMISTRY

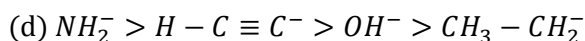
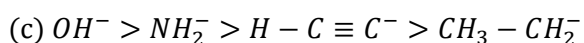
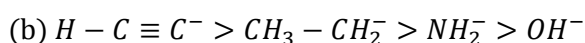
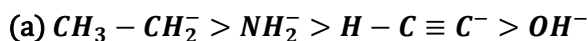
## SECTION-I (Total Marks: 24)

(Straight Correct Answer Type)

This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

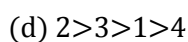
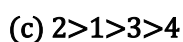
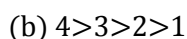
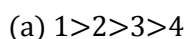
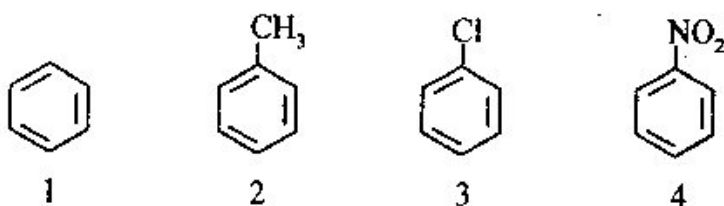
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1. What is the decreasing order of strength of the bases  $OH^-$ ,  $NH_2^-$ ,  $H-C \equiv C^-$  and  $CH_3 - CH_2^-$ ?



Answer: compare the conjugate acids

2. Identify the correct order of reactivity in electrophilic substitution reactions of the following compounds



Answer: only 2 is activating group

3. An  $S_N2$  reaction at an asymmetric carbon of a compound always gives

(a) an enantiomer of the substrate

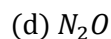
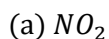
(b) a product with opposite optical rotation

(c) a mixture of diastereomers

(d) a single stereoisomer

It forms only one stereoisomer as it attacks from backside

4. When  $PbO_2$  reacts with concentrated  $HNO_3$  the gas evolved is

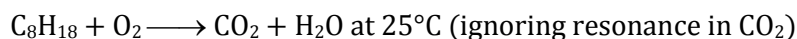


$HNO_3$  oxidises peroxide to oxygen

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Space For Rough Work

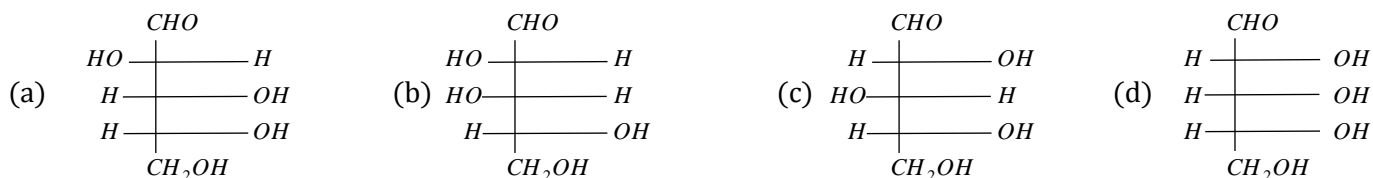
5. For the combustion of n - octane



- (A)  $\Delta H = \Delta E - 5.5 \times 8.31 \times 0.298$  in kJ/mol  
 (B)  $\Delta H = \Delta E + 4.5 \times 8.31 \times 0.298$  in kJ/mol  
**(C)  $\Delta H = \Delta E - 4.5 \times 8.31 \times 0.298$  in kJ/mol**  
 (D)  $\Delta H = \Delta E - 4.5 + 8.31 \times 0.298$  in kJ/mol

$\Delta H = \Delta E + \Delta n_g RT$ , here water is liquid at  $25^\circ\text{C}$

