DEC-2013 [BOOKLET-C]

CHEMICAL SCIENCES

Part-A

1. Three fishermen caught fishes and went to sleep. One of them woke up, took away one fish and 1/3rd of the remainder as his share, without others knowledge. Later, the three of them divided the remainder equally. How many fishes were caught?
(a) 58 (b) 19 (c) 76 (d) 88

2. What is the arithmetic mean of $\frac{1}{1\times 2}, \frac{1}{2\times 3}, \frac{1}{3\times 4}, \frac{1}{4\times 5}, \ldots\ldots, \frac{1}{100\times 101}$?
(a) 0.01 (b) $\frac{1}{101}$ (c) 0.00111... (d) $\frac{\frac{1}{49\times 50}+\frac{1}{50\times 51}}{2}$

3. Every time a ball falls to ground, it bounces back to half the height it fell from. A ball is dropped from a height of 1024 cm. The maximum height from the ground to which it can rise after the tenth bounce is
(a) 102.4 cm (b) 1.24 cm (c) 1 cm (d) 2 cm

4. A circle of radius 7 units lying in the fourth quadrant touches the x-axis at (10, 0). The centre of the circle has coordinates.
(a) (7, 7) (b) (–10, 7) (c) (10, –7) (d) (7, –7)

5. A cylinder of radius 1 cm and height 1 cm is broken into three pieces. Which of the following MUST be true?
(a) At least one pieces has volume equal to 1 cm^3.
(b) At least two pieces have equal volumes.
(c) At least one piece has volume less than 1 cm^3.
(d) At least one piece has volume greater than 1 cm^3.

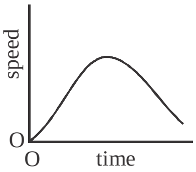
6. One of the four A, B, C and D committed a crime. A said, “I did it,” B said, “I didn’t.” C said, “B did it.” D said, “A did it.” Who is lying?
(a) A (b) B (c) C (d) D

7. Consider the sequence of ordered sets of natural numbers:
{1}, {2, 3}, {4, 5, 6}, ...
What is the last numbers in the 10th set?
(a) 10 (b) 19 (c) 55 (d) 67

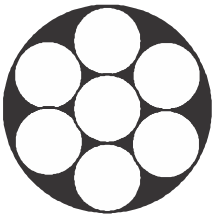
8. If a + b + c + d + e = 10 (all positive numbers), then the maximum value of a×b×c×d×e is
(a) 12 (b) 32 (c) 48 (d) 72

9. A farmer gives 7 full, 7 half-full and 7 empty bottles of honey to his three sons and asks them to share these among themselves such that each of them gets the same amount of honey and the same number of bottles. In how many ways can this be done? (bottles cannot be distinguhished otherwise, they are sealed and cannot be broken)
(a) 0 (b) 1 (c) 2 (d) 3

10. A car is moving aloing a straight track. Its speed is changing with time as shown above.
Which of the following statement is correct?
(a) The speed is never zero
(b) The acceleration is zero once on the path
(c) The distance covered initially increases and then decerases.
(d) The car comes back to its initial position once.

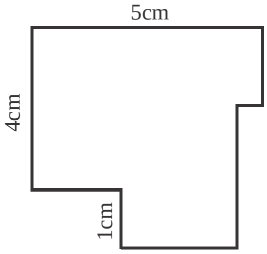


11. A circle circumscribes identical, close packed circles of unit diamter as shown in the figure above. What is the total area of the shaded portion?



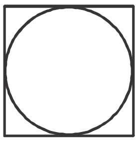
(a) 2 (b) 2π (c) $1/2$ (d) $\pi/2$

12. What is the perimeter of the given figure as above, where adjacent sides are at right angles to each other?



(a) 20 cm (b) 18 cm (c) 21 cm (d) cannot be determined.

13. What does the diagram above establish?



Note: The diagram is a circle inside a square.

(a) $\pi > 3$ (b) $\pi \geq 2\sqrt{2}$ (c) $\pi < 4$ (d) π is closer to 3 than to 4.

14. What is the next number in the following sequence?
39, 42, 46, 50, ...
(a) 52 (b) 53 (c) 54 (d) 55

15. $(25 \div 5 + 3 - 2 \times 4) + (16 \times 4 - 3) =$
(a) 61 (b) 22 (c) 41/24 (d) 16

16. A student buys a book from an online shop at 20% discount. His friend buys another copy of the same book in a book fair for Rs. 192 paying 20% less than his friend. What is the full price of the book?
(a) Rs. 275 (b) Rs. 300 (c) Rs. 320 (d) Rs. 392

17. How many nine-digit positive integers are there, the sum of squares of whose digits are 2?
(a) 8 (b) 9 (c) 10 (d) 11

18. 366 players participate in a knock-out tournament. In each round all competing players pair together and play a match, the winner of each match moving to the next round. If at the end of a round there is an odd number of winners, the unpaired one moves to the next round without playing a match. What is the total number of matches played?
(a) 366 (b) 282 (c) 365 (d) 418

19. There are 2 hills, A and B, in a region. If hill A is located N30°E of hill B, what will be the direction of hill B when observed from hill A? (N 30°E means 30° from month towards east).
(a) S 30°W (b) S 60°W (c) S 30°E (d) S 60°E

