

Prepp

Your Personal Exams Guide



NDA



CDS



SSC CGL



CBSE UGC NET



IAS



SSC CHSL



CTET



MPSC



AFCAT



CSIR UDC NET



IBPS PO



UP POLICE



SSC MTS



SBI PO



BPS



UPTET



IBPS RRB



IBPS CLERK



IES



UPSC CAPF



SSC Stenogr..



RRB NTPC



SSC GD



RBI GRADE B



RBI Assistant



DSSSB

CSIR NET 2020 Chemical Science Prev. Yr. Paper (30-Nov-2020)

Total Time: 3 Hour

Total Marks: 200

Instructions

Sl No.	Section Name	No. of Question	Maximum Marks
1	Part A	15	30
2	Part B	35	70
3	Part C	25	100

- 1.) A total of 180 minutes is allotted for the examination.
- 2.) The server will set your clock for you. In the top right corner of your screen, a countdown timer will display the remaining time for you to complete the exam. Once the timer reaches zero, the examination will end automatically. The paper need not be submitted when your timer reaches zero.
- 3.) There will, however, be sectional timing for this exam. You will have to complete each section within the specified time limit. Before moving on to the next section, you must complete the current one within the time limits.

Part A

1. Single-grain density and bulk density of four varieties of grains are given in the table. If we take 1 kg of each of these, which one will have the largest volume? (+2, -0.5)

Grain	Single-grain density (g/cm ³)	Bulk density (g/cm ³)
Rice	1.13	0.56
Wheat	1.39	0.80
Millet	1.27	0.77
Maize	0.97	0.68

a. Rice

b. Wheat

c. Millet

d. Maize

2. What will be the difference in mass (in g) between two packets each containing 500 sheets of 80 GSM and 70 GSM papers of size 20 cm × 30 cm? (GSM = g/m²) (+2, -0.5)

a. 200

- b. 2000
- c. 300
- d. 3000

3. Suppose there are 6 non-stop flights from Chennai to Mumbai in the morning and 4 non-stop flights from Mumbai to Goa in the evening. In how many ways can one fly from Chennai to Goa via Mumbai using these flights in a day? (+2, -0.5)

- a. 10
- b. 24
- c. 4^6
- d. 6^4

4. A pack contains 6 cards numbered 1, 2, 3, 4, 5 and 6. Four cards are drawn one by one at random without replacement. What is the probability that the card numbered 1 is drawn in the selected four cards? (+2, -0.5)

- a. $\frac{4}{6}$
- b. $1 - \frac{4}{6}$
- c. $\frac{1}{24}$
- d. $\frac{4}{10}$

5. The present age of a father is square of the age of his son. After six years, the age of the father would be $3\frac{1}{2}$ times the age of the son. The present age (+2, -0.5)

of the father is

- a. 36
- b. 42
- c. 48
- d. 54

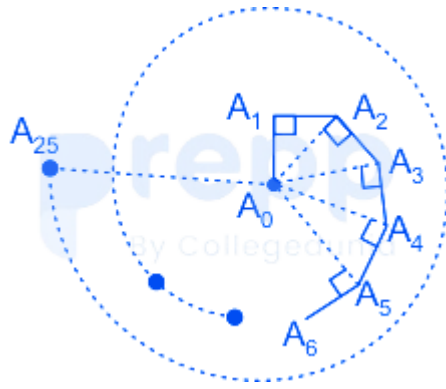
6. In an exam the average marks for the class was 60, the average of marks of the students who passed was 70 and those failed was 30. What is the percentage of the students of the class who failed? (+2, -0.5)

- a. 25
- b. 40
- c. 60
- d. 75



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7. A bug moves in a straight line from a point A_0 to a point A_1 1 cm away. It then turns by an angle of 90° and moves straight another 1 cm to reach a point A_2 . Then it moves 1 cm perpendicular to the line joining A_0 to A_2 to a point A_3 . It continues this way as shown, moving 1cm every time till it reaches a point A_{25} . What is the straight line distance from A_0 to A_{25} ? (+2, -0.5)



- a. 3 cm
- b. $\sqrt{5}$ cm
- c. 5 cm
- d. 16 cm

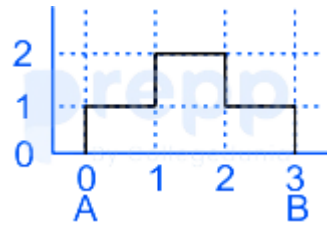
8. A worker is asked to arrange 1000 identical square tiles into a rectangular pattern and paint only the tiles forming the border. What should be the dimension of the rectangular pattern he arranges, in order to use the minimum amount of paint? (+2, -0.5)

- a. 50 tiles \times 20 tiles
- b. 8 tiles \times 125 tiles
- c. 200 tiles \times 5 tiles
- d. 40 tiles \times 25 tiles

9. There are 150 vehicles in a parking place. Each vehicle is either a bike or a car, and is either red or green. Sixty vehicles are red, and 100 vehicles are cars. If there are 20 green bikes, how many red cars are there? (+2, -0.5)

- a. 70

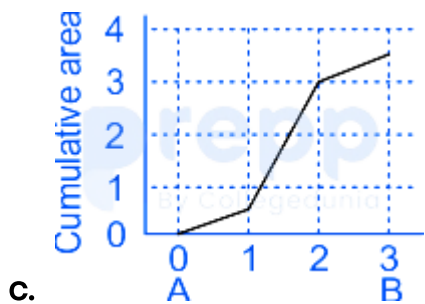
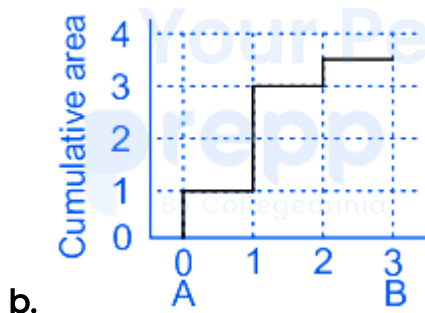
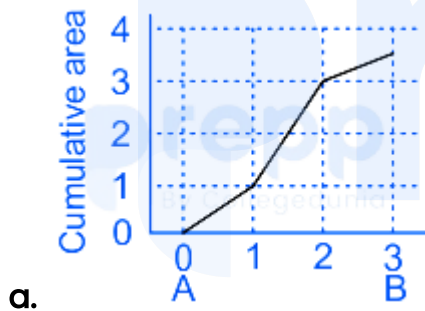
- b. 30
- c. 40
- d. 50

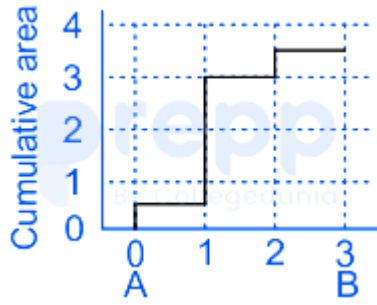


10.

(+2, -0.5)

Which one of the following graphs represents the cumulative area under the plot shown?

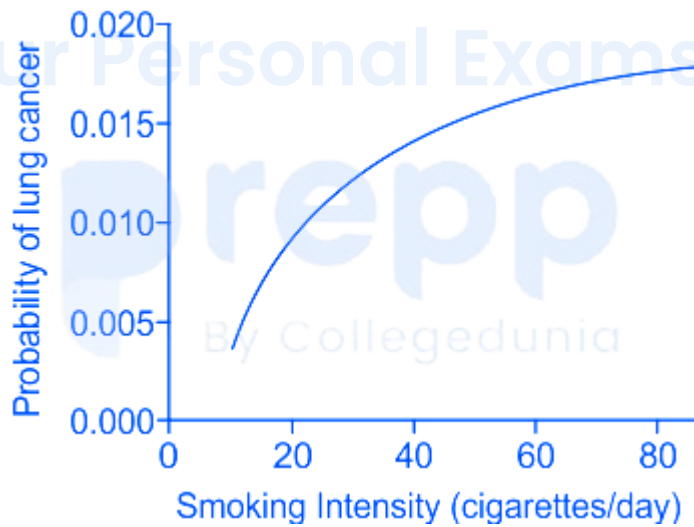




d.

11. The number of times the minute hand and the hour hand, in a clock, are exactly above each other (i.e. angle between them is zero) from 1 am of a day to 1 am on the next day is (+2, -0.5)

- a. 21
- b. 22
- c. 23
- d. 24

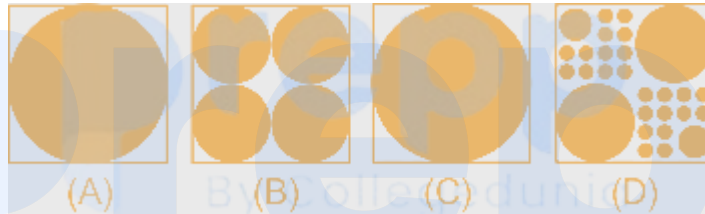


12. (+2, -0.5)

The graph shows relationship between smoking intensity and probability of getting lung cancer in a population. Which one of the following inferences is supported by the study?

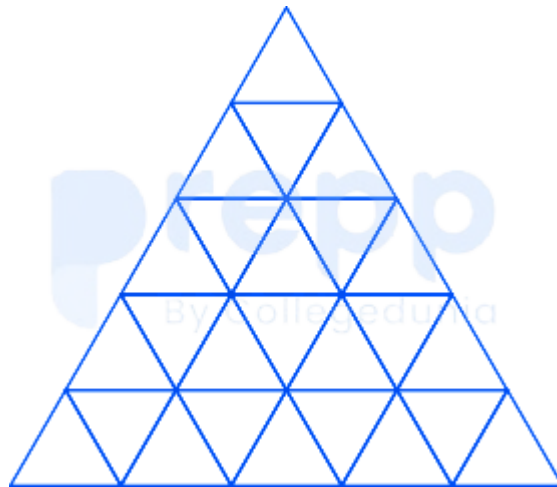
- a. Smoking always causes lung cancer.
- b. People have healthy lungs if they don't smoke.
- c. Smoking intensity is not directly proportional to the probability of getting lung cancer.
- d. High intensity smokers will get the lung cancer.