6. C Which of the following is the structure of D-xylose



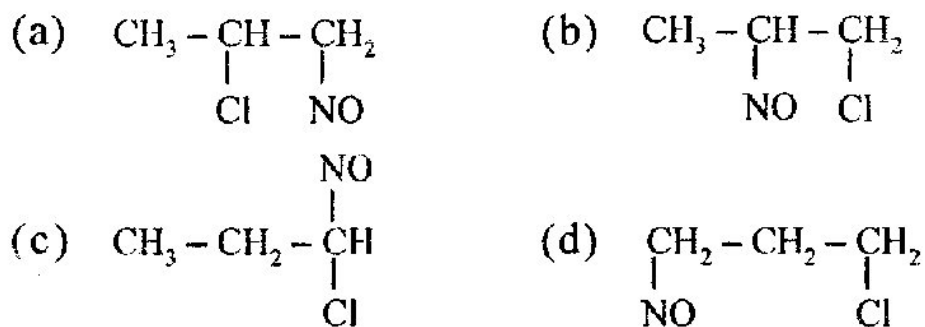
Answer: C

7. The optically inactive amino acid is

- (a) Lysine (b) Glycine (c) Arginine (d) Alanine

Answer: (B), it does not have any chiral carbon

8. A  $\text{CH}_3 - \text{CH} = \text{CH}_2 + \text{NOCl} \rightarrow \text{P}$ . Identify the adduct. A



Answer: NOCl will attached  $\text{NO}^+$  and  $\text{Cl}^-$

Space For Rough Work

## SECTION-II (Total Marks: 16)

### (Multiple Correct Answer Type)

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE** is correct.

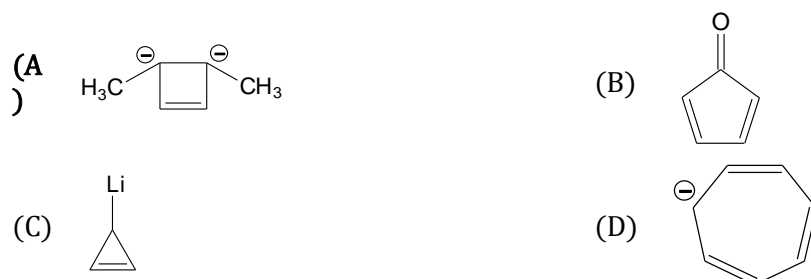
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9. Among  $\text{KO}_2$ ,  $\text{AlO}_2^-$ ,  $\text{BaO}_2$  and  $\text{NO}_2^+$ , unpaired electron is present in

- (a)  $\text{NO}_2^+$                       (b)  $\text{AlO}_2^-$   
(c)  **$\text{KO}_2$**                       (d)  $\text{BaO}_2$

$\text{O}_2^-$  has one unpaired electron

10. Which of the following is aromatic?



Answer: (A) satisfies all criteria for aromaticity

11. Which of the following is not oxidized by  $\text{O}_3$ ?

- (a) KI                      (b)  $\text{FeSO}_4$                       (c)  **$\text{KMnO}_4$**                       (d)  $\text{K}_2\text{MnO}_4$

$\text{KMnO}_4$  is already in its highest oxidation state

12. Ammonia, on reaction with hypochlorite anion, can form

- (a) NO                      (b)  $\text{NH}_4\text{Cl}$                       (c)  **$\text{N}_2\text{H}_4$**                       (d)  $\text{HNO}_2$

Answer (C):  $2\text{NH}_3 + \text{OCl}^- \rightarrow \text{NH}_2 - \text{NH}_2 + \text{H}_2\text{O} + \text{Cl}^-$

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Space For Rough Work

### SECTION-III (Total Marks: 24)

(Integer Answer Type)

This section contains **6 questions**. The answer to each of the questions is a **single-digit integer**, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS

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13. 3 Consider a reaction  $aG + bH \rightarrow$  products. When concentration of both the reagents G and H is doubled, the rate increases eight times. However, when concentration of G is doubled keeping the concentration of H fixed, the rate is doubled. The overall order of the reaction is

Answer:3, Solve for rate law and get the order

14. 6  ${}_{90}^{234}\text{Th}$  disintegrates to give  ${}_{82}^{206}\text{Pb}$  as the final product. How many beta particles are emitted during this process?

Answer: No. of alpha particles is 7 and beta is 6

15. 3 A 0.004 M solution of  $\text{Na}_2\text{SO}_4$  is isotonic with 0.010 M solution of glucose at same temperature. The percentage dissociation of  $\text{Na}_2\text{SO}_4$  is x%, then the value of x/25 is

Answer: 3, find i and then degree of dissociation,

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Space For Rough Work

16. 8 The ionization constant of a weak electrolyte is  $25 \times 10^{-6}$  while the equivalent conductance of its 0.01 M solution is  $19.6 S cm^2 eq^{-1}$ . The equivalent conductance of the electrolyte at infinite dilution (in  $S cm^2 eq^{-1}$ ) is  $49 \times X$ , then X is

Answer:  $\alpha = \frac{\pi}{\pi_0}, \pi_{eq} = \pi_1 + \pi_2 \dots$

17. 8 6M Urea is isotonic with xM NaCl, y M Na<sub>2</sub>SO<sub>4</sub>, z M AlCl<sub>3</sub>, the x+y+2z is

Answer: the value of i for NaCl, Na<sub>2</sub>SO<sub>4</sub>, AlCl<sub>3</sub> is 2, 3, 4 respectively

