Entrance Exam

2024



QUESTION PAPER

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1. The toxic environmental pollutant dioxin contains 44.8% carbon, 1.25% hydrogen and 44.0% chlorine. Its molecular mass is 320±10. What is the molecular formula of dioxin?

(A) $C_{10}H_8O_4Cl_4$

(B) $C_{12}H_6O_2Cl_4$

(C) $C_6H_2OCl_2$

(D) $C_{12}H_4O_2Cl_4$

2. Conversion of 2,5-dimethylfuran to 2,5-dimethylpyrrole (see equation) may be accomplished in two steps.

(i) Hydrolytic ring opening of the furan in aqueous acid
(ii) Heating the hydrolysis product with excess ammonium carbonate.

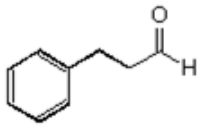
What is the intermediate hydrolysis product formed in first step that is subsequently used in the second step?

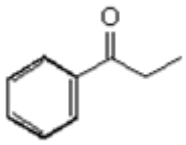


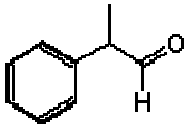
(A) 2,5-hexanedione
(B) 3,4-hexanedione
(C) hexanedial
(D) 2,5-dimethylcyclopentanone

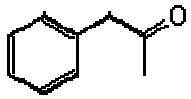
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3. A $C_9H_{10}O$ compound has a strong absorption at 1730 and two smaller but sharp absorption peaks at 2719 and 2818 cm^{-1} in the infrared. ^1H NMR spectrum of the compound exhibited a 3 proton doublet at δ1.00 ppm, a 1 proton doublet δ10.00 ppm along with other multiplets. Which among the following compounds displays these features?

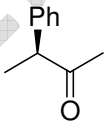
(A) 

(B) 

(C) 

(D) 

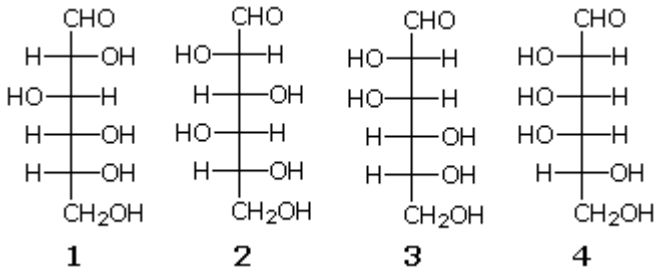
4. In the reaction of (*R*)-3-phenylbutan-2-one with methylmagnesium iodide to give 2-methyl-3-phenylbutan-2-ol, what happens to the configuration of the stereogenic center in it?



(A) Nothing, it remains unchanged
(B) Inversion takes place
(C) Racemization occurs
(D) The product is achiral

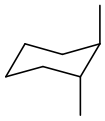
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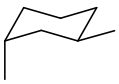
5. Which two of the following aldohexoses give the same osazone derivative?

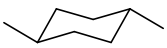


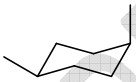
(A) 1 and 4
(B) 1 and 3
(C) 2 and 3
(D) 3 and 4

6. Assuming that their conformation is frozen as given below, which among the following C_8H_{16} isomers should have the lowest heat of combustion?

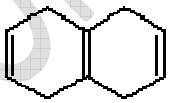
(A) 

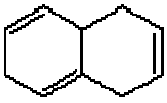
(B) 

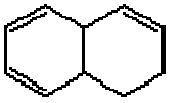
(C) 

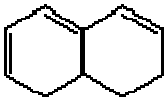
(D) 

7. Which of the following trienes will have the longest wavelength absorption in its UV-Vis spectrum?

(A) 

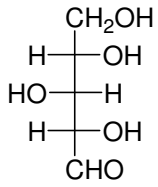
(B) 

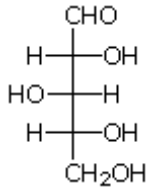
(C) 

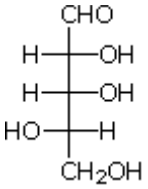
(D) 

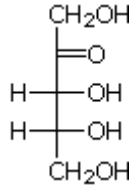
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8. Which of the following is a D-aldopentose?

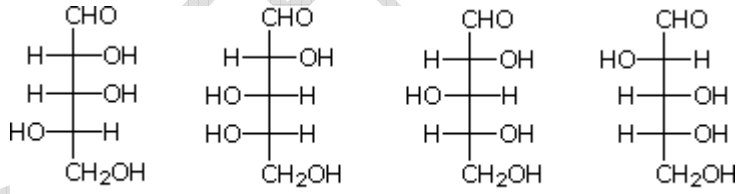
(A) 

(B) 

(C) 

(D) 

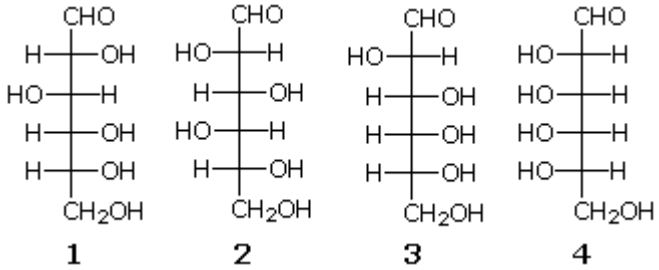
9. Which two of the following compounds are reduced to the same chiral alditol by sodium borohydride?



(A) **1** and **2**
(B) **1**, **2** and **4**
(C) **2** and **4**
(D) **3** and **4**

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10. Which two of the following compounds, if any, are epimers?