13. The shaded circles having diameter of 1, 0.5, 0.25 and 0.125 cm are inside squares of side 1 cm as shown in the figure. The ratio of shaded area in A and B is one. (+2, -0.5)



The ratio of shaded area in C and D would be

- a. 1
- b. 1.25
- c. 1.5
- d. 1.75



14.

(+2, -0.5)

How many triangles are there in the figure?

- a. 35
- b. 38
- c. 39
- d. 48

15. Each person in a group of teachers and students is given the same number of chocolates as the number of students. If 4 more students are added then in order to have the same number of chocolates per person as earlier, 28 more chocolates are needed. The total number of students now is

(+2, -0.5)

- a. 7
- b. 11
- c. 13
- d. 5

16. A ball is moving with a constant speed in a circular path in a vertical plane. The system is illuminated from the top so that the shadow of the ball on the ground oscillates. The maximum probability of finding the shadow of the ball is at (+2, -0.5)
- a. the extreme points.
 - b. the mean point.
 - c. half the distance from the mean point.
 - d. one third the distance from the mean point.
-

17. Five concentric, adjacent, semi-circular running tracks, each of mean length 100 m and width 2.5 m are marked on a field. If the angle subtended by inner track is 1.00 rad, the angle subtended by the outermost track is (+2, -0.5)
- a. 0.90 rad
 - b. 0.91 rad
 - c. 0.88 rad
 - d. 0.98 rad
-

18. In a legislative assembly of 250 members, political parties A, B, C, D and E got 100, 70, 48, 15, 7 seats, respectively, while 10 seats were won by the independents. If parties A, B and C decide not to support each other, what is the minimum number of political parties required to join hands to form a majority government? (+2, -0.5)
- a. One
 - b. Two

- c. Three
- d. Four

19. A heater is used to boil water in a container. The heater supplies heat at a constant rate R . Water boils at 100°C . Assume that the water in the container loses heat to the atmosphere at a rate that is proportional to both, the temperature of the water as well as to the volume of water in the container. If this proportionality constant is K then the maximum volume of water that can be boiled by the heater is (+2, -0.5)

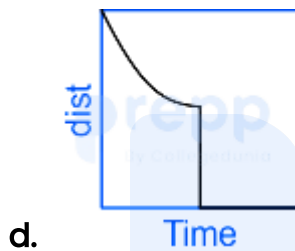
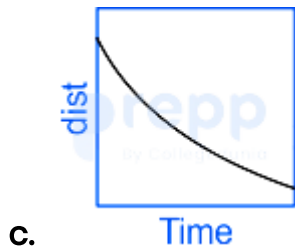
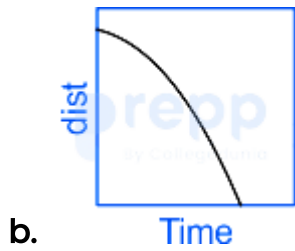
- a. $100/KR$
- b. $K/100R$
- c. $R/100K$
- d. $KR/100$

20. Two trains are approaching each other on the same straight track. One is moving at a constant speed, while the other is decelerating. Which of the graphs shows the correct change in their separation as a function of time? (+2, -0.5)



a.

Time



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Part B

21. The rate of hydration of $[\text{Cr}^{\text{III}}(\text{H}_2\text{O})_5\text{X}]^{n+}$, ($\text{X} = \text{N}_3^-, \text{F}^-, \text{CN}^-$ and NH_3) in neutral aqueous medium remains unaffected in acidic medium at room temperature, if 'X' is (+2, -0.5)
- a. N_3^-
 - b. F^-
 - c. CN^-
 - d. NH_3
-
22. The first ionization energy of the metals follows the order: (+2, -0.5)
- a. $\text{Zn} > \text{Cd} > \text{Hg}$
 - b. $\text{Hg} > \text{Zn} > \text{Cd}$
 - c. $\text{Hg} > \text{Cd} > \text{Zn}$
 - d. $\text{Cd} > \text{Zn} > \text{Hg}$
-
23. The red colour of the gem, ruby is predominantly due to (+2, -0.5)
- a. O^{2-} to Al^{3+} charge transfer
 - b. O^{2-} to Cr^{3+} charge transfer
 - c. Red emission (fluorescence) of Cr^{3+} ions
 - d. Red emission (phosphorescence) of Al^{3+} ions
-

24. The correct pair among the following, in which each species shows the same magnetic moment is (+2, -0.5)
- $[\text{CoCl}_4]^{2-}$ and $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 - $[\text{NiCl}_4]^{2-}$ and $[\text{CoF}_6]^{3-}$
 - $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
 - $[\text{Ni}(\text{NH}_3)_6]^{2+}$ and $[\text{CrCl}_4]^{2-}$

25. Marsh test is used to identify traces of the element, (+2, -0.5)
- As
 - Sb
 - Bi
 - Se

26. A radio isotope X with a half life 1.4×10^9 years decays to Y which is stable. A sample of the rock from a cave was found to contain X and Y in the ratio 1 : 7. The age of the rock is (+2, -0.5)
- 1.92×10^9 years
 - 3.92×10^9 years
 - 4.20×10^9 years
 - 8.40×10^9 years

27. The correct statement(s) for oxygen from the following (+2, -0.5)

- A. The ground state for the O atom is 3P_1 .
- B. Both the atom and the diatomic molecule are paramagnetic with two unpaired electrons.
- C. The most readily accessible singlet excited state for dioxygen has an empty π^* orbital.

is/are

Choose the **correct** answer from the options given below:

- a. A and B only
- b. B and C only
- c. A and C only
- d. B only

28. The correct statement for peroxydisulfuric and dithionic acids from the following, is: (+2, -0.5)

- a. Each of these has two O-H bonds.
- b. Peroxydisulfuric has one O-H bond and dithionic acid has two O-H bonds.
- c. Peroxydisulfuric has two O-H bonds and dithionic acid has one O-H bond
- d. Each of these has only one O-H bond

29. The correct statement for the CO and N₂ ligands in the complexes *trans*-[IrCl(CO)(PPh₃)₂] and *trans*-[IrCl(N₂)(PPh₃)₂] is: (+2, -0.5)
- N₂ is both better σ-donor and better π-acceptor ligand than CO
 - CO is a better π-acceptor, but poor σ-donor ligand than N₂
 - CO is a better σ-donor, but poor π-acceptor ligand than N₂
 - CO is both better σ-donor and better π-acceptor ligand than N₂

30. Among the following divalent metal ions which forms polymeric compound, when ligand used is C₅H₅⁻ only (+2, -0.5)
- V
 - Ni
 - Mn
 - Co

31. Match List I with List II (+2, -0.5)

List I		List II	
Metalloprotein		Metal	
A.	carboxypeptidase A	I.	Mn
B.	oxygen-evolving complex	II.	Fe
C.	hemerythrin	III.	Ni
D.	coenzyme F-430	IV.	Zn

Choose the correct answer from the options given below:

- a. A - III, B - I, C - II, D - IV
- b. A - IV, B - I, C - II, D - III
- c. A - II, B - III, C - IV, D - I
- d. A - IV, B - III, C - I, D - II

32. ^{212}Bi decays with the emission of an α particle. The resulting nuclide emits a β particle to give an element (+2, -0.5)

- a. Tl
- b. Pb

c. Po

d. At

33. Consider the following statements with respect to Jacobsen's catalyst used for the epoxidation reaction. It is/has (+2, -0.5)

A. manganese(III) complex

B. salen type ligand

C. cobalt(III) bromide complex

D. 1-nitroso-2-naphthol type ligand

E. square pyramid geometry

F. square planar geometry

Choose the **correct** answer from the options given below:

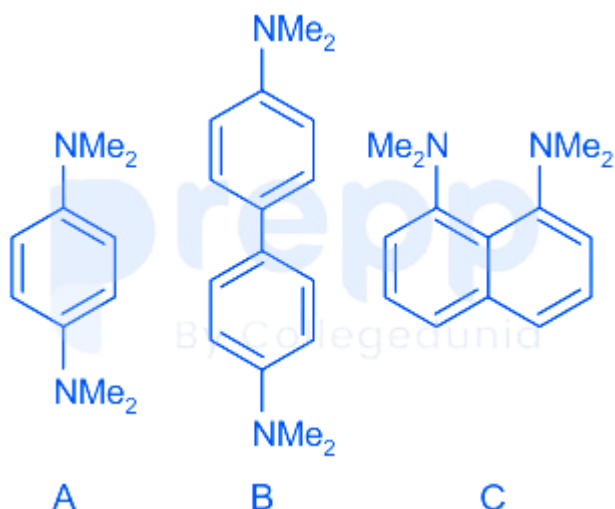
a. C, D and F only

b. A, B and E only

c. A, D and E only

d. B, C and F only

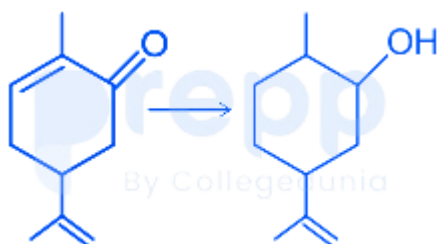
34. The correct order of basicity for following compounds is (+2, -0.5)