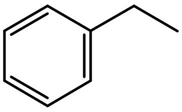
20. For real numbers x and y, $x^2 + (y-4)^2 = 0$. Then the vlaue of x + y is
(a) 0 (b) 2 (c) $\sqrt{2}$ (d) 4

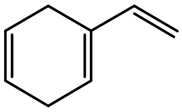
Part-B

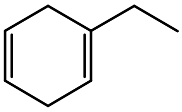
21. L-DOPA is used for the treatment of
(a) Tuberculosis (b) Parkinson's disease
(c) Diabetes (d) Cancer

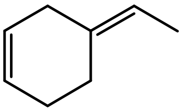
22. In the IR spectrum of p-nitrophenyl acetate, the carbonyl absorption band appears at
(a) 1660 cm^{-1} (b) 1700 cm^{-1} (c) 1730 cm^{-1} (d) 1770 cm^{-1}

23. The major product formed in the reaction of styrene with an excess of lithium in liquid ammonia and t-butyl alcohol is:

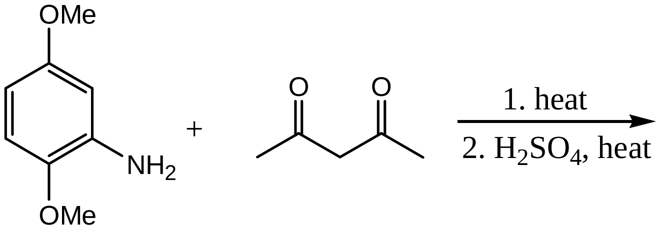
(a) 

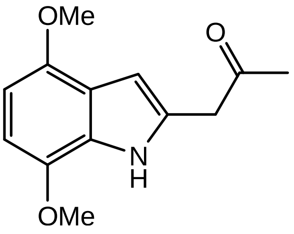
(b) 

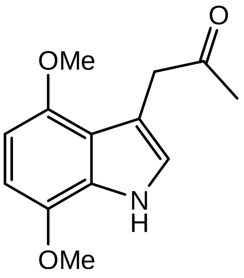
(c) 

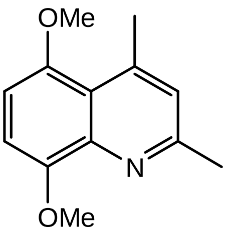
(d) 

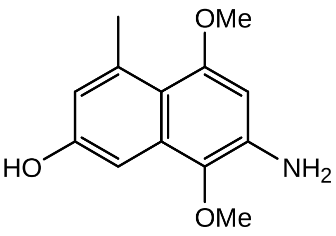
24. The major product formed in the following reaction is



(a) 

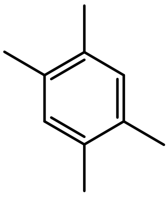
(b) 

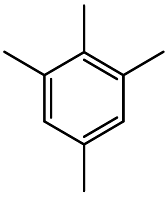
(c) 

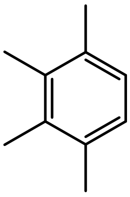
(d) 

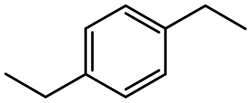
25. For estrone, among the statements A–C, the correct ones are
A. It is a steroidal hormone
B. It has two hydroxyl groups
C. It has one ketone and one hydroxyl groups
(a) A, B and C (b) A and B (c) A and C (d) B and C

26. An organic compound having the molecular formula $C_{10}H_{14}$ exhibited two singlets in the ^1H NMR spectrum, and three signals in the ^{13}C NMR spectrum. The compound is

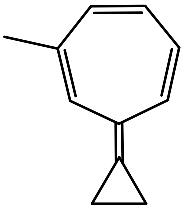
(a) 

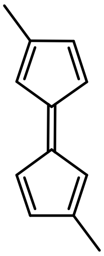
(b) 

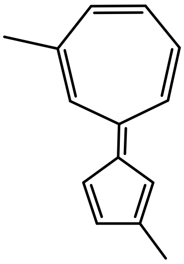
(c) 

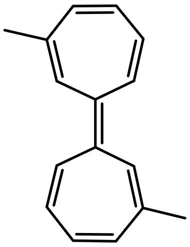
(d) 

27. Amongst the following, the compound which has the lowest energy barrier for the cis-trans isomerisation is:

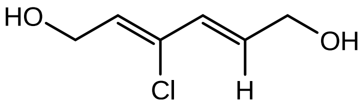
(a) 

(b) 

(c) 

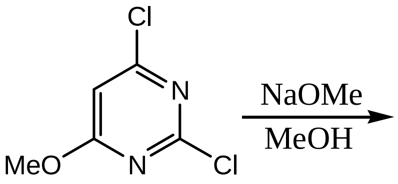
(d) 

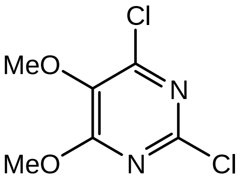
28. The IUPAC name of the compound given below is