(A) **1** and **2**
(B) **3** and **4**
(C) **2** and **3**
(D) None of the above

11. Which among the following reagents is used in color test for amino acids?

(A) ninhydrin
(B) cyanogen bromide
(C) trypsin
(D) chymotrypsin

12. Under identical reaction conditions which among the following compounds will undergo nitration at the fastest rate? (*Hint*: Baker Nathan Effect)



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

13. Which if any of the following compounds will display spin-spin splitting of protons in its ^{1}H NMR spectrum?

(A) $(CH_3)_3COCH_3$
(B) $Br(CH_2)_3Br$
(C) *p*-xylene (1,4-dimethylbenzene)
(D) None of the above

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14. The ^{1}H NMR spectrum of diethyl ether ($CH_3CH_2OCH_2CH_3$) shows

(A) Two peaks, one a triplet, the other a quartet respectively in a 3:2 ratio
(B) Two peaks, one a triplet, the other a quartet respectively in a 2:3 ratio
(C) Four peaks, two 2 proton triplets and two 3 proton quartets
(D) Four peaks, two 3 proton triplets and two 2 proton quartets

15. Neopentyl chloride, $(CH_3)_3CCH_2Cl$ (C_5H_9Cl), reacts with the strong base sodium amide (can pick a C-H proton!) to form a new compound. This compound has a molecular ion at *m/z* = 70 amu corresponding to the molecular formula C_5H_{10}, and displays two singlets at δ 0.20 and 1.05 ppm (intensity ratio = 2**:**3) in its ^{1}H NMR spectrum. What is a plausible structure for this C_5H_{10} compound?

(A) 2-methyl-2-butene
(B) 1,1-dimethylcyclopropane
(C) Methylcyclobutane
(D) Cyclopentane

16. Which of the following reactions **would not** be a useful method for preparing 1-phenylbutan-2-ol?

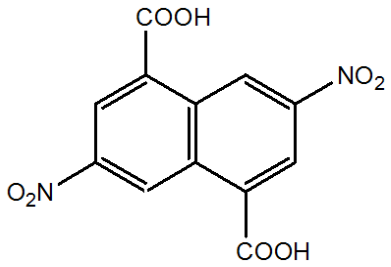
(A) phenylacetaldehyde + ethylmagnesium bromide
(B) butanal + phenylmagnesium bromine
(C) propanal + benzylmagnesium bromine
(D) 1-phenylbutan-2-one + $NaBH_4$

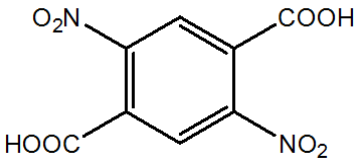
17. What can be the possible number of isomers of tribromobenzene?

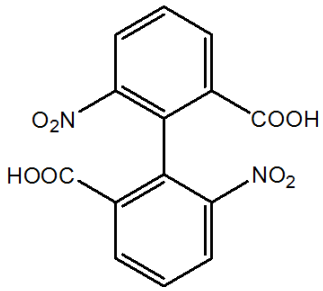
(A) 1
(B) 2
(C) 3
(D) 4

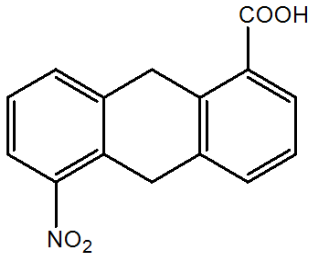
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18. Among the four aromatic carboxylic acids given below, which one can be resolved into its enantiomers by reaction with an enantiomerically pure chiral amine?

(A) 

(B) 

(C) 

(D) 

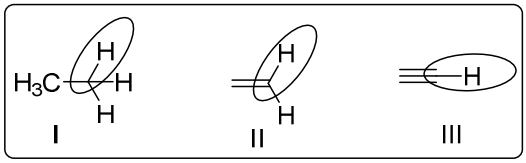
19. How many stereoisomers do you expect for the following structural formula?

Ph-CH(Cl)-CH=CH-CH(Cl)-Ph

(A) 2
(B) 3
(C) 4
(D) 6

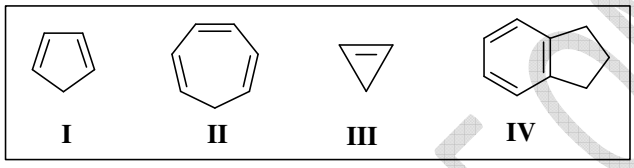
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20. Arrange in order of C-H bond strength (C-H bond circled)



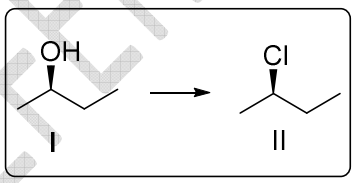
(A) I > II > III
(B) III > II > I
(C) II > I > III
(D) II > III > I

21. Which among these has highest acidity?



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

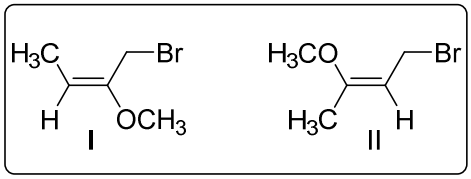
22. The reagent/reagents used to convert I to II is



(A) PCl_5
(B) $SOCl_2$
(C) $SOCl_2$+Pyridine
(D) HCl

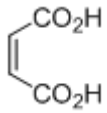
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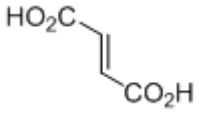
23. Designate E/Z notation for the following:

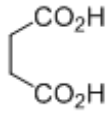


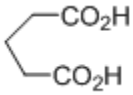
(A) I= E, II=E
(B) I= Z, II=Z
(C) I= E, II=Z
(D) I= Z, II=E

24. Which among the following acids, forms anhydride fastest on heating?

(A) 

(B) 

(C) 

(D) 

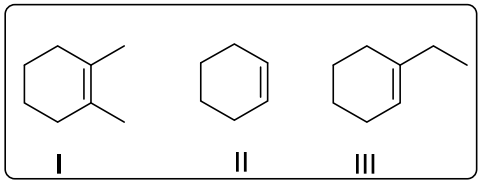
25. Arrange the following carbanions in stability order (note: some of these carbanions may have more than one canonical form)

I. $CH_3COCH_2^-$ II. CH_3^- III. $(CH_3)_3C^-$ IV. $PhCH_2^-$ (Ph = phenyl)

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

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26. Arrange in the order of stability



(A) I < II < III
(B) II < I < III
(C) I < III < II
(D) II < III < I

27. Which of the following is a *meso* compound?

(A) (2*R*,3*R*)-2,3-Dibromobutane
(B) (2*R*,3*S*)-2,3-Dibromopentane
(C) (2*R*,4*R*)-2,4-Dibromopentane
(D) (2*R*,4*S*)-2,4-Dibromopentane