Choose the **correct** answer from the options given below

- a. $A > B > C$
- b. $B > A > C$
- c. $C > B > A$
- d. $C > A > B$

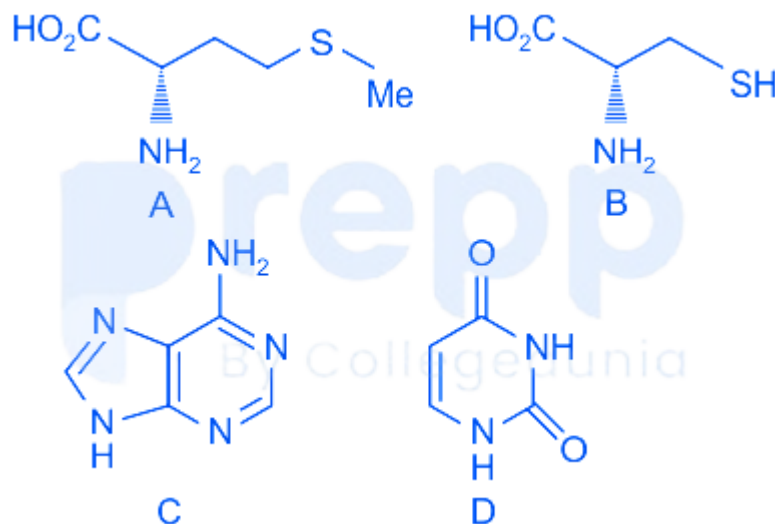
35. The most suitable reagent to effect the following conversion is (+2, -0.5)



- a. $\text{BH}_3 \cdot \text{SMe}_2$
- b. Na, EtOH
- c. $\text{NaBH}_4, \text{CeCl}_3$
- d. $\text{H}_2, \text{Pd/C}$

36. Components of S-adenosyl methionine are

(+2, -0.5)

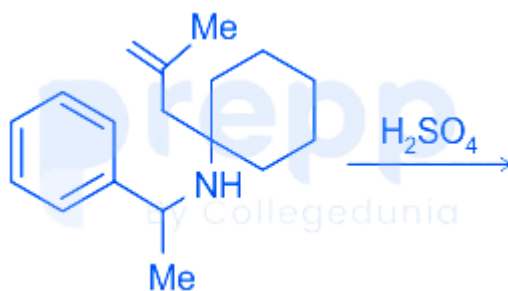


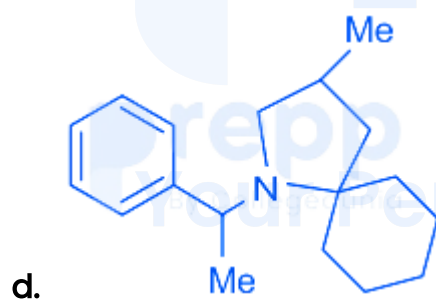
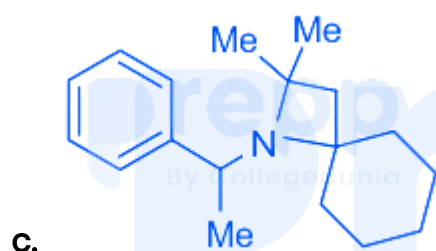
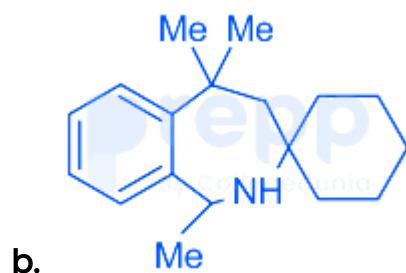
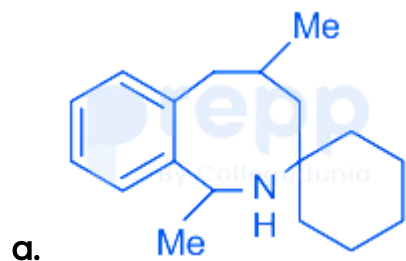
Choose the *correct* answer from the options given below:

- a. A and C only
- b. A and D only
- c. B and C only
- d. B and D only

37. The major product formed in the following reaction is

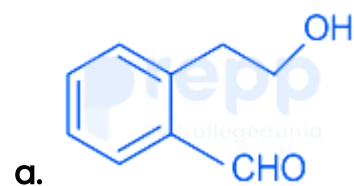
(+2, -0.5)

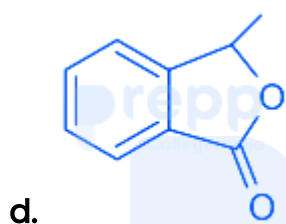
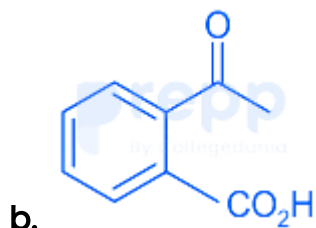




38. The compound that answers both, haloform and Tollens' tests, is

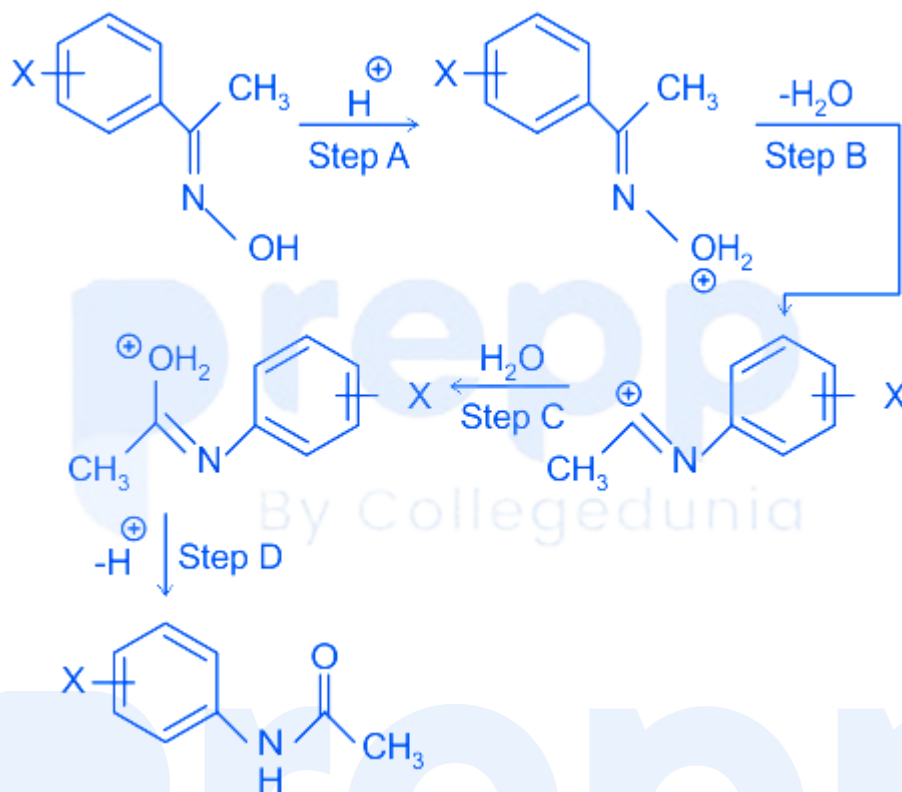
(+2, -0.5)





39. The Hammett ρ -value for the following reaction is -2.0 . The rate-determining step (RDS) is: (+2, -0.5)

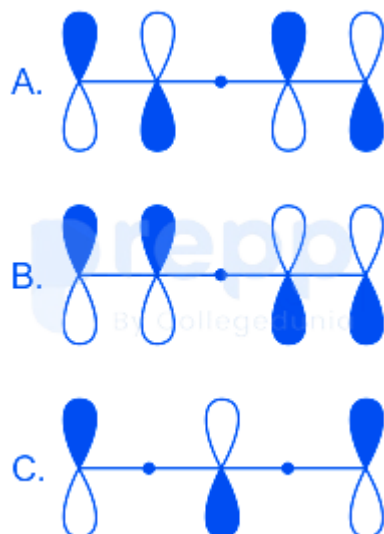
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- a. Step A
- b. Step B
- c. Step C
- d. Step D

40. The correct order of energy for the following molecular orbitals is

(+2, -0.5)



Choose the **correct** answer from the options given below

- a. $C > A > B$
- b. $C > B > A$
- c. $A > C > B$
- d. $B > A > C$

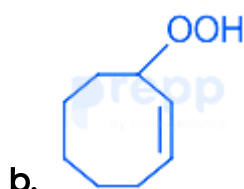
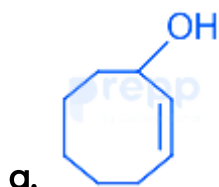
41. The following hydrocarbon, twistane, is

(+2, -0.5)

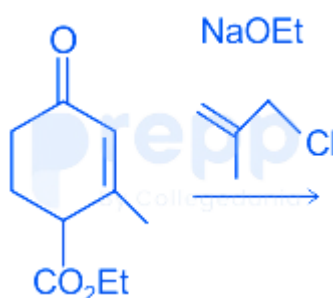


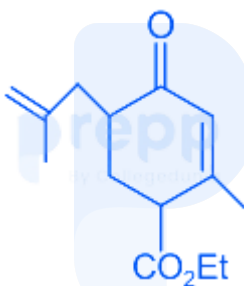
- a. achiral due to the presence of centre of symmetry
- b. achiral due to the presence of plane of symmetry
- c. chiral with no elements of symmetry
- d. chiral with C_2 -axes of symmetry

42. The major product formed in the photochemical reaction of cyclooctene in the presence of oxygen and a photosensitizer is (+2, -0.5)



43. The major product formed in the following reaction is (+2, -0.5)

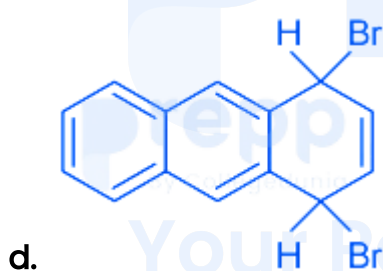
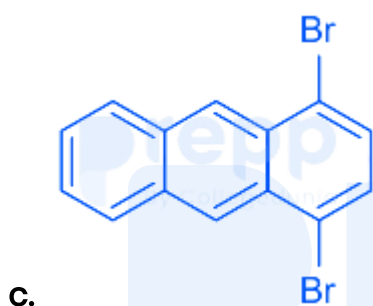
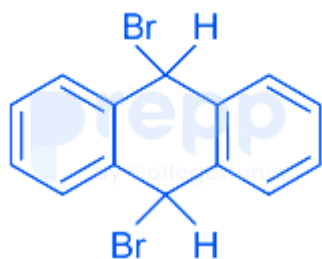