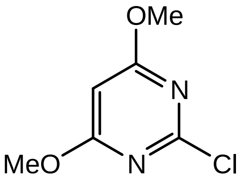


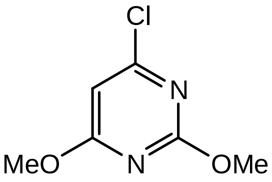
(a) (2E, 4E)-3-chlorohexa-2, 4-diene-1, 6-diol
(b) (2Z, 4E)-3-chlorhexa-2, 4-diene-1, 6-diol
(c) (2Z, 4Z)-4-chlorohexa-2, 4-diene-1, 6-diol
(d) (2E, 4Z)-4-chlorohexa-2, 4-diene-1, 6-diol

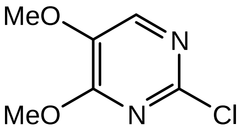
29. The major product formed in the following reaction is



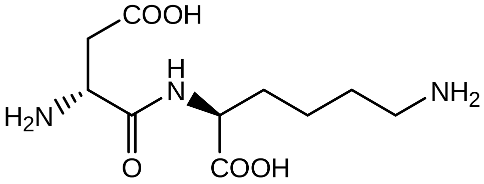
(a) 

(b) 

(c) 

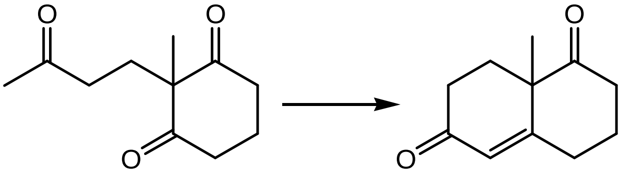
(d) 

30. The constituent amino acids present in the following dipeptide, respectively, are



(a) (R)-aspartic acid and (S)-lysine
(b) (S)-aspartic acid and (R)-lysine
(c) (R)-glutamic acid and (S)-arginine
(d) (S)-glutamic and (S)-arginine

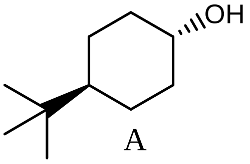
31. A suitable organocatalyst for enantioselective synthesis of Wieland-Miescher ketone (A) is



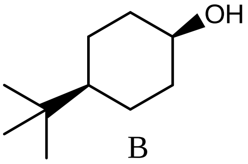
A (optically active)

(a) (–)-proline (b) (+)-menthone (c) guanidine (d) (+)–BINOL

32. For acylation with acetic anhydride/triethylamine, and oxidation with chromium trioxide of the trans-and cis-alcohols A and B, the correct statement is



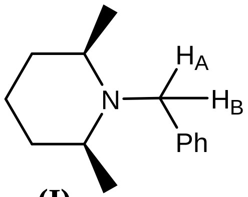
A



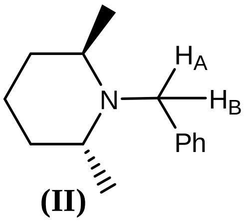
B

(a) A undergoes acylation as well as oxidation faster than B
(b) B undergoes acylation as well as oxidation faster than A
(c) A undergoes acylation faster than B, whereas B undergoes oxidation faster than A
(d) B undergoes acylation faster than A, whereas A undergoes oxidation faster than B.

33. The two benzylic hydrogens H_A and H_B in the compounds I and II, are



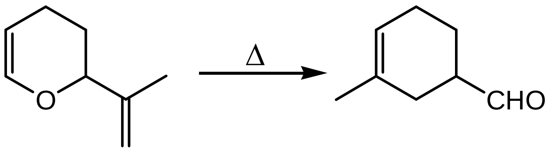
(I)



(II)

(a) diastereotopic in I and enantiotopic in II (b) diastereotopic in II and enantiotopic in I
(c) diastereotopic in both I and II (d) enantiotopic in both I and II

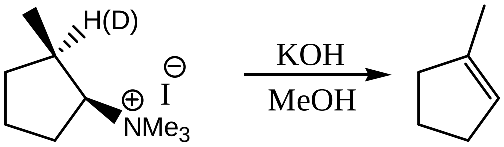
34. The following reaction proceeds through a



(a) 1, 3-sigmatropic rearrangement (b) 2, 3-sigmatropic rearrangement
(c) 3, 3-sigmatropic rearrangement (d) 3, 5-sigmatropic rearrangement

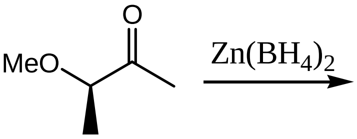
35. The number of nodes present in the highest occupied molecular orbital of 1, 3, 5-hexatriene in its ground state is
(a) one (b) two (c) three (d) four

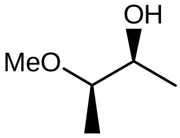
36. Deuterium kinetic isotope effect for the following reaction was found to be 4.0. Based on this information, mechanism of the reaction is

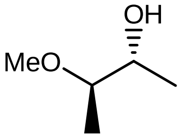


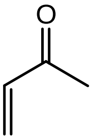
(a) E_1 (b) E_2 (c) E_{1CB} (d) free radical

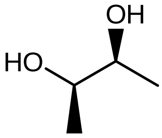
37. The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

38. The bond order of the metal-metal bond in the dimeric complex $\left[Re_2\,Cl_4\left(PMe_2Ph\right)_4\right]^+$ is

(a) 4.0 (b) 3.5 (c) 3.0 (d) 2.5

39. The reaction of $FeCl_3.6H_2O$ with $SOCl_2$ yields.

(a) $FeCl_2$(s), SO_2(g) and HCl (g) (b) $FeCl_3$(s), SO_2(g) and HCl(*l*)