28. Ozonolysis of *cis*-but-2-ene followed by work-up and treatment with H_2O_2 yields

(A) CH_3CHO
(B) CH_3COCH_3
(C) CH_3CO_2H
(D) $CH_3CHO + CH_3CO_2H$

29. Reactive intermediate involved in the conversion of bromobenzene to aniline in the presence of sodamide in liquid ammonia is

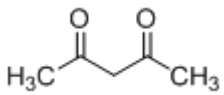
(A) carbanion
(B) free-radical
(C) benzyne
(D) carbocation

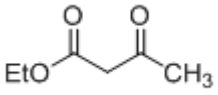
30. Grignard reagents react efficiently with carbon dioxide and various carbonyl compounds including acid halides. Products isolated after workup from the reaction of phenylmagnesium bromide with carbon dioxide and benzoyl chloride are

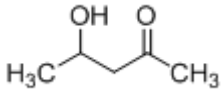
(A) $PhCO_2H$ & Triphenyl carbinol (Ph_3C-OH) respectively
(B) $PhCO_2H$ (from both)
(C) PhCHO (from both)
(D) $PhCO_2H$ & PhCOBr respectively

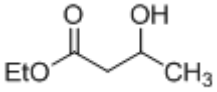
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31. Acetaldehyde on reduction with $NaBH_4$ yields product **M** which on treatment with acetyl chloride yields **N**. Two molecules of **N** underwent condensation in presence of sodium ethoxide and final work-up to yield **O**. The structure of **O** is

(A) 

(B) 

(C) 

(D) 

32. Benzoic acid can be converted to benzoyl chloride and ethyl benzoate in high yields using **X** and **Y** respectively. **X** and **Y** are

(A) **X** = HCl, **Y** = $EtOH/H^+$
(B) **X** = PCl_5, **Y** = $EtOH/H^+$
(C) **X** = HCl, **Y** = $EtOH/OH^-$
(D) **X** = PCl_5, **Y** = Et_2O/OH^-

33. Absorbance of a solution showing 50% transmittance is

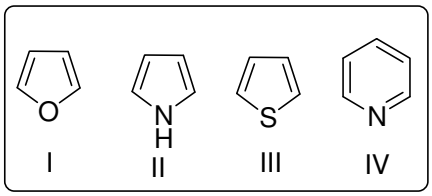
(A) 0.5
(B) 2
(C) log 2
(D) log 0.5

34. *N,N*-Dimethyl-2-aminobutane on successive treatment with excess methyl iodide followed by base yielded 1-butene as the product. Mechanism involved in the final elimination step is

(A) E1
(B) E2C
(C) E1cB
(D) Ei

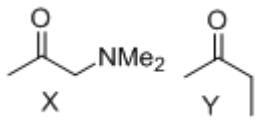
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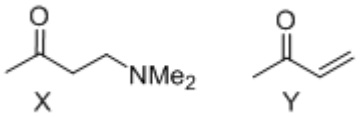
35. Which among the following heteroaromatic compounds is more reactive towards nucleophiles?

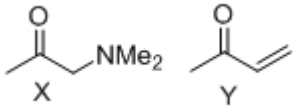


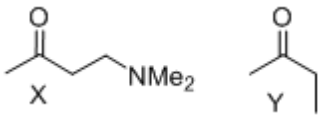
(A) I
(B) III
(C) IV
(D) II

36. Acetone is treated with the Mannich reagent ($HCHO+Me_2NH.HCl$) to produce compound **X**. The latter is then heated to produce **Y**. The structures of **X** and **Y** are

(A) 

(B) 

(C) 

(D) 

37. The common feature of all alkaloids is that

(A) All have aromatic ring residues
(B) All have heterocyclic ring residues
(C) All are polycyclic compounds
(D) All contain N

38. Molecular formula (general) of a sesquiterpene is

(A) $C_{10}H_{16}$
(B) C_5H_8
(C) $C_{15}H_{24}$
(D) $C_{20}H_{32}$

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39. Reaction of a carboxylic acid with one equivalent each of bromine and PBr_3 followed by aqueous workup yields

(A) α-bromoacid
(B) α-bromoester
(C) acyl bromide
(D) alkyl bromide

40. 1,3,5-Trihydroxybenzene is also called

(A) Pyrogallol
(B) Phloroglucinol
(C) Quinol
(D) Resorcinol

41. Which among these is used to catalyze the conversion of propyne to acetone in presence of 40% H_2SO_4?

(A) $MgSO_4$
(B) $CuSO_4$
(C) K_2SO_4
(D) $HgSO_4$

42. Which oxidant is used successfully to convert toluene to benzaldehyde in high yields?

(A) $KMnO_4$
(B) Cu_2O
(C) CrO_2Cl_2
(D) Cr_2O_3

43. Skraup synthesis of quinoline starts with

(A) Glycol
(B) Glycerol
(C) Benzyl alcohol
(D) Amyl alcohol

44. Which is the chief source of morphine?

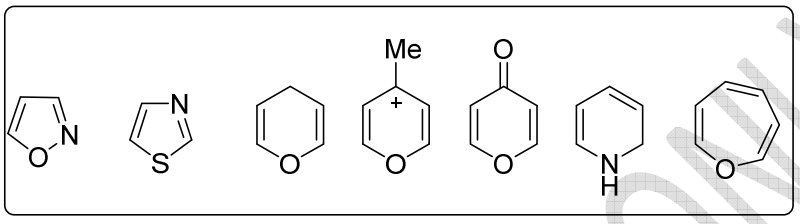
(A) Tobacco
(B) Pepper
(C) Cinchona
(D) Poppy

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45. Acetic acid on treatment with PCl_5 yield **P** which on reaction with sodium azide yields **Q**. The latter on heating yielded **R**. Compounds **P**, **Q**, and **R** are

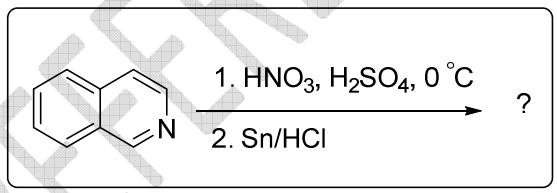
(A) CH_3Cl, CH_3N_3, CH_3NH_2
(B) CH_3COCl, CH_3N_3, CH_3NH_2
(C) CH_3COCl, CH_3CON_3, CH_3NCO
(D) CH_3Cl, CH_2N_2, CH_4

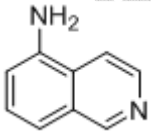
46. Among the following, how many obey Huckel's [4n+2] rule for aromaticity?