18. 5 An aqueous solution of 6.3 g of oxalic acid dehydrate is made up to 250 ml. the volume of 0.1 N NaOH required to completely neutralize 10 ml of this solution is  $8 \times Y$ , the Y is

Answer: equivalents of  $H_2C_2O_4 \cdot 2H_2O$  in 10 ml = equivalents of NaOH

$$\therefore \frac{6.3}{63} \times \frac{10}{250} = 0.1 \times V \text{ (in litres)} \text{ (Eq. wt of } H_2C_2O_4 \cdot 2H_2O = 63)$$

$$\text{Or } V = 0.04 L \text{ or } 40 ml$$

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Space For Rough Work

## SECTION-IV (Total Marks: 16)

### (Matrix MatchType)

This section contains **2 questions**. Each question has four statements (A, B, C and D) given in Column 1 and five statements (p, q, r, s and t) in Column II. Any given statement in Column 1 can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to p and r is the ORS.

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19. Match List-I with List - II.

List - I		List - II (Method of extraction)	
(A)	Iron r	(p)	Self reduction process
(B)	Silver s	(q)	Electrolytic reduction
(C)	Copper p	(r)	Carbon reduction
(D)	Aluminium q	(s)	Cyanide process

**Answer: (A)-r; (B)-s; (C)-p; (D)-q**  
**20.**

(A) $[\text{Ni}(\text{CN})_4]^{2-}$	(p) Paramagnetic octahedral
(B) $[\text{Ni}(\text{Co})_4]^{2+}$	(q) Diamagnetic octahedral
(C) $[\text{Co}(\text{en})_3]^{3+}$	(r) Tetrahedral, diamagnetic
(D) $[\text{Co}(\text{Br})_3(\text{Cl})_3]^{3-}$	(s) Square planar diamagnetic

**Answer: (A)-s; (B)-r; (C)-q; (D)-p**

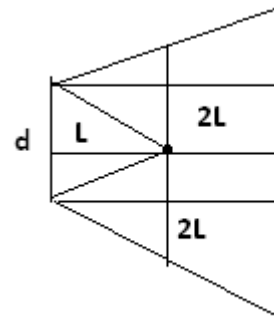
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Space For Rough Work

21. Solution : (c) According to conservation of momentum i.e.  $p_1 = p_2$

$$\lambda = \frac{h}{p} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{p_1}{p_2} = \frac{1}{1}$$

22. In the diagram find the length of the last line in terms of d  
(Use Similar triangle)



(Use

23.  $P_0 + 10 \times 1.3 \times 980 = P_0 + h \times 0.8 \times 980 + (10 - h) \times 13.6 \times 980$

24. Question should be Initial vel of the bullet (let  $v$ )

By, CLM  $mv = (M + m)v'$  and By COE  $\frac{1}{2}(M + m)v'^2 = (M + m)gh$

25. By parallel axis theorem  $\frac{(2\pi r\rho) \times r^2}{2} + (2\pi r)\rho \times r^2$

26.  $\frac{\alpha z}{K\theta}$  should be dimension less, so find z and  $\frac{\alpha}{\beta}$  should have the dimension of pressure.

27. Range = time of flight x horizontal velocity  $\left(\frac{2v_1}{g} \times v_2\right)$

28. Work done for the 1<sup>st</sup> block =  $(b^3D) \times 0 \times g = 0$

Work done for the 2<sup>nd</sup> block =  $(b^3D) \times b \times g$

Work done for the 3<sup>rd</sup> block =  $(b^3D) \times 2b \times g$

And so on ..so  $F_{net} = b^4Dg[1 + 2 + \dots + N - 1]$

29. Stopping potential depend upon frequency of the incident light only.

30.  $\frac{3v}{2L_1} = \frac{(2 \times 2 + 1)v}{4L_2} \Rightarrow \frac{L_2}{L_1} = \frac{5}{6}$  and  $\frac{(2 \times 1 + 1)v/4L_1}{2v/2L_2} = 10/9$

31.  $T = 2\pi \sqrt{\frac{m}{K_{eq}}}$  where  $K_{eq} = K_1 + K_2$  (Parelle combination)

By IMT (Impulse Momentum Theorem)  $50 = mv \Rightarrow v = 5 \text{ m/s (max)}$

$$\frac{1}{2}(K_1 + K_2)A^2 = \frac{1}{2} \times 5 \times 5^2$$

32. We take momentum change in case of pressure calculation which is not negligible.

33. Three different part will behave like three different lenses so no of images will be 3

34.  $r = \frac{R(l-l')}{l'}$  (for derivation see HCV-2 page 185)

35. Significant figures in the measured value of a physical quantity tell the number of digits in which we have confidence.