(c) $FeCl_2$(s), SO_3(s) and HCl (g) (d) $FeCl_3$(s), SO_2(g) and HCl(g)

40. Patients suffering from Wilson's disease have

(a) Low level of Cu-Zn superoxide dismutase

(b) High level of Cu-Zn superoxide dismutase

(c) Low level of copper-storage protein, ceruloplasmin

(d) High level of copper-storage protein, ceruloplasmin

41. High dose of dietary supplement $ZnSO_4$ for the cure of Zn deficiency

(a) reduces myoglobin (b) increases iron level in blood

(c) increases copper level in brain (d) reduces copper, iron and calcium levels in body

42. Which of the following in NOT suitable as catalyst for hydroformylation?

(a) $HCo(CO)_4$ (b) $HCo(CO)_3PBu_3$ (c) $HRh(CO)(PPh_3)_3$ (d) $H_2Rh(PPh_3)_2Cl$

43. Commonly used scintillator for measuring radiation is

(a) NaI(AI) (b) NaI(TI) (c) CsI (TI) (d) CsI(AI)

44. A sample of aluminium ore (having no other metal) is dissolved in 50 mL of 0.05 M EDTA. For the titration of unreacted EDTA, 4 mL of 0.05 M $MgSO_4$ is required. The percentage of AI in the sample is:

(a) 27 (b) 31 (c) 35 (d) 40

45. In a cluster, $H_3CoRu_3(CO)_{12}$, total number of electrons considered to be involved in its formation is

(a) 57 (b) 60 (c) 63 (d) 72

46. Among the following, the correct acid strength trend is represented by

(a) $\left[Al\left(H_2O\right)_6\right]^{3+} < \left[Fe\left(H_2O\right)_6\right]^{3+} < \left[Fe\left(H_2O\right)_6\right]^{2+}$

(b) $\left[Fe\left(H_2O\right)_6\right]^{3+} < \left[Al\left(H_2O\right)_6\right]^{3+} < \left[Fe\left(H_2O\right)_6\right]^{2+}$

(c) $\left[Fe\left(H_2O\right)_6\right]^{2+} < \left[Fe\left(H_2O\right)_6\right]^{3+} < \left[Al\left(H_2O\right)\right]^{3+}$

(d) $\left[Fe\left(H_2O\right)_6\right]^{2+} < \left[Al\left(H_2O\right)_6\right]^{3+} < \left[Fe\left(H_2O\right)_6\right]^{3+}$

47. Among the molten alkali metals, the example of an immiscible pair (in all proportions) is

(a) K and Na (b) K and Cs (c) Li and Cs (d) Rb and Cs

48. Among the following, an example of a hypervalent species is

(a) $BF_3.OEt_2$ (b) SF_4 (c) $[PF_6]^-$ (d) Sb_2S_3

49. An octahedral metal ion M^{2+} has magnetic moment of 4.0 B.M. The correct combination of metal ion and d-electron configuration is given by

(a) $Co^{2+}, t_2g^5e_g^2$ (b) $Cr^{2+}, t_2g^4e_g^2$ (c) $Mn^{2+}, t_2g^3e_g^1$ (d) $Fe^{2+}, t_2g^4e_g^2$

50. According to VSEPR theory, the geometry (with lone pair) around the central iodine in I_3^+ and I_3^- ions respectively are

(a) tetrahedral and tetrahedal
(b) trigonal bipyramidal and trigonal bipyramidal
(c) tetrahedral and trigonal bipyramidal
(d) tetrahedral and octahedral

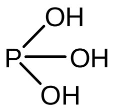
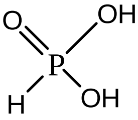
51. Treatment of CIF_3 with SbF_5 leads to the formation of a/an

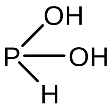
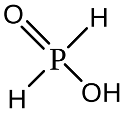
(a) polymeric material
(b) covalent cluster
(c) ionic compound
(d) lewis acid-base adduct

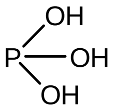
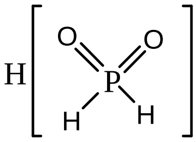
52. The reason for the chemical inertness of gaseous nitrogen at room temperature is best given by its

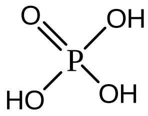
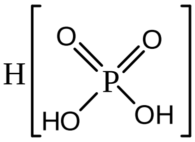
(a) high bonding energy only
(b) electronic configuration
(c) HOMO-LUMO gap only
(d) high bond energy and HOMO-LUMO gap

53. Two tautomeric forms of phosphorus acid are

(a)  and 

(b)  and 

(c)  and 

(d)  and 

54. The correct thermodynamics relation among the following is

(a) $\left(\frac{\partial U}{\partial V}\right)_S = -P$ (b) $\left(\frac{\partial H}{\partial V}\right)_S = -P$ (c) $\left(\frac{\partial G}{\partial V}\right)_S = -P$ (d) $\left(\frac{\partial A}{\partial V}\right)_S = -S$

55. The boiling point of a solution of non-volatile solid is higher than that of the pure solvent. It always indicates that

(a) the enthalpy of the solution is higher than that of the pure solvent.
(b) the entropy of the solution is higher than that of the pure solvent.
(c) the Gibbs free energy of the solution is higher than that of the pure solvent.
(d) the internal energy of the solution is higher than that of pure solvent.