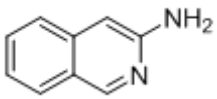


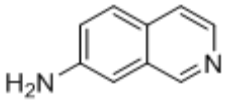
(A) 4
(B) 5
(C) 6
(D) 3

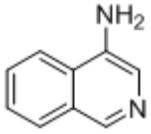
47. Identify the major product formed in the following reaction carried out under kinetically controlled conditions



(A) 

(B) 

(C) 

(D) 

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48. L-DOPA is used for the treatment of

(A) Tuberculosis
(B) Parkinson disease
(C) Diabetes
(D) Cancer

49. Among the following, the natural product which is not an alkaloid is

(A) Reserpine
(B) Piperine
(C) β-Carotene
(D) Papavarine

50. n-π* Transition in acetone will be most blue shifted in which among the following solvents?

(A) Water
(B) Methanol
(C) Acetonitrane
(D) Haxane

51. Among the following molecules which one shows pure rotation spectra:

(A) N_2
(B) CO_2
(C) H_2S
(D) CH_4

52. A particular vibration in a polyatomic molecule is IR active if during vibration, there is a change in

(A) Polarizability
(B) Dipole moment
(C) Frequency
(D) Potential energy

53. Free radicals may be detected by

(A) Mass spectrometry
(B) IR spectroscopy
(C) ESR spectroscopy
(D) UV- Visible spectroscopy

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54. Match items in Column I with the appropriate items in Column II

	Column I - Spectral Technique		**Column II - Selection rule**
(P)	Rotational transition	(I)	$\Delta v = \pm 1$
(Q)	Vibrational Transition	(II)	$\Delta J = \pm 1$
(R)	Electronic Transition in atoms	(III)	$\Delta v = 0$
		(IV)	$\Delta l = \pm 1$
		(V)	$\Delta l = 0$

(A) (P)-(II), (Q)-(I), (R)-(IV)
(B) (P)-(II), (Q)-(III), (R)-(V)
(C) (P)-(III), (Q)-(II), (R)-(I)
(D) (P)-(V), (Q)-(I), (R)-(II)

55. The packing fraction of a simple cubic lattice is close to

(A) 0.94
(B) 0.76
(C) 0.52
(D) 0.45

56. When Frenkel defects are created in an otherwise perfect ionic crystal, the density of the ionic crystal

(A) increases
(B) decreases
(C) remains same
(D) oscillates with the number of defects

57. A compound is formed by two elements M and N. The element N forms ccp lattice and atoms of M occupy $\frac{1}{3}^{rd}$ of tetrahedral voids. What is the formula of the compound?

(A) MN_2
(B) M_2N_3
(C) M_3N_2
(D) M_2N_2

58. A metal crystallizes in fcc structure with a unit cell side of 500 pm. If the density of the crystal is 1.33 g/cc, the molar mass of the metal is close to

(A) 23
(B) 24

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(C) 25
(D) 26

59. A metal crystallizes in fcc lattice. The edge length of the unit cells is 4.04×10^{-8} cm and density is 10.5g cm^{-3}. Calculate the atomic mass of the metal.

(A) 144 g/mol
(B) 125 g/mol
(C) 106.6 g/mol
(D) 213 g/mol

60. Which of the following statements is **not true** about the hexagonal close packing?

(A) The coordination number is 12
(B) It has 74% packing efficiency
(C) Tetrahedral voids of the second layer are covered by the spheres of the third layer
(D) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer

61. The standard cell potential for the reaction $Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$ is +1.10 V. The Gibbs free energy change during the reaction is ($F = 96500$ coulomb mol^{-1})

(A) -21.2 kJ mol^{-1}
(B) +212 kJ mol^{-1}
(C) -212 kJ mol^{-1}
(D) -212 J mol^{-1}

62. An absorbance shift towards a longer wavelength caused by chromophore is called

(A) Hypochromic shift
(B) Hypsochromic shift
(C) Hyperchromic shift
(D) Bathochromic shift

63. The rate of a chemical reaction doubles for every 10°C rise of temperature. If the temperature is raised by 50°C, the rate of the reaction increases by about

(A) 32 times
(B) 64 times
(C) 10 times
(D) 24 times

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64. Choose the **incorrect** property of colloids

(A) Colloidal particles do not settle down when left undisturbed that is colloidal sols are quite stable
(B) A colloidal solution is homogeneous in nature
(C) The size of colloidal particles lies in the range of 10-5 -10-7 cm
(D) Colloidal particles are stabilized by surface charges

65. When O_2 is adsorbed on a metallic surface, electron transfer occurs from the metal to O_2. The true statements regarding the adsorption are

a. O_2 is physisorbed
b. Heat is released
c. Occupancy of $\pi^* 2p$ of O_2 is increased
d. Bond length of O_2 is increased

(A) a, b, c
(B) b, c, d
(C) a, c, d
(D) a, b, d

66. Match the **Catalysts** to the correct **Processes**:

	Catalyst		**Process**
(P)	$TiCl_3$	(i)	Wacker process
(Q)	$PdCl_2$	(ii)	Ziegler-Natta polymerisation
(R)	$CuCl_2$	(iii)	Contact process
(S)	V_2O_5	(iv)	Deacon's process

(A) (P)-(iii), (Q)-(ii), (R)-(iv), (S)-(i)
(B) (P)-(ii), (Q)-(i), (R)-(iv), (S)-(iii)
(C) (P)-(ii), (Q)-(iii), (R)-(iv), (S)-(i)
(D) (P)-(iii), (Q)-(i), (R)-(ii), (S)-(iv)