44. The major product formed in the following reaction is

(+2, -0.5)





45. Given in the options are compounds with the molecular weight 125. The one that will show the EI mass spectral data: 125 ($[M]^+$, 55%), 126 ($[M + 1]^+$, 3.65%), 127 ($[M + 2]^+$, 2.35%) is (+2, -0.5)
- a. C₆H₇NS
 - b. C₆H₇NO₂
 - c. C₇H₈FN

d. C₈H₁₅N

46. The compound that will show six signals in the proton-decoupled ¹³C NMR spectrum is (+2, -0.5)



47. The point groups of cis- and trans-1, 2-dichloroethylene are respectively (+2, -0.5)

a. C_{2v} and C_{2v}

b. C_{2v} and C_{2h}

c. C_{2h} and C_{2v}

d. C_{2h} and C_{2h}

48. The correct expression for the internal energy of a system following Boltzmann distribution of energy is (Q: partition function, T : temperature, k_B: Boltzmann constant, N: number of molecules and V : volume) (+2, -0.5)

- a. $k_B T \left(\frac{\partial \ln Q}{\partial T} \right)_{N,V}$
- b. $k_B T^2 \left(\frac{\partial \ln Q}{\partial T} \right)_{N,V}$
- c. $k_B T \left(\frac{\partial \ln Q}{\partial \beta} \right)_{N,V}$
- d. $k_B T^2 \left(\frac{\partial \ln Q}{\partial \beta} \right)_{N,V}$

49. A metallic lattice exhibits peaks corresponding to Miller indices (110), (111), (210), and (211) in its powder XRD pattern. The metal is crystallized in the Bravais lattice (+2, -0.5)
- a. body centered cubic
 - b. face centered cubic
 - c. side centered cubic
 - d. primitive cubic

50. In the electric double layer model, the difference in potential between the fixed part of the double layer and bulk solution is called: (+2, -0.5)
- a. Zeta potential
 - b. Double layer potential
 - c. Sedimentation potential
 - d. Chemical potential

51. The resistance of a 0.1 M KCl solution in a cell is 300 ohms and specific conductance is 1.5 Scm^{-1} . (+2, -0.5)

If the resistance of a 0.05 M NaCl in the same cell is 750 ohms, then the molar conductance ($\text{S cm}^2 \text{mol}^{-1}$) of the NaCl is:

- a. 6,000
- b. 8,000
- c. 12,000
- d. 3,000

52. The angle between the z-axis and the intrinsic spin angular momentum for $m_s = \pm 1/2$ is (+2, -0.5)

- a. $\cos^{-1}(1/\sqrt{2})$
- b. $\cos^{-1}(\sqrt{3}/2)$
- c. $\cos^{-1}(1/2)$
- d. $\cos^{-1}(1/\sqrt{3})$

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53. The permitted values of the total angular momentum quantum number, j , for an electron occupying an f orbital are (+2, -0.5)

- a. $7/2$ and $5/2$
- b. $1/2$ and $-1/2$
- c. $9/2$ and $7/2$
- d. $3/2$ and $1/2$

54. Assuming that the enthalpy of mixing is zero, the mixture with the largest Gibbs free energy, at the same temperature, among the following, is (+2, -0.5)
- a. 0.1 moles of benzene and 0.9 moles of toluene
 - b. 0.25 moles of benzene and 0.75 moles of toluene
 - c. 0.6 moles of benzene and 0.4 moles of toluene
 - d. 0.8 moles of benzene and 0.2 moles of toluene
-
55. The quantity that is an exact differential of a state function is (following the convention that heat flowing in and work done on the system are positive) (+2, -0.5)
- a. dq
 - b. $TdS - PdV$
 - c. $TdS - VdP$
 - d. $VdP + SdT$
-
56. A diatomic molecule undergoing simple harmonic motion has a displacement (q) of 4.9×10^{-12} m. Its force constant is 1610 N m^{-1} . The potential energy of the molecule is (in Joules) (+2, -0.5)
- a. 1.93×10^{22}
 - b. 1.93×10^{-23}
 - c. 3.86×10^{-20}

d. 1.93×10^{-20}

57. The spin density in propenyl radical is predominantly localized on (+2, -0.5)

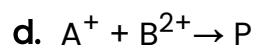
- a. atoms 1 and 2
- b. atoms 2 and 3
- c. atoms 1 and 3
- d. equally on all the atoms

58. The units of a rate constant for the reaction $nA \rightarrow \text{products}$, is $\text{L}\cdot\text{mol}^{-1}\cdot\text{min}^{-1}$ (+2, -0.5)
 If the half life is 300 min when $[A_0] = 0.05 \text{ M}$, its half-life (in min), when $[A_0] = 0.1 \text{ M}$, is closest to

- a. 450
- b. 300
- c. 150
- d. 75

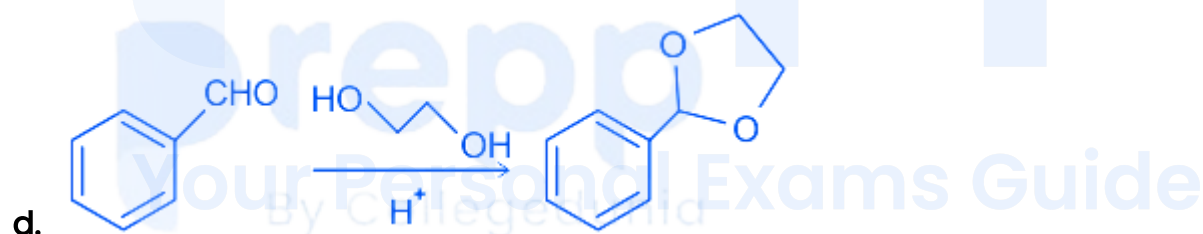
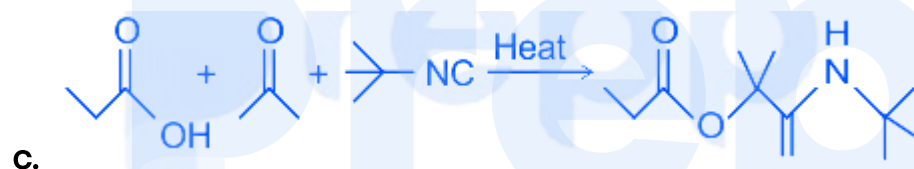
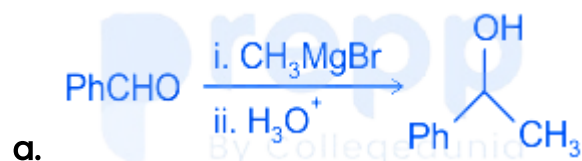
59. The reaction whose rate constant is least dependent on the dielectric constant of the medium is: $[P = \text{product(s)}]$ (+2, -0.5)

- a. $S_2O_8^{2-} + I^- \rightarrow P$
- b. $CH_3COOC_2H_5 + OH^- \rightarrow P$
- c. $A^{2+} + [M(C_2O_4)_3]^{3-} \rightarrow P$



60. The most efficient reaction in terms of atom economy, among the following, is

(+2, -0.5)



Part C

61. Consider the following statements for hemoglobin (Hb) and myoglobin (Mb). (+4, -1)

A. Oxy-Hb is formed in the lungs, whereas oxy-Mb is formed in tissues.

B. Mb has a greater affinity for dioxygen than Hb.

C. The equilibrium constant for the formation of the oxy-Mb is $K_{Mb} = \frac{[MbO_2]}{[Mb][O_2]}$

D. The equilibrium constant for the formation of the oxy-Hb is $K_{Hb} = \frac{[Hb(O_2)_4]}{[Hb][O_2]^4}$

Choose the **correct** answer from the options given below:

a. A, B and C only

b. A, C and D only

c. B, C and D only

d. A, B and D only

62. Based on Wade's rules, the correct structure types for $[B_4H_{10}]$, $[B_8H_8]^{2-}$, (+4, -1)

$[B_{10}H_{14}]$ and

$[Mn(CO)_4B_3H_8]$ respectively, are

a. *arachno, closa, arachno, and hypho*

b. *nido, nido, arachno, and hypho*

c. *arachno, closa, nido, and arachno*

d. *nido, closa, nido, and hypho*

63. The number of Ge-Ge, Te-Te and Pb-Pb bonds in Ge_4^{4-} , Te_4^{2+} and Pb_5^{2+} , respectively are (+4, -1)

- a. 6, 4 and 8
- b. 4, 6 and 9
- c. 6, 4 and 9
- d. 4, 6 and 8

64. The $[(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2]_2$ molecule exists in solution as a 1 : 1 mixture of cis- and trans-isomers. (+4, -1)

At 28°C, ^1H NMR spectrum of the molecule shows

- a. One singlet
- b. Two singlet
- c. Four singlet
- d. Three singlet

65. Consider the following with regard to gas chromatography (GC). (+4, -1)

- A. Electron capture
- B. Deemter equation
- C. Partition Coefficient
- D. Critical temperature of gas

Of the above, which are relevant to GC?

Choose the **correct** answer from the options given below:

- a. A, B and D only
- b. A, C and D only
- c. B, C and D only
- d. A, B and C only

66. Considering spin-orbit coupling, the multiplet width $[W_{SO} = \lambda S(2L + 1)]$ for Eu^{3+} ion is (+4, -1)

- a. 14λ
- b. 21λ
- c. 7λ
- d. 28λ

67. Among the following combinations of metal carbonyl clusters and their skeletal structures, identify the correct ones. (+4, -1)

- A. $\text{Co}_6(\text{CO})_{14}^{4-} \rightarrow$ capped trigonal bipyramid
- B. $\text{Ni}_6(\text{CO})_{12}^{2-} \rightarrow$ trigonal antiprism
- C. $\text{Rh}_6\text{C}(\text{CO})_{15}^{2-} \rightarrow$ trigonal prism
- D. $\text{Os}_6(\text{CO})_{18} \rightarrow$ octahedron

Choose the **correct** answer from the options given below:

- a. A, C and D only

- b. B and C only
- c. B and D only
- d. C and D only

68. For octahedral geometry the triad with **no** net gain in CFSE, when the ligand field changes from weak to strong, is (+4, -1)

- a. Fe^{2+} , Co^{3+} , Mn^{3+}
- b. Ni^{2+} , Pt^{2+} , Cr^{3+}
- c. Mn^{2+} , Fe^{3+} , Ni^{3+}
- d. Co^{2+} , Os^{3+} , Rh^{3+}

69. The possible terms arising from a p^1d^1 configuration are (+4, -1)

- a. 1 F and 2 D
- b. 3 F and 3 D
- c. 3 F and 1 D
- d. 3 F and 1 F

70. Consider following statements regarding the magnetic moment of the 3d transition metal complexes: (+4, -1)

A. Octahedral complexes of Mn^{II} (high spin) and Fe^{III} (high spin) have μ_{eff} approximately equal to their μ_{spin} values.