56. According to Arrhenius equation (k = rate constant and T = temperature)

(a) ln k decreases linearly with 1/T
(b) ln k decreases linearly with T
(c) ln k increases linearly with 1/T
(d) ln k increases linearly with T

57. The angle at which the first order Bragg reflection is observed from (110) plane in a simple cubic unit cell of side 3.238Å, when chromium K_α radiation of wavelength 2.29Å is used, is

(a) 30° (b) 45° (c) 60° (d) 90°

58. The orbital with two radial and two angular nodes is

(a) 3p (b) 5d (c) 5f (d) 8d

59. Michael Faraday observed that the colour of colloidal suspensions of gold nanoparticles changes with the size of the nanoparticles. This is because

(a) Gold forms complex with the solvent
(b) Band gap of gold changes with size of the nanoparticle.
(c) Gold in nanocrystalline form undergoes transmutation to other elements.
(d) Colloidal suspensions diffract light

60. The energy of 2s and 2p orbitals is the same for
(a) Li (b) Li^{2+} (c) Be^{2+} (d) H^-

61. If a homonuclear diatomic molecule is oriented along the Z-axis, the molecular orbital formed by linear combination of p, orbitals of the two atoms is
(a) σ (b) σ^* (c) π (d) δ

62. A reaction contains a mixture of N_2, H_2 and NH_3 in equilibrium ($K_p = 3.75\ atm^{-2}$). If sufficient He is introduced into the reactor to double the total pressure, the value of K_p at the new equilibrium would be
(a) 0.94 atm^{-2} (b) 3.75 atm^{-2} (c) 7.50 atm^{-2} (d) 15.00 atm^{-2}

63. The volume of a gas absorbed on a solid surface is 10.0 ml, 11.0 ml, 11.2 ml, 14.5 ml and 22.5 ml at 1.0, 2.0, 3.0, 4.0 and 5.0 atm, pressure, respectively. These data are best represented by
(a) Gibb's isotherm (b) Langmuir isotherm
(c) Freundlich isotherm (d) BET isotherm

64. A compound of M and X atoms has a cubic unit cell. M atoms are at the corners and body centre position and X atoms are at face centre positions of the cube. The molecular formula of the compound is
(a) MX (b) MX_2 (c) M_3X_2 (d) M_2X_3

65. 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

66. The molecule in which the bond order increases upon addition of an electron is
(a) O_2 (b) B_2 (c) P_2 (d) N_2

67. In a potentiometric titration, the end point is obtained by observing
(a) change in colour (b) jump in potential (c) increase in current (d) increase in turbidity

68. Electrolysis of an aqueous solution of 1.0 M NaOH results in
(a) Na at the cathode and O_2 at the anode.
(b) H_2 at the cathode and O_2 at the anode.
(c) Na and H_2 at the cathode, and O_2 at the anode.
(d) O_2 at the cathode and H_2 at the anode.

69. The cell voltage of Daniel cell $\left[\mathrm{Zn} \mid \mathrm{ZnSO_4}(aq) \| \mathrm{CuSO_4}(aq) \mid \mathrm{Cu}\right]$ is 1.07 V. If reduced potential of $Cu^{2+}|Cu$ is 0.34 V, the reduction potential of $Zn^{2+}|Zn$ is
(a) 1.141 V (b) –1.41 V (c) 0.73 V (d) –0.73 V

70. In the mechanism of reaction, $H_2 + Br_2 \longrightarrow 2HBr$, the first step is
(a) dissociation of H_2 into H•radicals (b) dissociation of Br_2 into Br•radicals
(c) reaction of H•radical with Br_2 (d) reaction of Br•radical with H_2

Part-C

71. For an electronic configuration of two non-equivalent π electronics $\left[\pi^1, \pi^1\right]$, which of the folllowing terms is not possible?

(a) ${}^1\Sigma$ (b) ${}^3\Sigma$ (c) ${}^3\Delta$ (d) ${}^3\Phi$

72. Consider a two-dimensional harmonic oscillator with potential energy $V(x,y)=\frac{1}{2}k_x x^2+\frac{1}{2}k_y y^2$. If $\psi_{nx}(x)$ and $\psi_{ny}(y)$ are the eigensolutions and E_{nx} and E_{ny} are the eigenvalues of harmonic oscillator problem in x and y direction with potential $\frac{1}{2}k_x x^2$ and $\frac{1}{2}k_y y^2$, respectively, the wave function and eigenvalues of the above two-dimensional harmonic oscillator problem are