67. Rate of physisorption increases with

(A) Decrease in temperature
(B) Increase in temperature at low temperatures
(C) Decrease in pressure
(D) Decrease in surface area

68. The process with negative entropy change is

(A) Dissolution of iodine in water
(B) Sublimation of dry ice
(C) Synthesis of ammonia from N_2 and H_2
(D) Dissociation of $CaSO_4(s)$ to $CaO(s)$ and $SO_3(g)$

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69. An emulsion consists of

(A) one liquid and one solid
(B) one liquid and one gas
(C) two liquids
(D) two solids

70. Which of the following statements regarding the second law of thermodynamics is true?

(A) Energy cannot be created or destroyed, only transferred or transformed
(B) The total entropy of an isolated system can decrease over time
(C) Natural processes tend to move toward states of lower entropy
(D) Heat flows spontaneously from a hot body to a cold body

71. The heat given to an ideal gas in isothermal conditions is used to

(A) Increase temperature
(B) Do external work
(C) Increase temperature and do external work
(D) Increase internal energy

72. What is the source temperature of the Carnot engine in K required to get 70% efficiency? Given: sink temperature = 27 °C

(A) 1000 K
(B) 90 K
(C) 270 K
(D) 727 K

73. A gas undergoes a process in which its volume changes from V_1 to V_2 at constant pressure P. During this process, Q amount of heat is added to the gas, and W amount of work is done by the gas. If ΔU represents the change in internal energy of the gas, which of the following equations correctly represents the relationship among Q, W, and ΔU?

(A) $Q=W+P(V_2-V_1)$
(B) $Q=\Delta U+W$
(C) $\Delta U=Q+W$
(D) $Q=W-\Delta U$

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74. A PMR spectrometer operates at 300 MHz. Find the value of magnetic field. Given: $g_N = 5.585$ and $B_N = 5.05 \times 10^{-27}$ JT^{-1}

(A) 7.05 T
(B) 6.38 T
(C) 7.58 T
(D) 5.93 T

75. Which of the following statement is **false** for mass spectroscopy?

(A) Mass spectroscopy is used to identify unknown compounds within a sample, and to elucidate the structure and chemical properties of different molecules
(B) Particle are characterized by their mass to charge ratios (m/z) and relative abundances
(C) This technique basically studies the effect of ionizing energy on molecules
(D) This technique can be used on all state of matter

76. Which spectroscopy is used for determination of heavy metal contamination in food?

(A) Electrophoresis
(B) X-ray Diffraction
(C) ELISA
(D) Inductively coupled plasma spectroscopy

77. Which of the following statements about IR spectroscopy is **true**?

(A) IR spectroscopy measures the absorption of visible light by a compound
(B) IR spectroscopy is commonly used to determine the molecular weight of a compound
(C) In IR spectroscopy, stretching vibrations typically occur at higher wave numbers than bending vibrations
(D) IR spectroscopy can distinguish between cis and trans isomers based on their absorption spectra

78. Choose the correct sequence of process during Atomization in atomic absorption spectroscopy

(A) Desolvation – Nebulization – Dissociation – Volatilization – Ionization
(B) Nebulization – Desolvation – Volatilization – Dissociation – Ionization
(C) Desolvation – Nebulization – Volatilization – Dissociation – Ionization
(D) Nebulization – Volatilization – Desolvation – Dissociation – Ionization

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79. What is the heat of formation of ethane?

(Given that the heat of combustion of ethane (C_2H_6), hydrogen (H_2) and carbon (C) are –1411 kJ/mol, –393 kJ/mol, –286 kJ/mol respectively.)

(A) –240 kJ/mol
(B) 240 kJ/mol
(C) –340 kJ/mol
(D) 440 kJ/mol

80. Which of the following is true for the process of spontaneous adsorption of a gaseous component?

(A) $\Delta G < 0, \Delta S < 0, \Delta H > 0$
(B) $\Delta G < 0, \Delta H < 0, \Delta S > 0$
(C) $\Delta H > 0, \Delta S > 0, \Delta G < 0$
(D) $\Delta H < 0, \Delta G < 0, \Delta S < 0$

81. Which of the following is Langmuir adsorption isotherm?

(NOTE: x = amount of substance adsorbed, m = mass of adsorbent, p = pressure, a and b = constants)

(A) $\frac{m}{x} = \frac{1+bp}{ap}$

(B) $\frac{x}{m} = \frac{ap}{1+bp}$

(C) $\frac{x}{m} = \frac{ap}{1+ap}$

(D) $\frac{m}{x} = \frac{ap}{1+bp}$

82. The isotope ^{90}Sr emits radiation by a first order process and has a half-life of 23 years. When ingested by humans, it becomes permanently incorporated in bone tissue. If 1 μg is administered to a person, how much of this isotope remains in the body after 34 years?

(A) 0.86 μg
(B) 0.36 μg
(C) 0.61 μg
(D) 0.55 μg

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83. For the reaction A + B → products, it is observed that

(i) On doubling the concentration of B only, the rate of reaction is also doubled.
(ii) On doubling the initial concentration of both A and B, there is change by a factor of 8 in the rate of reaction.

The rate of reaction is given by

(A) rate = k $[A]^2$ [B]
(B) rate = k [A] $[B]^2$
(C) rate = k $[A]^2$ $[B]^2$
(D) rate = k [A] [B]

84. Which of the following plots yields a straight line graph for a second order reaction?

$2A \rightarrow B$

$[A]_0$ = initial concentration of A; $[A]_t$ = concentration of A at time = t

(A) Half-life vs.$1/[A]_0$
(B) Half-life vs. $[A]_0$
(C) Half-life vs. $\ln[A]_0$
(D) Half-life vs. $[A]_t$

85. The rise of liquid in a capillary does **NOT** depend upon

(A) Angle of contact
(B) Radius of the capillary
(C) Atmospheric pressure
(D) Density of the liquid

86. Calculate the ionic strength in a solution that contains 0.0100 mol KCl, 0.0050 mol $MgCl_2$, 0.0020 mol $MgSO_4$ and 100 g H_2O.