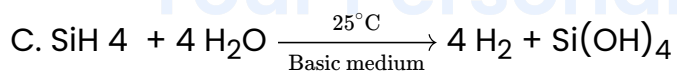
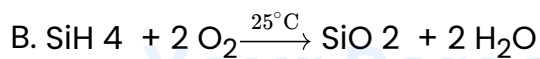
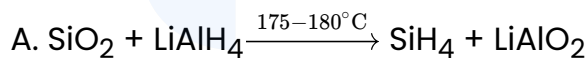
- B. Tetrahedral complexes of Ni^{II} and octahedral complexes of Co^{II} have orbital contribution added to their magnetic moments.
- C. Orbital contribution is quenched for metal ions having A or E ground state.
- D. tetrahedral complexes of Co^{II} have $\mu_{\text{eff}} > \mu_{\text{spin}}$ value at 300 K due to orbital contribution added to their magnetic moments

Choose the **correct** answer from the options given below:

- a. A, B and D only
- b. B, C and D only
- c. A, B and C only
- d. A, C and D only

71. Among the following feasible reaction(s) is/are?

(+4, -1)



Choose the **correct** answer from the options given below:

- a. A only
- b. C only
- c. B and C only
- d. A, B and C only

72. Isolobal pairs from the fragments (A-D) is/are

(+4, -1)

- A. {BH}
- B. {Fe(CO)₃}
- C. {P}
- D. {Co(CO)₃}

Choose the **correct** answer from the options given below:

- a. A and D; B and C
- b. A and B; C and D
- c. A and B only
- d. A and C; B and D

73. The reaction(s)/event(s) used to prove the existence of neutrinos is/are

(+4, -1)

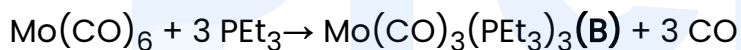
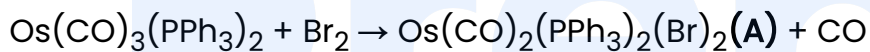
- A. $e^+ + e^- \rightarrow \gamma + \gamma$
- B. $^{113}\text{Cd}(n, \gamma)^{114}\text{Cd}^*$
- C. $^{133}\text{Cs}(\alpha, 4n)^{133}\text{La}$

Choose the **correct** answer from the options given below:

- a. A and C only
- b. A and B only
- c. B and C only
- d. B only

74. In solution, Vaska's complex is known to bind O_2 reversibly. In the product, oxidation state of the metal ion center coordination geometry and mode of binding of O_2 , respectively are (+4, -1)
- +3, octahedron and side-on
 - +3, square pyramid and end-on
 - +1, octahedron and side-on
 - +1, trigonal bipyramid and end-on

75. Consider the following reactions. (+4, -1)

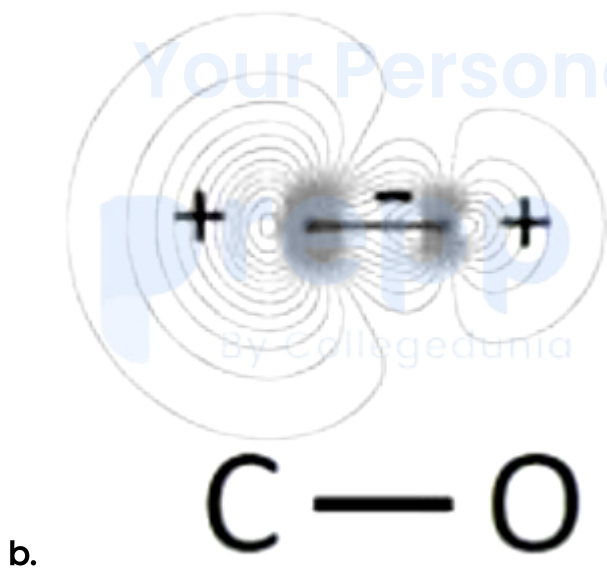
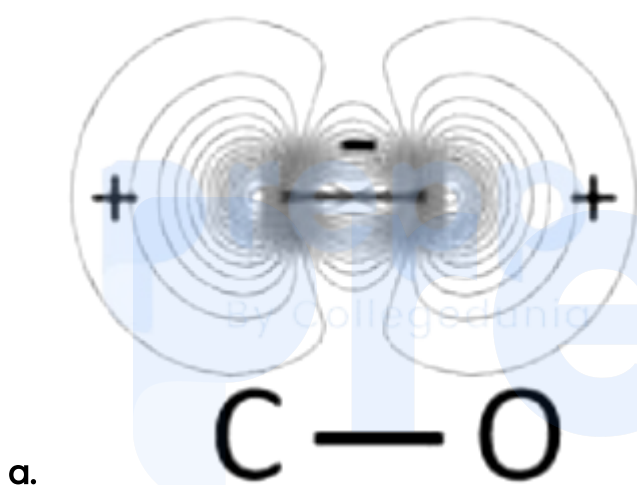


The correct stereochemical dispositions of the Br ligands in **A** and the CO ligands in **B**, respectively, are

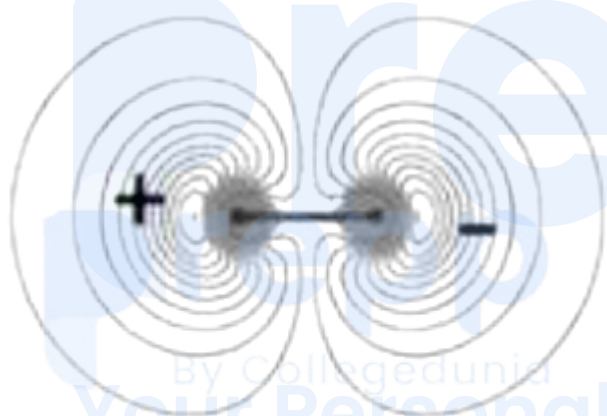
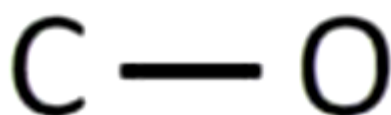
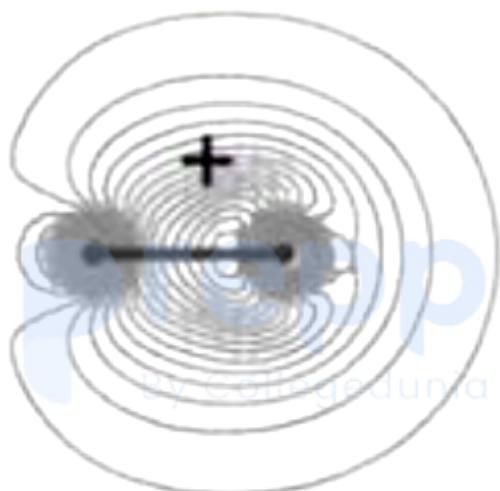
- trans and fac
 - trans and mer
 - cis and fac
 - cis and mer
76. The ground state term symbol and the g_j value for Pr^{3+} ion, respectively are (+4, -1)
(Atomic number of Pr is 59)
- $3H_4$ and $6/7$

- b. 3 H 6 and 4/5
- c. 3 H 6 and 6/7
- d. 3 H 4 and 4/5

77. For CO, the contour plot of the molecular orbital which best represents the HOMO is (+4, -1)



b.



78. Among the following statements, select those which best describe plastocyanin

(+4, -1)

- A. Coordination geometry of Cu^{II} -ion is distorted tetrahedron
- B. The geometry around Cu^{II} changes to square-planar on reduction

C. In the EPR spectrum, the $A_{||}$ values are smaller in plastocyanin than in CuCl_4^{2-}

D. The active site contains the amino acids histidine and cysteine only

Choose the **correct** answer from the options given below:

- a. A and C only
- b. A and D only
- c. A, B and D only
- d. B, C, and D only

-
79. Consider the ^{31}P NMR (decoupled from ^1H and ^{195}Pt) spectra for the isomers of 'A' $[\text{PtBrCl}(\text{PMe}_3)_2]$ and 'B' $[\text{IrCl}_3(\text{PMe}_3)_3]$, separately. The number of ^{31}P NMR signals for the different isomers of the complexes are given in the table below. The correct answer is set (+4, -1)

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1.	No. of ^{31}P resonance signal(s)			
	Complex A		Complex B	
	isomer 1	isomer 2	isomer 1	isomer 2
	one	one	one	one
2.	No. of ^{31}P resonance signal(s)			
	Complex A		Complex B	
	isomer 1	isomer 2	isomer 1	isomer 2
	one	two	one	Two
3.	No. of ^{31}P resonance signal(s)			
	Complex A		Complex B	
	isomer 1	isomer 2	isomer 1	isomer 2
	two	two	one	Two