(1) All non-zero digits are significant.

(2) A zero becomes significant figure if it appears between two non-zero digits.

(3) Leading zeros or the zeros placed to the left of the number are never significant.

(4) Trailing zeros or the zeros placed to the right of the number are significant.

(5) In exponential notation, the numerical portion gives the number of significant figures.

36. By Lenz law  $e = -\frac{d\phi}{dt} \Rightarrow i = -\frac{1}{R} \frac{d\phi}{dt}$ . Find  $I$  as  $f(t) I = -4(10t - 1)$  and  $d\phi = -R \int_4^0 I dt$

37.  $\frac{100-0}{R} = \frac{20}{4}$  and for second case  $\frac{100-0}{\frac{R}{2}}$ , so 20 calories will pass in one min.

38.  $\frac{\frac{T}{\Delta l_1}}{L} = \frac{\frac{T}{\Delta l_2}}{L}$  then find  $\frac{\Delta l_1}{\Delta l_2}$

39. Since direction of  $\vec{E}$  is in +ve X axis and + Y-axis. So potential will increase if we move against the field and decreases if we move towards the field. Use  $V_b - V_a = \int \vec{E} \cdot \vec{dl}$

40. Use the concept If current will increase in the wire, the induced current in the loop will be such that it opposes the change. Second concept is two wire kept at a distance having current flowing in same direction attract each other.

**Single Choice Correct:**

41. If  $m$  be the slope of a tangent to the curve  $e^y = 1 + x^2$  then

- (A)  $|m| > 1$  (B)  $m < 1$  (C)  $|m| < 1$  (D)  $|m| \leq 1$

Solution: (D)  $|m| = \frac{2|x|}{1+x^2}$  where  $1 + |x|^2 \geq 2|x|$

42. Let  $P_r(x_r, y_r, z_r); r = 1,2,3;$  be three points where  $x_1, x_2, x_3; y_1, y_2, y_3$  and  $z_1, z_2, z_3$  are each in G.P with the same common ratio. Then  $P_1, P_2$  and  $P_3$  are

- (A) Coplanar points (B) collinear points (C) vertices of an equilateral triangle (D) none of these

Solution: (B)  $P_1P_2 // P_2P_3$

43. If  $\vec{a}$  and  $\vec{b}$  are unit vectors and  $\alpha$  is the angle between them then  $\cos \frac{\alpha}{2}$  is equal to

- (A)  $\frac{1}{2}|\vec{a} + \vec{b}|$  (B)  $\frac{1}{2}|\vec{a} - \vec{b}|$  (C)  $|\vec{a} + \vec{b}|$  (D) None of these

Solution: (A) Use  $\cos \alpha = 2 \cos^2 \frac{\alpha}{2} - 1$

44. The number of real solutions of the equation  $\sin(e^x) = 5^x + 5^{-x}$  is

- (A) 0 (B) 1 (C) 2 (D) infinitely many

Solution: (A)  $5^x + 5^{-x} \geq 2$  (A.M  $\geq$  G.M) and  $\sin(e^x) \leq 1$

45. Let the  $r^{\text{th}}$  term  $t_r$  of a series be given by  $t_r = \frac{r}{1+r^2+r^4}$  then  $\lim_{n \rightarrow \infty} \sum_{r=1}^n t_r$  is

- (A)  $\frac{1}{4}$  (B) 1 (C)  $\frac{1}{2}$  (D) None of these

Solution: (C)  $t_r = \frac{r}{1+r^2+r^4} = \frac{1}{2} \left( \frac{1}{r^2-r+1} + \frac{1}{r^2+r+1} \right)$

46. Let S be the set of all functions from the set A to the set A. If  $n(A) = k$  then  $n(S)$  is

- (A)  $k!$  (B)  $k^k$  (C)  $2^k - 1$  (D)  $2^k$

Solution: (B) Each element of the set A can be given the image in set A in k ways. Hence, the required number of functions =  $k^k$

47. The value of  $2 \tan^{-1} \frac{\sqrt{1+x^2}-1}{x}$  is equal to

- (A)  $\cot^{-1} x$  (B)  $\sec^{-1} x$  (C)  $\tan^{-1} x$  (D) None of these

Solution: (C) Put  $x = \tan \theta$

48. Let  $h(x) = \min\{x, x^2\}$  for every real number x. Then which of the following statements is wrong

- (A) h is continuous for all x (B) h is differentiable for all x (C)  $h'(x) = 1$  for all  $x > 1$  (D) f(x) is not differentiable at two values of x