(A) 0.68
(B) 0.17
(C) 0.33
(D) 0.19

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87. Calculate E_{cell} for the given cell at 25°C and 1 bar given that activity coefficient of $CuSO_4$ is 0.043:

$Cu|CuSO_4$ (1.0 mol/kg)$|Hg_2SO_4(c)|Hg|Pt$

(NOTE: Standard reduction potential for the $Cu|CuSO_4$ electrode is 0.339 V and for the $Hg|Hg_2SO_4(c)$ electrode is 0.615 V at 298 K.)

(A) 0.122 V
(B) 0.243 V
(C) 0.542 V
(D) 0.316 V

88. For a given amount of an ideal gas the volume was increased by four times and the temperature was increased by two times. What will be the change in pressure of the gas?

(A) Increases 2 times
(B) Increases 4 times
(C) Remains same
(D) Reduces to half

89. The area under the curve $\int TdS$ is equal to

(A) Change in entropy
(B) Work done in reversible conditions
(C) Total heat transferred reversibly
(D) Change in internal energy

90. Of the following, which will effectively lower the activation energy?

(A) Increasing concentrations of reactants
(B) Adding a catalyst for the reaction
(C) Raising the temperature of the reaction
(D) Removing products as reaction proceeds

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91. The reaction A + B → P is endothermic and has an activation energy of 75 kJ/mol. Which of the following statements are correct?

I. The reverse reaction has an activation energy equal to 75 kJ/mol.
II. The reverse reaction has an activation energy greater than 75 kJ/mol.
III. The reverse reaction has an activation energy less than 75 kJ/mol.
IV. The change in internal energy is greater than zero.
V. The change in internal energy is less than zero.

(A) I and IV
(B) II and V
(C) III and V
(D) III and IV

92. Which of the following is the correct set of quantum numbers for outermost electron of potassium (Z = 19)?

(A) $n = 4, l = 3, m = 2, s = -½$
(B) $n = 4, l = 2, m = 0, s = -½$
(C) $n = 4, l = 1, m = 0, s = ½$
(D) $n = 4, l = 0, m = 0, s = -½$

93. If the electronic configuration of nitrogen (Z = 7) is written as ($1s^2$, $2s^2$, $2p_x^2$, $2p_y^1$), which of the following rules would be violated?

(A) Pauli exclusion principle
(B) Hund's rule of maximum multiplicity
(C) Aufbau's principle
(D) Bohr's atomic rule

94. The relation $\Delta x.\Delta p = \frac{h}{4\pi}$ represents

(Note: symbols 'x' and 'p' carry their conventional meaning in quantum mechanics)

(A) Heisenberg's uncertainty principle
(B) de Broglie equation
(C) Pauli exclusion principle
(D) Schodinger wave equation

95. In dsp^2 hybridisation, what is the general geometry of the newly formed molecular orbitals expected to be?

(A) Tetrahedral
(B) Square planar
(C) Trigonal pyramidal
(D) Trigonal bipyramidal

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96. The solubility of a salt is 's' and its solubility product is '$4s^3$'. What is the ratio of cations and anions in the salt?

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

97. Let λ be the equivalent conductance of an electrolyte at a given concentration and $\lambda\infty$ be the equivalent conductance at infinite dilution. What would be the correct expression for degree of dissociation (α) of the electrolyte?

(A) $\alpha = \lambda\infty - \lambda$
(B) $\alpha = \lambda\infty / \lambda$
(C) $\alpha = \lambda - \lambda\infty$
(D) $\alpha = \lambda / \lambda\infty$

98. The equilibrium constant for the reaction $3C_2H_2 \rightleftharpoons C_6H_6$ at 298 K is 4. If the equilibrium concentration of C_2H_2 is 0.5 mol/L, what would be the concentration of C_6H_6 at that point?

(A) 1.2 M
(B) 0.1 M
(C) 2.3 M
(D) 0.5 M

99. The function $\Phi = e^{ax}$ is an eigenfunction of the operator $\left(\frac{d^2}{dx^2}\right)$. What would be the resulting eigenvalue?

(A) $2a$
(B) a^2
(C) a
(D) $2a^2$

100. The Daniel cell is

(A) $Zn_{(s)} \mid Zn^{2+}_{(aq)} \parallel Cu^{2+}_{(aq)} \mid Cu_{(s)}$
(B) $Zn_{(s)} \mid Zn^{2+}_{(aq)} \parallel Ag^{2+}_{(aq)} \mid Ag_{(s)}$
(C) $Fe_{(s)} \mid Fe^{2}_{+(aq)} \parallel Cu^{2+}_{(aq)} \mid Cu_{(s)}$
(D) $H_{2(s)} \mid H_2SO_{4(aq)} \parallel Cu^{2+}_{(aq)} \mid Cu_{(s)}$

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101. The bond orders in N_2 and $[N_2]^-$ are

(A) 3 and 2.5
(B) 3 and 3
(C) 2.5 and 3
(D) 2.5 and 2.5

102. Identify the geometry of the following species

I = :$N(SiH_3)_3$ II = :$N(CH_3)_3$ III = •CF_3 IV = •CH_3

(A) I & II pyramidal, III & IV planar
(B) I & III pyramidal, II & IV planar
(C) I, II & III pyramidal, IV is planar
(D) I & IV planar, II & III pyramidal

103. The number of metal-metal bonds present in $Co_4(CO)_{12}$ is

(A) 4
(B) 5
(C) 6
(D) 7

104. Among $Si(CH_3)_4$, NCl_3, trans-$\left[SnCl_4(py)_2\right]$ (py = pyridine), $P(O)Cl_3$, those with zero dipole moment are

(A) $Si(CH_3)_4$ & NCl_3
(B) $POCl_3$ & trans-$[SnCl_4(py)_2]$
(C) $Si(CH_3)_4$ & trans-$[SnCl_4(py)_2]$
(D) $POCl_3$ & $Si(CH_3)_4$

105. The half-life of the first excited state of ^{57}Fe is 1.5×10^{-7} s. The line width of the resonance is

(A) $4.85\,J$
(B) $4.86\times10^{-28}\,J$
(C) $4.55\,J$
(D) $4.58\times10^{-20}\,J$