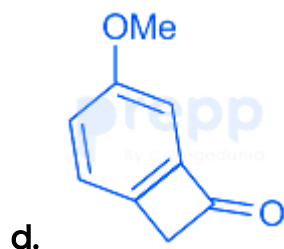
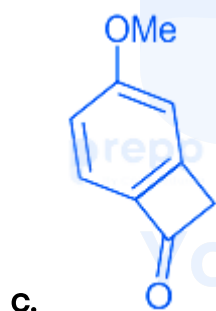
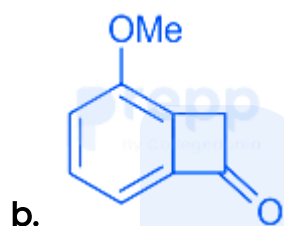
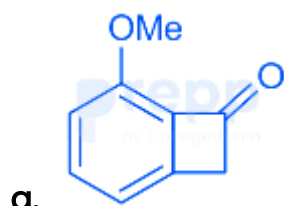
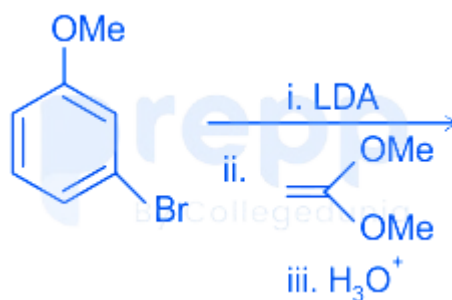
4.	No. of ^{31}P resonance signal(s)			
	Complex A		Complex B	
	isomer 1	isomer 2	isomer 1	isomer 2
	one	two	Two	Two

- a. 1
- b. 2
- c. 3
- d. 4

80. Mössbauer spectrum of $\text{Fe}(\text{CO})_5$ at liquid nitrogen temperature in the presence of a field gradient and taking into effect quadrupole interaction [For ^{57}Fe , $I = 1/2$ for the ground state and $I = 3/2$ for the first excited state], shows a (+4, -1)

- a. quintet
- b. triplet
- c. doublet
- d. singlet

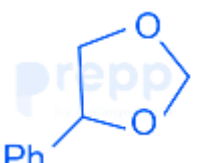
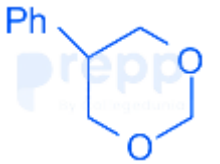

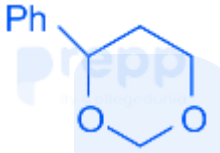
81. The major product formed in the following reaction is (+4, -1)



82. The major product formed in the following reaction is

(+4, -1)



- a. 
- b. 
- c. 
- d. 

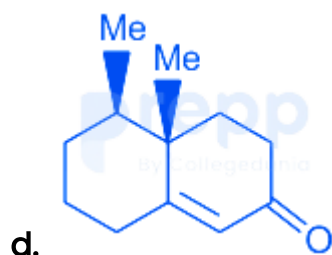
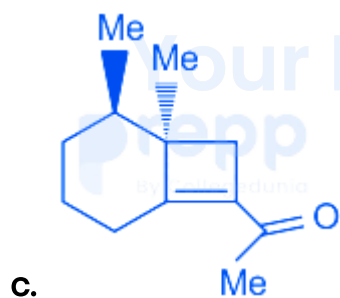
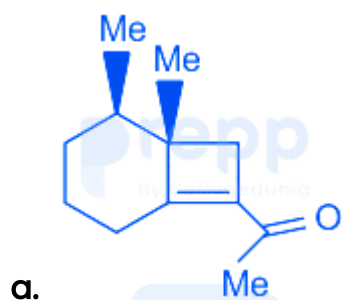
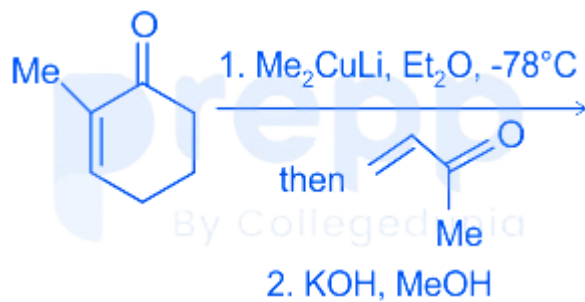
83. The sequence through which the following reaction proceeds is (+4, -1)



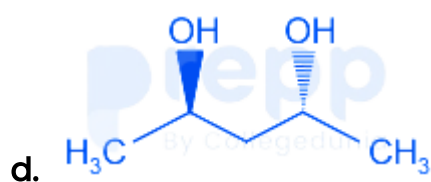
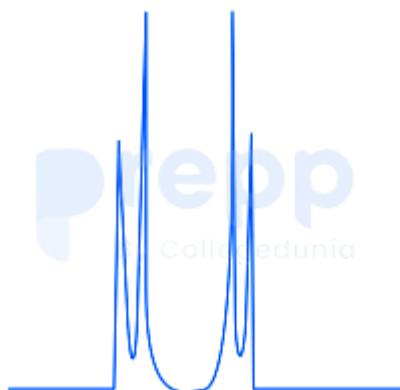
- a. Claisen rearrangement, tautomerization and Cope rearrangement
- b. Claisen rearrangement, aza-Claisen rearrangement and tautomerization
- c. Cope rearrangement, Claisen rearrangement and tautomerization
- d. Claisen rearrangement, tautomerization and aza-Claisen rearrangement

84. The major product formed in the following reaction sequence is

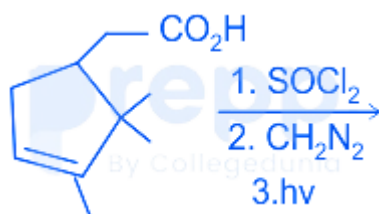
(+4, -1)

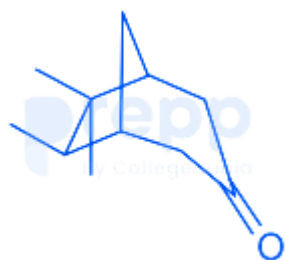


85. The compound that will show the following characteristic splitting pattern in the ^1H NMR spectrum is (+4, -1)



86. The major product formed in the following reaction sequence is (+4, -1)

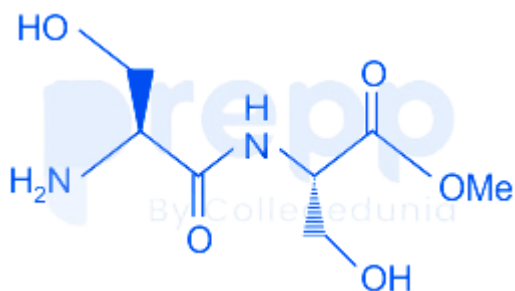


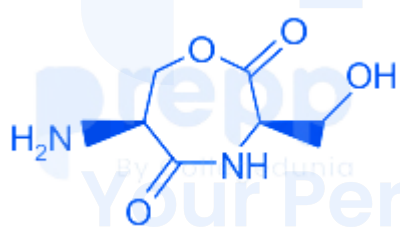
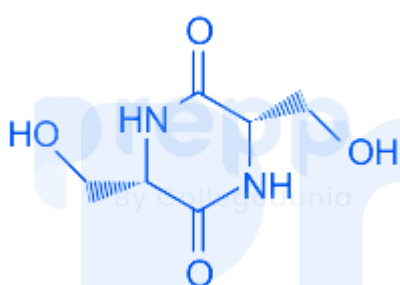
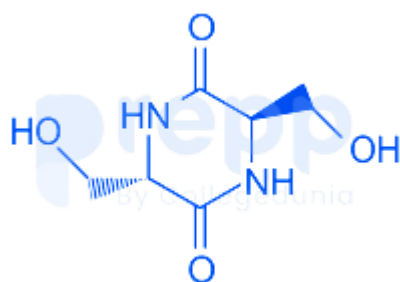
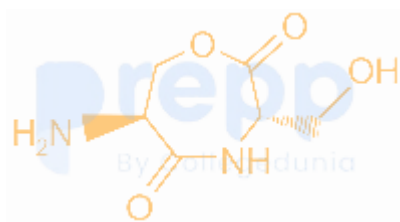


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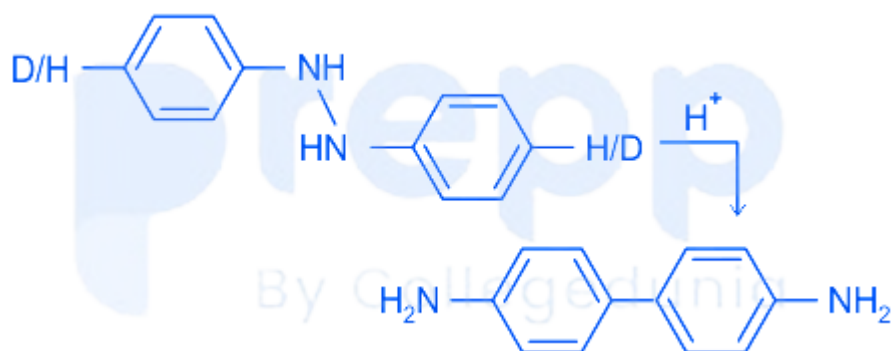
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87. Cyclization of the following dipeptide under mildly basic conditions gives (+4, -1)



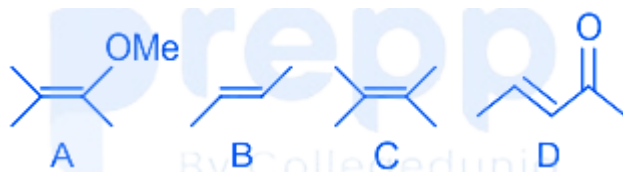


88. For the given reaction, isotopic substitution (H to D) at the indicated position of A will lead to the observation of (+4, -1)



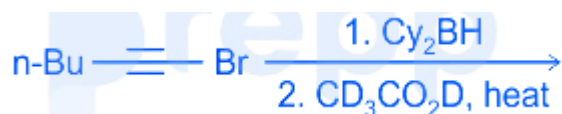
- a. primary kinetic isotope effect
- b. secondary kinetic isotope effect with $k_H > k_D$
- c. secondary kinetic isotope effect with $k_D > k_H$
- d. no kinetic isotope effect, $k_H = k_D$