(a) $\psi_{nx,ny}=\psi_{nx}(x)+\psi_{ny}(y)$
$E_{nx,\,ny}=E_{nx}+E_{ny}$

(b) $\psi_{nx,ny}=\psi_{nx}(x)\psi_{ny}(y)$
$E_{nx,\,ny}=E_{nx}E_{ny}$

(c) $\psi_{nx,ny}=\psi_{nx}(x)\psi_{ny}(y)$
$E_{nx,\,ny}=E_{nx}+E_{ny}$

(d) $\psi_{nx,ny}=\psi_{nx}(x)+\psi_{ny}(y)$
$E_{nx,\,ny}=E_{nx}E_{ny}$

73. The quantum mechanical virial theorem for a general potential $V(x,y,z)$ is given by $\left\langle x\frac{\partial v}{\partial x}+y\frac{\partial v}{\partial y}+z\frac{\partial v}{\partial z}\right\rangle$ where T is the kinetic energy operator and < > indicates expectation value. This leads to the following relation between the expectation value of kinetic energy and potential energy for a quantum mechanical harmonic oscillator problem with potential $V=\frac{1}{2}k_x x^2+\frac{1}{2}k_y y^2+\frac{1}{2}k_z z^2$

(a) $\langle T\rangle=\langle V\rangle$ (b) $\langle T\rangle=-\frac{1}{2}\langle V\rangle$ (c) $\langle T\rangle=\frac{1}{2}\langle V\rangle$ (d) $\langle T\rangle=-\langle V\rangle$

74. Consider a particle in a one dimensional box of length 'a' with the following potential

$V(x)=\infty \qquad x<0$
$V(x)=\infty \qquad x>a$
$V(x)=0 \qquad 0\le x\le a/2$
$V(x)=V_1 \qquad a/2\le x\le a$

Starting with the standard particle in a box hamiltonian as the zeroth order Hamiltonian and the potential of V_1 from 'a/2' to 'a' as a perturbation, thefirst-order energy correction to the ground state is

(a) V_1 (b) $V_1/4$ (c) $-V_1$ (d) $V_1/2$

75. The most probable value of 'r' for an electron in 1s orbital of hydrogen atom is

(a) $a_0/2$ (b) a_0 (c) $\sqrt{2}a_0$ (d) $3a_0/2$

76. The angular momentum operator $\hat{L}_y$ is

(a) $-\frac{\hbar}{i}\left(y\frac{\partial}{\partial z}-z\frac{\partial}{\partial y}\right)$ (b) $\frac{\hbar}{i}\left(z\frac{\partial}{\partial x}-x\frac{\partial}{\partial z}\right)$ (c) $\frac{-i\hbar}{2m}\frac{\partial}{\partial x}$ (d) $\frac{\hbar}{i}\left(z\frac{\partial}{\partial x}-y\frac{\partial}{\partial y}\right)$

77. The molecule with the smallest rotation partition function at any temperature among the following is

(a) $CH_3-C\equiv C-H$ (b) $H-C\equiv C-H$ (c) $H-C\equiv C-D$ (d) $D-C\equiv C-D$

78. Both NaCl and KCl crystallize with the Fcc structure. However, the X-ray powder diffraction pattern of NaCl corresponds to the fcc structure whereas, that of KCl corresponds to simple cubic structure. This is because

(a) K^+ and Cl^- are isoelectronic
(b) Na^+ and Cl^- are isoelectronic
(c) K^+ and Cl^- are disordered in the crystal lattice
(d) KCl has anti-site defects.

79. Consider the cell:

$Zn\,|\,Zn^{2+}(a=0.01)\,||\,Fe^{2+}(a=0.001),\,Fe^{3+}(a=0.01)\,|\,Pt$

E_{cell} = 1.71V at 25°C for the above cell. The equilibrium constant for the reaction:

$$Zn + 2Fe^{3+} \rightleftharpoons Zn^{2+} + 2Fe^{2+} \text{ at 25°C would be close to}$$

(a) 10^{27} (b) 10^{54} (c) 10^{81} (d) 10^{40}

80. The molecule that has the smallest diffusion coefficient in water is

(a) glucose (b) fructose (c) ribose (d) surcrose

81. Metallic gold crystallizes in Fcc structure with unit cell dimension of 4.00 Å. The atomic radius of gold is

(a) 0.866Å (b) 1.414Å (c) 1.732Å (d) 2.000Å

82. A first order gaseous reaction is 25% complete in 30 minutes at 227°C and in 10 minutes at 237°C. The activation eneryg of the reaction is closest to (R = 2 cal K^{-1} mol^{-1})

(a) 27 kcal mol^{-1} (b) 110 kcal mol^{-1} (c) 55 kcal mol^{-1} (d) 5.5 kcal mol^{-1}

83. In the reaction between NO and H_2 the following data are obtained

Experiment I: P_{H_2} = constant

P_{NO} (mm of Hg)	359	300	152
$\frac{-dP_{NO}}{dt}$	1.50	1.03	0.25

Experiment II : P_{NO} = constant

P_{H_2} (mm of Hg)	289	205	147
$\frac{-dP_{H_2}}{dt}$	1.60	1.10	0.79

The orders with respect to H_2 and NO are

(a) 1 with respect to NO and 2 with respect to H_2
(b) 2 with respect to NO and 1 with respect to H_2
(c) 1 with respect to NO and 3 with respect to H_2
(d) 2 with respect to NO and 2 with respect to H_2