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106. The correct order of second ionization energy (IE_2) values of C, N, O and F is

(A) O > F > N > C
(B) F > O > N > C
(C) F > O > C > N
(D) N > C > F > O

107. How many signals will you observe in the ESR spectrum of ^2H-atom?

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

108. Which of the following pair is not iso-structural?

(A) XeO_4 & $S_2O_3^{2-}$
(B) $\bullet CH_3$ (radical) & $\bullet CF_3$ (radical)
(C) $SOCl_2$ & NH_3
(D) ICl_4^- & XeF_4

109. Unit less property among the following is

(A) Electron potential
(B) Electron affinity
(C) Ionization enthalpy
(D) Electronegativity

110. When NaCl crystal is heated in Na vapour, it develops a yellow colour, owing to trapping of an electron in an anion vacancy. The colour centre is called

(A) M - centre
(B) R- centre
(C) F_A- centre
(D) F- centre

111. The increasing order of Brönsted acidity of boron hydrides is

(A) $B_5H_9 < B_4H_{10} < B_{10}H_{14}$
(B) $B_4H_{10} < B_{10}H_{14} < B_5H_9$
(C) $B_4H_{10} < B_5H_9 < B_{10}H_{14}$
(D) $B_{10}H_{14} < B_5H_9 < B_4H_{10}$

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112. An insulator NiO when heated in air to 1000 °C produce a black colored defect NiO which behaves as a semiconductor. The semiconductor is

(A) Metal excess semiconductor
(B) Controlled valency semiconductor
(C) p-type
(D) n-type

113. The structure of O_3 and N_3^- are

(A) Linear and bent respectively
(B) Both linear
(C) Both bent
(D) Bent and linear respectively

114. Which of the following is the correct meaning of an improper rotational axis of symmetry?

(A) Rotation followed by reflection
(B) Rotation followed by translation
(C) Rotation by 180^o
(D) Reflection followed by translation

115. Which of the following is the ground state spectroscopic term symbol for free V^{3+} ion?

(A) ^3F
(B) ^3P
(C) ^4F
(D) ^4P

116. In Mn_3O_4, the number of manganese ions in tetrahedral and octahedral sites are respectively

(A) One Mn^{3+} and two Mn^{2+}
(B) One Mn^{2+} and two Mn^{3+}
(C) Two Mn^{3+} and one Mn^{2+}
(D) Two Mn^{2+} and one Mn^{3+}

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117. Which of the following is responsible for higher μ_{eff} value of $[Co(H_2O)_6]^{2+}$ than that of $[CoCl_4]^{2-}$?

(A) spin-orbit coupling in $[Co(H_2O)_6]^{2+}$
(B) spin-orbit coupling in $[CoCl_4]^{2-}$
(C) orbital contribution in $[CoCl_4]^{2-}$
(D) orbital contribution in $[Co(H_2O)_6]^{2+}$

118. A Cr^{3+} metal complex has strong transitions at λ_{max} at 431 nm, 781 nm, and 1,250 nm in an octahedral field. What will be the Δ_{oct} for this complex?

(A) 23, 200 cm^{-1}
(B) 12,805 cm^{-1}
(C) 8,000 cm^{-1}
(D) 4, 805 cm^{-1}

119. What kind of indicator is Ferroin?

(A) acid-base indicator
(B) complexometric indicator
(C) pH indicator
(D) redox indicator

120. A transition metal forms two octahedral complexes in the same oxidation state. One of them is having a magnetic moment 4.9 B.M., while that of another is 0.0 B.M. The metal ion that fit this description is

(A) Cr(II)
(B) Mn(II)
(C) Fe(II)
(D) Ni(II)

121. The complex which follows the 18-electron rule is

(A) $\left[(\eta^5\text{-}C_5H_5)Fe(CO)_2\right]$
(B) $\left[(\eta^5\text{-}C_5H_5)Mo(CO)_3\right]$
(C) $\left[(\eta^5\text{-}C_5H_5)_2Co\right]$
(D) $\left[(\eta^5\text{-}C_5H_5)Re(\eta^6\text{-}C_6H_6)\right]$

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122. The orbital hybridization involved in CrO_4^{2-} is

(A) sp^3
(B) sd^3
(C) spd^2
(D) sp^2d

123. The point group of ClF_3 is

(A) C_{2v}
(B) C_s
(C) D_{3h}
(D) C_{3v}

124. The correct order of electron transfer rate in the reaction is

$[Co(NH_3)_5X]^{2+} + [Cr(OH_2)_6]^{2+} \rightarrow [Co(OH_2)_6]^{3+} + [Cr(OH_2)_5X]^{2+} + 5NH_3$

$X = F^-, Cl^-, Br^-$ and I^-

(A) $I^- < F^- < Cl^- < Br^-$
(B) $F^- > Cl^- > Br^- > I^-$
(C) $F^- < Cl^- > Br^- < I^-$
(D) $F^- < Cl^- < Br^- < I^-$

125. Which of the following doesn't contribute to crystal field splitting parameter 10Dq?

(A) Nuclear charge
(B) Spin-orbit coupling
(C) Electron and neutron interaction
(D) Electron and nucleus distance

126. Which of the following is considered as cellular storehouse of iron?

(A) Ceruloplasmin
(B) Transferrin
(C) Ferroportin
(D) Ferritin

127. Kroll process is adopted for the extraction of

(A) Sc
(B) Zr
(C) V
(D) Hf

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128. Which of the following is meant for, the orbitals on the metal ion are smeared out over a larger region of space whenever the ligands bind to a metal ion?

(A) j-j coupling effect
(B) nephelauxetic effect
(C) lanthanide contraction effect
(D) LS coupling effect

129. Which of the following is **NOT** a reducing agent?

(A) $NaBH_4$
(B) $LiAlH_4$
(C) NH_2NH_2
(D) $Na_2S_2O_8$

130. Which of the following are the products formed when XeF_4 reacts with water

(A) $XeOF_2 + 2HF_2$
(B) $XeO_3 + Xe + HF + O_2$
(C) $XeOF_4 + XeF_2 + HF$
(D) $XeO_3 + HF$

131. The structure of $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ complexes are

(A) both square planar
(B) square planar and tetrahedral respectively
(C) tetrahedral and square planar respectively
(D) both tetrahedral

132. The correct electronic configuration and magnetic moment of Gd^{3+} is

(A) $[Xe]4f^7$ and 7.9 B.M.
(B) $[Xe]5f^7$ and 7.9 B.M.
(C) $[Xe]4f^6$ and 8.9 B.M.
(D) $[Xe]4f^9$ and 11.9 B.M.