89. The correct order of reactivity of the following olefins towards ozone is (+4, -1)

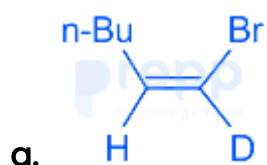


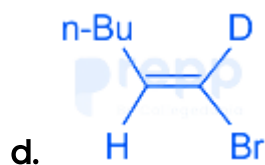
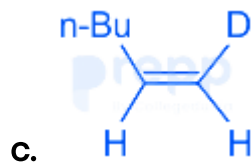
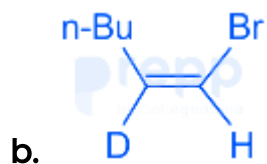
- a. $A > C > B > D$
- b. $A > B > D > C$
- c. $B > C > A > D$
- d. $C > A > D > B$

90. The major product formed in the following reaction sequence is (+4, -1)



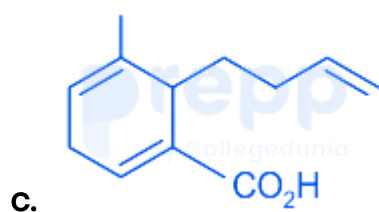
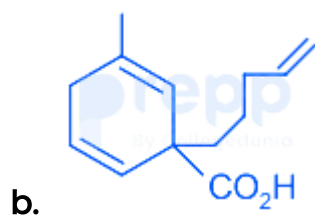
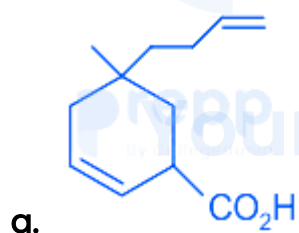
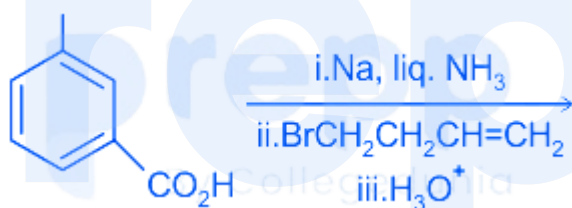
(Cy_2BH = dicyclohexylborane)

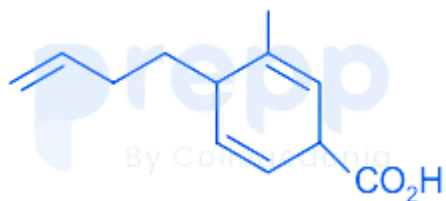




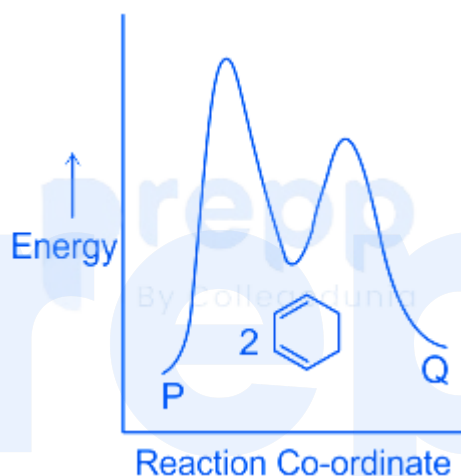
91. The major product formed in the following reaction is

(+4, -1)

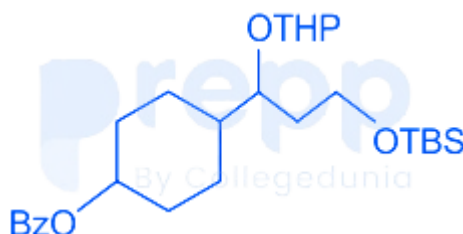




92. P and Q are isomers of cyclopentadiene dimer. A representative energy profile diagram of the dimerization is given below. The correct statement about the reaction under ambient conditions is (+4, -1)



- a. P is the major product as it is more stable.
 b. Q is the major product as it is more stable.
 c. P is the major product as it is formed faster.
 d. Q is the major product as it is formed faster.
93. The correct match of reagents in Column I for the selective cleavage of the protecting group in Column II for the following substrate is (+4, -1)



Column I		Column II	
A.	TBAF, THF	I.	THP
B.	AcOH, H ₂ O, THF	II.	Bz
C.	LiOH, H ₂ O, THF	III.	TBS

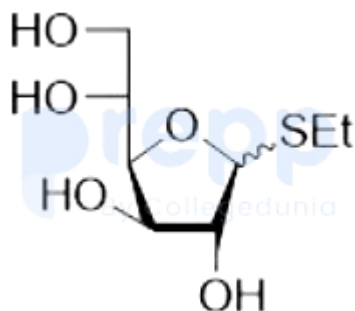
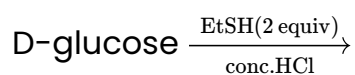
Choose the **correct** answer from the options given below:

- a. A - III, B - I, C - II
- b. A - III, B - II, C - I
- c. A - II, B - III, C - I
- d. A - I, B - III, C - II

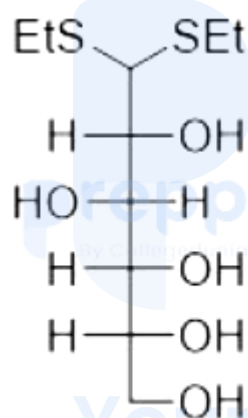
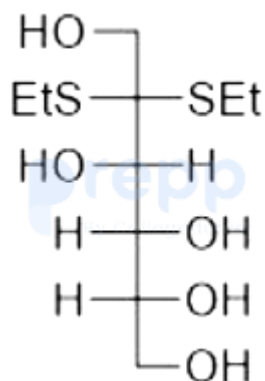
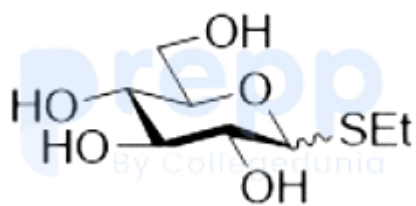
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94. The major product formed in the following reaction is

(+4, -1)



a.



95. Match List I with List II

(+4, -1)

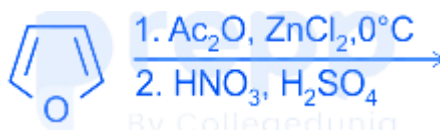
List I		List II	
functional groups		respective approximate symmetric and asymmetric stretching frequencies	
A.	N - H bonds of R - NH ₂	I.	1790 and 1810
B.	N - O bonds of R - NO ₂	II.	3300 and 3400
C.	C = O bonds of anhydride	III.	1350 and 1550

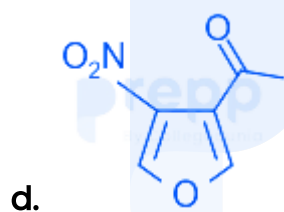
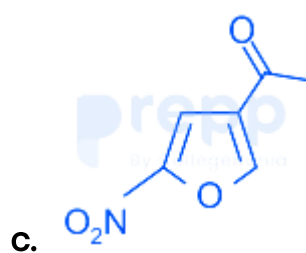
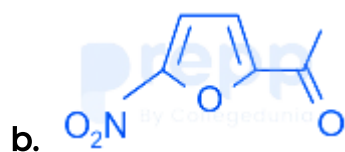
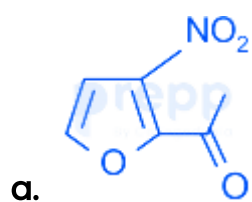
Choose the **correct** answer from the options given below:

- a. A - II, B - I, C - III
- b. A - III, B - I, C - II
- c. A - III, B - II, C - I
- d. A - II, B - III, C - I

96. The major product formed in the following reaction sequence is

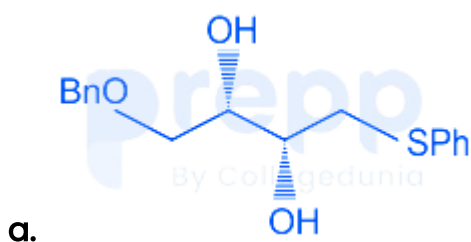
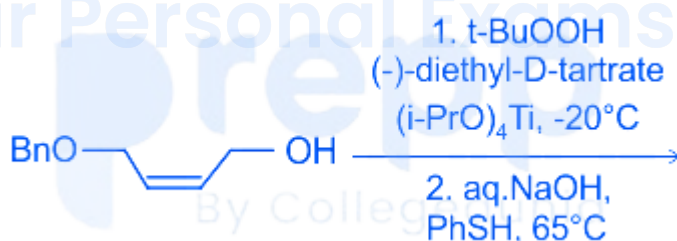
(+4, -1)

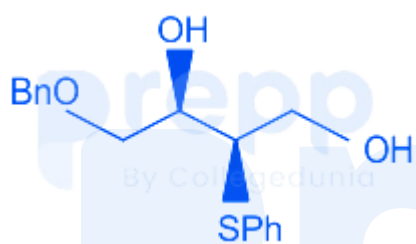
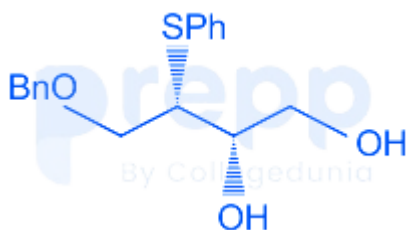
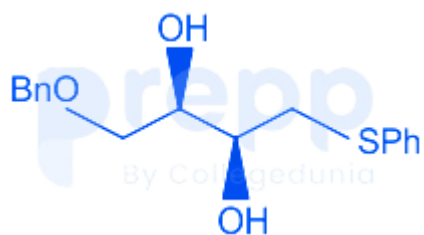




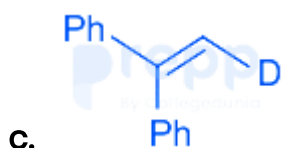
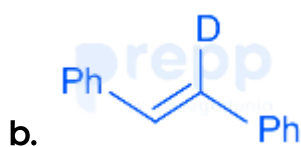
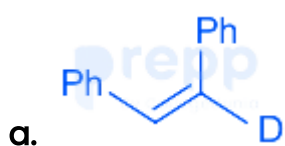
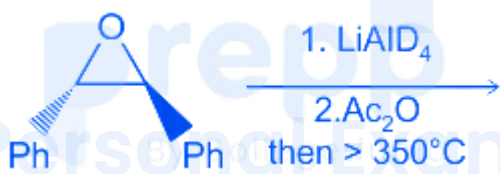
97. The major product formed in the following reaction sequence is