84. The energy for a single electron excitation in cyclopropenium cation in Huckel theory is

(a) β (b) 2β (c) 3β (d) 4β

85. The atomic masses of fluorine and hydrogen are 19.0 and 1.0 amu, respectively ($1\ \text{amu} = 1.67\times10^{-27}$ kg). The bond length of HF is 2.0Å. The moment of inertia of HF is

(a) $3.2\times10^{-47}\ \text{kg m}^2$ (b) $6.4\times10^{-47}\ \text{kg m}^2$ (c) $9.6\times10^{-47}\ \text{kg m}^2$ (d) $4.8\times10^{-47}\ \text{kg m}^2$

86. The masses recorded when a substance is weighed 4 times are 15.8, 15.4, 15.6 and 16.0 mg. The variance (square of the standard deviation) is closest to

(a) 0.02 (b) 0.05 (c) 0.10 (d) 0.20

87. The transition that is allowed by x-polarized light in trans-butadiene is
(The character table for C_{2h} is given below)

C_{2h}	E	C_2	i	σ_h	
A_g	1	1	1	1	R_x, x^2, y^2, z^2, xy
B_g	1	−1	1	−1	R_x, R_y, xz, yz
A_u	1	1	−1	−1	z
B_u	1	−1	−1	1	x, y

(a) $^1A_u \rightarrow {}^1A_u$ (b) $^1A_u \rightarrow {}^1B_g$ (c) $^1B_u \rightarrow {}^1B_g$ (d) $^3B_g \rightarrow {}^1A_g$

88. The heat capacity of 10 mol of an ideal gas at a certain temperature is 300 JK^{-1} at constant pressure. The heat capacity of the same gas at the same temperature and at constant volume would be

(a) $383\ \text{JK}^{-1}$ (b) $217\ \text{JK}^{-1}$ (c) $134\ \text{JK}^{-1}$ (d) $466\ \text{JK}^{-1}$

89. The Maxwell's relationship derived from the equation $dG = VdP - SdT$ is

(a) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial S}{\partial P}\right)_T$ (b) $\left(\frac{\partial P}{\partial V}\right)_T = \left(\frac{\partial T}{\partial S}\right)_P$ (c) $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$ (d) $\left(\frac{\partial P}{\partial V}\right)_T = -\left(\frac{\partial T}{\partial S}\right)_P$

90. The chemical potential (μ_i) of the i^{th} component is defined as

(a) $\mu_i = \left(\frac{\partial U}{\partial n_i}\right)_{T,P}$ (b) $\mu_i = \left(\frac{\partial H}{\partial n_i}\right)_{T,P}$ (c) $\mu_i = \left(\frac{\partial A}{\partial n_i}\right)_{T,P}$ (d) $\mu_i = \left(\frac{\partial G}{\partial n_i}\right)_{T,P}$

91. Work (w) involved in isothermal reversible expansion from V_i to V_f of n moles of an ideal gas is

(a) $w = -nRT\ln(V_f / V_i)$ (b) $w = nRT\ln(V_f / V_i)$

(c) $w = -nRT(V_f / V_i)$ (d) $w = -nRT\log(V_f / V_i)$

92. The limiting molar conductivities of NaCl, NaI and RbI are 12.7, 10.8 and 9.1 mS $\text{m}^2\ \text{mol}^{-1}$, respectively. The limiting molar conductivity of RbCl would be

(a) 32.6 mS $\text{m}^2\ \text{mol}^{-1}$ (b) 7.2 mS $\text{m}^2\ \text{mol}^{-1}$
(c) 14.4 m S $\text{m}^2\ \text{mol}^{-1}$ (d) 11.0 mS $\text{m}^2\ \text{mol}^{-1}$

93. The number of ways in which four molecules can be distributed in two different energy levels is

(a) 6 (b) 3 (c) 16 (d) 8

94. An element exists in two crystallographic modifications with FCC and BCC structures. The ratio of the densities of the FCC and BCC modifications in terms of the volumes of their unit cells (V_{FCC} and V_{BCC}) is

(a) $V_{BCC} : V_{FCC}$ (b) $2V_{BCC} : V_{FCC}$ (c) $V_{BCC} : 2V_{FCC}$ (d) $V_{BCC} : \sqrt{2}V_{FCC}$

95. Given $\gamma\left({}^{1}\text{H}\right) \simeq 2.7\times10^{8}\ \text{T}^{-1}\text{s}^{-1}$. The resonance frequency of a proton in magnetic field of 12.6 T is close to $(\pi = 3.14)$

(a) 60 MHz (b) 110 MHz (c) 540 MHz (d) 780 MHz

96. In Mossbauer experiment, a source emitting at 14.4 KeV $\left(3.48\times10^{18}\ \text{Hz}\right)$ had to be moved towards absorber at 2.2 mm s^{-1} for resonance. The shift in the frequency between the source and the absorber is

(a) 15.0 MHz (b) 20.0 MHz (c) 25.5 MHz (d) 30.0 MHz

97. Among the following, the correct combination of complex and its color is

	Complex	**Color**
(a)	$\left[\text{Co}(\text{CN})_4\right]^{2-}$	Red
(b)	$\left[\text{CoCl}_4\right]^{2-}$	Orange
(c)	$\left[\text{Co}(\text{NCS})_4\right]^{2-}$	Blue
(d)	$\left[\text{CoF}_4\right]^{2-}$	Yellow