133. The spin-only magnetic moment (in B.M.) value of $[Fe(CN)_6]^{3-}$ ion is

(A) 5.916
(B) 1.73
(C) 0
(D) 1.414

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134. Predict the bond order variation in the following
$O_2, O_2^+, O_2^-, O_2^{2-}$

(A) $O_2^+ > O_2 > O_2^- > O_2^{2-}$
(B) $O_2^{2-} > O_2^- > O_2 > O_2^+$
(C) $O_2^{2-} > O_2 > O_2^- > O_2^+$
(D) $O_2^{2-} > O_2^- > O_2^+ > O_2$

135. The correct order of electron gain enthalpies of P, S, Cl and F is

(A) F > Cl > S > P
(B) Cl > F > P > S
(C) F > Cl > P > S
(D) Cl > F > S > P

136. Three centre two electron bond is present in

(A) BF_3
(B) B_2H_6
(C) H_3BO_3
(D) $AlCl_3$

137. Which among the following doesn't obey 18-electron rule?

(A) $V(CO)_6$
(B) $Mn_2(CO)_{10}$
(C) $Fe(CO)_5$
(D) $Ni(CO)_4$

138. Among the oxides of nitrogen, N_2O_3, N_2O_4, N_2O_5 the compound(s) having N–N bond(s) is/are

(A) N_2O_4 and N_2O_5
(B) N_2O_3 and N_2O_5
(C) N_2O_4 and N_2O_3
(D) N_2O_5 only

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139. Which of the following is not considered as an organometallic compound?

(A) Ferrocene
(B) Cis-platin
(C) Ziese's salt
(D) Grignard reagent

140. A stable oxidation state of +4 is shown by

(A) La
(B) Yb
(C) Sm
(D) Ce

141. Which of the following does not exist?

(A) $XeOF_4$
(B) XeF_4
(C) ArF_3
(D) $XePtF_6$

142. The indicator used in the complexometric titration of $ZnSO_4$ and EDTA is

(A) Diphenylamine
(B) N-Phenylanthranilic acid
(C) Thymol blue
(D) Eriochrome black –T

143. The crystal field stabilization energy of $[Fe(CN)_6]^{2-}$ is (Δ_o is the splitting energy and P is the pairing energy.

(A) $2.4\ \Delta_o - 3P$
(B) $1.2\ \Delta_o - 3P$
(C) $2.4\ \Delta_o - P$
(D) 0

144. Dimethylglyoxime (DMG) is used in spot test for confirming which cation?

(A) Ni^{2+}
(B) Zn^{2+}
(C) K^{+}
(D) Pt^{4+}

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145. Which of the following complex ions is diamagnetic in nature?

(A) $[CoF_3]^{3-}$
(B) $[Ni(CN)_4]^{2-}$
(C) $[NiCl_4]^{2-}$
(D) $[Fe(CN)_4]^{-}$

146. The complexes, $[Co(NH_3)_3]$ $[Cr(CN)_6]$ and $[Cr(NH_3)_3]$ $[Co(CN)_6]$ are the examples of

(A) Geometrical isomerism
(B) Linkage isomerism
(C) Ionisation isomerism
(D) Coordination isomerism

147. The magnetic moment of a transition metal ion is $\sqrt{15}$ BM. Therefore the number of unpaired electrons present in it is

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

148. Name the type of structure of silicate in which only one oxygen atom of $[SiO_4]^{4-}$ is shared.

(A) Three dimensional silicate
(B) Ambhibole
(C) Sheet silicate
(D) Pyrosilicate

149. In which of the following set is the bond order 3 for all species?

(A) NO, N_2 and CO
(B) NO, N_2, CN^-
(C) NO^+, N_2, CO
(D) NO^+, N_2, CN^-

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150. In the reaction $2X + B_2H_6 \rightarrow [BH_2(X)_2]^+[BH_4]^-$, the amine X is

(A) $(CH_3)_3N$
(B) $(CH_3)_2NH$
(C) CH_3NH_2
(D) NH_3

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ANSWER KEY									
Subject Name: 604 CHEMISTRY									
SI No.	**Key**	**SI No.**	**Key**	**SI No.**	**Key**	**SI No.**	**Key**	**SI No.**	**Key**
1	D	31	B	61	C	91	D	121	D
2	A	32	B	62	D	92	D	122	B
3	C	33	C	63	A	93	B	123	A
4	A	34	C	64	B	94	A	124	D
5	B	35	C	65	B	95	B	125	C
6	C	36	B	66	B	96	A	126	D
7	D	37	D	67	A	97	D	127	B
8	B	38	C	68	C	98	D	128	B
9	A	39	A	69	C	99	B	129	D
10	C	40	B	70	D	100	A	130	B
11	A	41	D	71	B	101	A	131	C
12	A	42	C	72	A	102	D	132	A
13	B	43	B	73	B	103	C	133	B
14	A	44	D	74	A	104	C	134	A
15	B	45	C	75	D	105	B	135	D
16	B	46	A	76	D	106	A	136	B
17	C	47	A	77	C	107	C	137	A
18	C	48	B	78	C	108	B	138	C
19	D	49	C	79	C	109	D	139	B
20	B	50	A	80	D	110	D	140	D
21	A	51	C	81	C	111	C	141	C
22	B	52	B	82	B	112	C	142	D
23	C	53	C	83	A	113	D	143	A
24	A	54	A	84	A	114	A	144	A
25	D	55	C	85	C	115	A	145	B
26	D	56	C	86	C	116	B	146	D
27	D	57	B	87	D	117	D	147	C
28	C	58	C	88	D	118	C	148	D
29	C	59	C	89	C	119	D	149	C
30	A	60	D	90	B	120	C	150	D

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