(+4, -1)





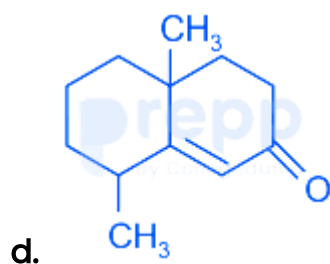
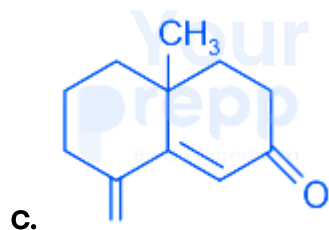
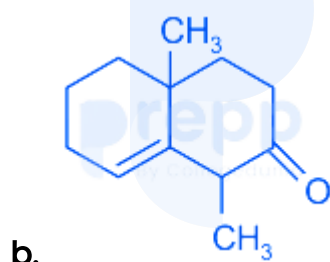
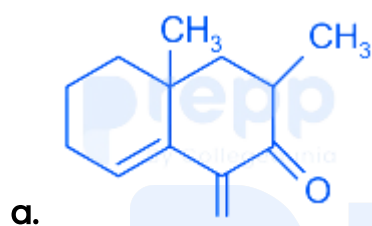
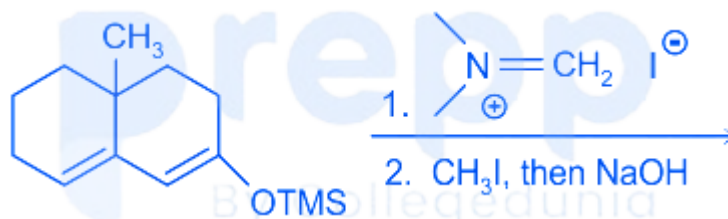
98. The major product formed in the following reaction sequence is (+4, -1)





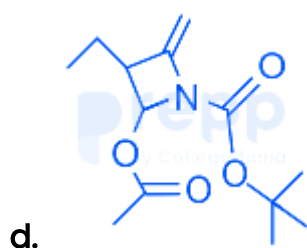
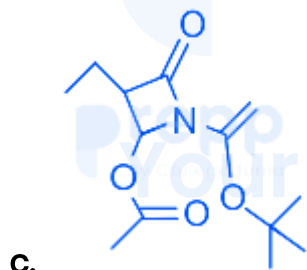
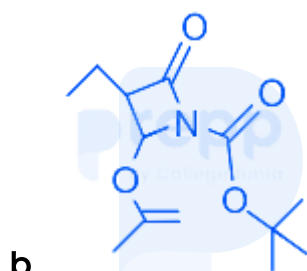
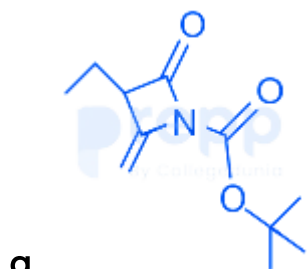
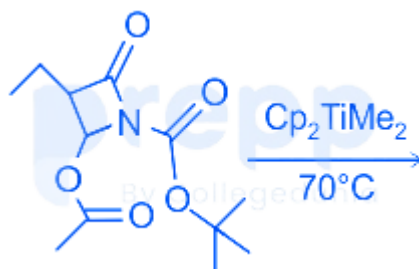
99. The major product formed in the following reaction sequence is

(+4, -1)



100. The major product formed in the following reaction is

(+4, -1)



101. The equivalent symmetry operations for S_6^4 and S_3^3 are, respectively,

(+4, -1)

- a. C_3^2 and C_3
- b. C_6^4 and i
- c. C_3^2 and σ_h
- d. C_6^4 and E

102. The characters of a reducible representation Γ_R under the C_{3h} point group (+4, -1) are presented at the end of the character table below. The correct coefficients of the irreducible representations A' and A'' in the Γ_R are

C_{3h}	E	$2 C_3$	σ_h	$2 S_3$
A'	1	1	1	1
E'	2	-1	2	-1
A''	1	1	-1	-1
E''	2	-1	-2	1
Γ_R	21	0	7	-2

- a. 3, 3
- b. 4, 3
- c. 3, 4
- d. 4, 4

103. Entropy associated with a die with all its six faces having equal probability of being on top is (+4, -1)
 (k_B : Boltzmann constant):

- a. $\exp(-k_B / 6)$
- b. $\exp(-6 k_B)$
- c. $6 \ln k_B$
- d. $k_B \ln 6$

104. A compound consists of atoms A and B. Atoms of B form cubic close packing lattice and atoms of A occupy half of octahedral voids and half of tetrahedral voids. What is the molecular formula of the compound? (+4, -1)

- a. AB
- b. A_3B_2
- c. A_2B_3
- d. A_2B

105. The system with the largest internal pressure is (+4, -1)

- a. a droplet of pure water with 0.1 mm radius
- b. a droplet of 0.1M aqueous soap solution with radius of 0.1 mm radius
- c. a droplet of 0.1M aqueous NaCl solution with a radius of 0.1 mm radius
- d. a 0.1M bulk aqueous sugar solution

106. The approximate length (in μm) of the extended chain (contour length) of polypropylene of molar mass 420 kg mol^{-1} is close to: (+4, -1)

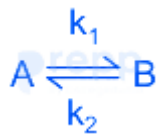
- a. 1.5
- b. 3
- c. 4.5
- d. 0.5

107. The equilibrium constant for the formation of the complex $\text{Zn}(\text{NH}_3)_4^{2+}$ at 25°C is close to: (+4, -1)

[Given: $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.763\text{V}$ and $E_{\text{Zn}(\text{NH}_3)_4^{2+}/\text{Zn},\text{NH}_3}^0 = -1.03\text{V}$]

- a. 2×10^8
- b. 5.5×10^{10}
- c. 1×10^9
- d. 6.6×10^7

108. Consider (+4, -1)



the action

If a , x , and x_e are the initial concentration of A, the concentration of B at time t , and the equilibrium concentration of B, respectively for the above reaction, then the $\frac{dx}{dt}$ is:

- a. $\frac{k_1 a}{x_e}(x_e + x)$
- b. $k_1(x_e - x)$

c. $\frac{k_1 a}{x_e} (x_e - x)$

d. $\frac{k_1 x_e}{a} (x_e - x)$

109. Thermal decomposition of acetaldehyde follows a chain reaction mechanism in which methane gas is produced in the chain propagation step. The rate of methane formation is proportional to: (+4, -1)

a. $[\text{CH}_3\text{CHO}]^{3/2}$

b. $[\text{CH}_3\text{CHO}]^{1/2}$

c. $[\text{CH}_3\text{CHO}]^{5/2}$

d. $[\text{CH}_3\text{CHO}]^2$

110. The data obtained from an enzyme-catalyzed reaction are plotted as $1/\text{rate}$ against $1/[S]_0$, where $[S]_0$ is the initial substrate concentration. The slope and y-intercept obtained from this plot are 50 and 100, respectively. If the enzyme concentration used in this reaction is 0.5 mM, then the turnover number (in mM^{-1}) of the enzyme is: (+4, -1)

a. 0.02

b. 0.04

c. 0.08

d. 0.06

111. Two angular momenta with quantum numbers $j_1 = 3/2$ and $j_2 = 5/2$ are added. The possible values of J for the resultant angular momentum states are (+4, -1)

- a. 4, 3, 2, 1
- b. 4, 1
- c. 4, 3, 2, 1, 0
- d. $\pm 4, \pm 1$

112. Radiation from a helium ion He^+ is nearly equal in wavelength to the H_α line (+4, -1) (the first line of the Balmer series). The states (values of n) between which the transition in the helium ion occur are

- a. 6, 2
- b. 3, 1
- c. 3, 2
- d. 6, 4

113. Lamb dip spectroscopy can reduce (+4, -1)

- a. Natural line width
- b. Doppler line width
- c. Collision induced line width
- d. Saturation line width

114. The molecule that can absorb in the infra-red among the following is (+4, -1)

- a. $^{13}\text{N}_2$

- b. $^{13}\text{N}^{16}\text{O}$
- c. $^{16}\text{O}_2$
- d. $^{13}\text{N}^{14}\text{N}$

115. The first two lines in the R- branch of the vibrational spectrum of HCl appear at 2906 and 2926 cm^{-1} respectively. (+4, -1)

The first line in the R- branch of DCl appears at 2102 cm^{-1} .

The second line (in cm^{-1}) is expected to appear close to

- a. 2112
- b. 2122
- c. 2152
- d. 2192

116. $(\partial T/\partial P)_S =$ Your Personal Exams Guide (+4, -1)

- a. $(\partial S/\partial U)_S$
- b. $(\partial T/\partial P)_V$
- c. $-(\partial V/\partial S)_P$
- d. $(\partial U/\partial P)_T$

117. The depression in the freezing point of four solutions containing one g/L of the solutes A, B, C, D are 2, 4, 3, and 1°C respectively. The solute with the (+4, -1)

largest molecular weight is

- a. A
- b. B
- c. C
- d. D

118. The equilibrium constant of a chemical reaction decreases monotonically with increasing temperature. From this, we may conclude that (+4, -1)

- a. $\Delta H^\circ < 0$
- b. $\Delta G^\circ < 0$
- c. $\Delta S^\circ < 0$
- d. $\Delta U^\circ < 0$

119. The molecule that is better described by single determinantal MO theory rather than the elementary single resonance structure VB theory is (+4, -1)

- a. LiH
- b. F₂
- c. H₂
- d. O₂

120. An electron in a hydrogen atom is exposed to a perturbation $V = V_0 \cos \varphi$. (+4, -1)
The first order correction to the ground-state energy of the electron is

- a. $-V_0/2$
- b. $4V_0/15a$
- c. $V_0/2$
- d. V_0

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