Solution: (B)  $h(x) = x, x \leq 0$

$$x^2, 0 < x < 1$$

$$x, x \geq 1$$

### Multiple Choice Correct:

49. If the tangents drawn from the point (0,2) to the parabola  $y^2 = 4ax$  are inclined at an angle  $\frac{3\pi}{4}$  then the value of a is:

- (A) 2 (B) -2 (C) 1 (D) None of these

Solution: (A), (B)

50. Let  $n \in N$  and let  $x$  be a perfect square. Let  $f(x)$  = the quotient when  $x$  is divided by 5 and  $g(x)$  = the remainder when  $x$  is divided by 5. Then  $\sqrt{x} = f(x) + g(x)$  holds for  $x$  equals to:

(A) 0 (B) 16 (C) 25 (D) none of these

Solution: (B), (C)

51. The number of possible triangles ABC in which  $BC = \sqrt{11}$  cm,  $CA = \sqrt{13}$  cm and  $A = 60^\circ$  is

(A) 0 (B) 1 (C) 2 (D) None of these

Solution: (B), (C) Use cosine law.

52. If the equations of the three sides of a triangle are  $x + y = 1$ ,  $3x + 5y = 2$  and  $x - y = 0$  then the orthocenter of the triangle lies on the line

(A)  $5x - 3y = 2$  (B)  $3x - 5y + 1 = 0$  (C)  $2x - 3y = 1$  (D)  $5x - 3y = 1$

Solution: (B), (D) As  $x + y = 1$ ,  $x - y = 0$  represent perpendicular lines, the triangle is right angled and the orthocenter is the point of intersection of these lines.

### Integer Type:

53. Let  $z_1$  and  $z_2$  be two nonreal complex cube roots of unity and  $|z - z_1|^2 + |z - z_2|^2 = \lambda$  be the equation of a circle with  $z_1, z_2$  as the ends of the diameter then  $\lambda =$

Solution: 3  $\lambda = |\omega - \omega^2|^2$

54. The number of distinct normal that can be drawn to the parabola  $y^2 - 4x - 2y - 2 = 0$  from  $(-2, 1)$  is

Solution: 1 The point lies outside the parabola hence only 1 normal is possible

55.  $2^{\frac{1}{4}} \cdot 4^{\frac{1}{8}} \cdot 8^{\frac{1}{16}} \dots$  to  $\infty$  is equal to

Solution: 1 Value =  $2^{\frac{1}{4} + \frac{2}{8} + \frac{3}{16} \dots}$

56.  $\lim_{n \rightarrow \infty} 0.2^{\log_{\sqrt{54} + \frac{1}{8} + \frac{1}{16} + \dots} \dots}$  to  $n$  terms is equal to

Solution: 4

57. The number of values of  $x$  for which  $\sin 2x + \cos 4x = 2$  is

Solution: 0  $\sin 2x + \cos 4x = 2 \Rightarrow \sin 2x = 1$  and  $\cos 4x = 1$

58. Let  $n$  be an odd natural number greater than 1. Then the number of zeroes at the end of  $99^n + 1$  is

Solution: 2  $99^n + 1 \Rightarrow (100 - 1)^n + 1$ . Now expand using binomial theorem.

**Match the columns:**

59.

(A) The line $\frac{x-1}{l} = \frac{y+1}{4} = \frac{z-2}{2}$ lies on the plane $2x - y + z - 5 = 0$ if $l$ equals	(P) 3
(B) The length of the latus rectum of the rectangular hyperbola is	(Q) 1
(C) The line cutting a positive intercept 1 on the $y$ -axis will be a tangent to $y^2 = 12x$ if its slope is	(R) 4
(D) The lines $\frac{x-5}{4} = \frac{y-7}{m} = \frac{z+3}{-5}$ and $\frac{x-8}{7} = \frac{y-4}{1} = \frac{z-5}{3}$ are intersecting if $m$ equals to	(S) 2

Solution: (A)- (Q), (B)- (S), (C)-(P), (D)-(R)

60.

(A) If $f: [2, +\infty] \rightarrow X$ be a bijective, where $f(x)=5 - 4x + x^2$ , then $X$ is	(P) $R - [-2,2]$
(B) The domain of $f(x)=\frac{x-3}{(x-1)\sqrt{x^2-4}}$	(Q) $[1, +\infty]$
(C) The interval in which $f(x)=2x^2 - \log x$ is <i>monotonically increasing</i> is	(R) $(-2, -1)$
(D) $4x^3 + 9x^2 + 6x + 3$ has a real root lying in	(S) $(\frac{1}{2}, +\infty)$

Solution: (A)-(Q), (B)-(P), (C)-(S), (D)-(R)