98. In a specific reaction, hexachlorocyclotriphosphazene, $N_3P_3Cl_6$ was reacted with a metal fluoride to obtain mixed halo derivatives namely $N_3P_3Cl_5F$(A), $N_3P_3Cl_4F_2$(B), $N_3P_3Cl_3F_3$(C), $N_3P_3Cl_2F_4$(D), $N_3P_3ClF_5$(E). Compositions among these which can give isomeric products are

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

99. Xenon forms several fluorides and oxofluorides which exihibit acidic behaviour. The correct sequence of descending Lewis acidity among the given species is represented by

(a) $XeF_6 > XeOF_4 > XeF_4 > XeO_2F_2$ (b) $XeOF_4 > XeO_2F_2 > XeOF_4 > XeF_6$

(c) $XeF_4 > XeO_2F_2 > XeOF_4 > XeF_6$ (d) $XeF_4 > XeF_6 > XeOF_4 > XeO_2F_2$

100. Number of isomeric derivatives possible for the neutral closo-carborane, $C_2B_{10}H_{12}$ is

(a) three (b) two (c) four (d) six

101. For higher boranes 3c-2e ‘BBB’ bond may be a part of their structures. In B_5H_9, the number of such electron deficient bond(s) present is/are

(a) four (b) two (c) zero (d) one

102. In the atomic absorption spectroscopic estimation of Fe(III) using O_2/H_2 flame, the absorbance decreases with the addition of

(a) CO_3^{2-} (b) SO_4^{2-} (c) EDTA (d) Cl^-

103. In a polarographic estimation, the limiting currents (μA) were 0.15, 4.65, 9.15 and 27.15 when concentration (mM) of Pb(II) were 0, 0.5, 1.0 and 3.0 respectively. An unknown solution of Pb(II) gives a limiting current of 13.65μA. Cocentration of Pb(II) in the unknown is

(a) 1.355 mM (b) 1.408 mM (c) 1.468 mM (d) 1.500 mM

104. The gases SO_2 and SO_3 were reacted separately with ClF gas under ambient conditions. The major products expected from the two reactions respectively, are

(a) SOF_2 and $ClOSO_2F$ (b) SOF_2 and SO_2F_2

(c) SO_2ClF and SO_2F_2 (d) SO_2ClF and $ClOSO_2F$

105. The correct statement regarding terminal/bridging CO groups in solid $Co_4(CO)_{12}$ and $Ir_4(CO)_{12}$ is
(a) both have equal number of bridging CO groups
(b) number of bridging CO groups in $Co_4(CO)_{12}$ is 4
(c) the number of terminal CO groups in $Co_4(CO)_{12}$ is 8
(d) the number of bridging CO groups in $Ir_4(CO)_{12}$ is zero.

106. On reducing $Fe_3(CO)_{12}$ with an excess of sodium, a carbonylate ion is formed. The iron is isoelectronic with

(a) $\left[Mn(CO)_5\right]^-$ (b) $\left[Ni(CO)_4\right]$ (c) $\left[Mn(CO)_5\right]^+$ (d) $\left[V(CO)_6\right]^-$

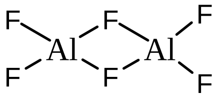
107. The correct statement for ozone is
(a) It absorbs radiations in wavelength region 290-320 nm.
(b) It is mostly destroyed by NO radical in atmosphere
(c) It is non toxic even at 100 ppm level
(d) Its concentration near poles is high due to its paramagnetic nature.

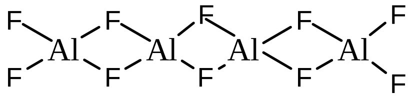
108. Among the following clusters,

$A = \left[(H)Co_6(CO)_{15}\right]^-$, $B = \left[(H)_2Os_6(CO)_{18}\right]$, $C = \left[(H)_2Os_5(CO)_{16}\right]$

H is encapsulated in
(a) A only (b) B only (c) B and C only (d) A and B only

109. The solid state structure of aluminum fluoride is

(a)


(b)


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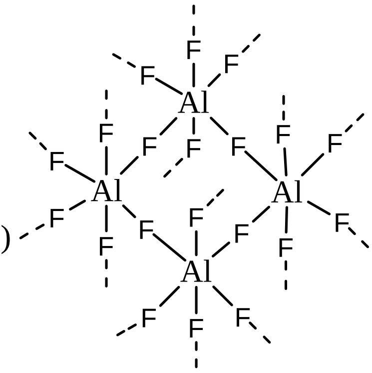

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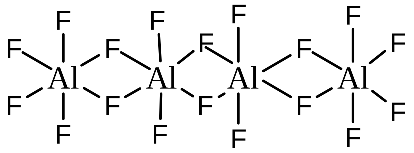
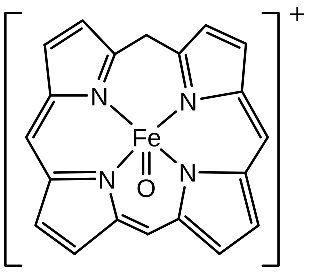


110. Oxidised form of enzyme catalase (structure A); prepared by the reaction of $\left[Fe(P)\right]^+$ $(P = \text{porphyrin})$ with H_2O_2, has green color becauase



A(substitutents on ring are removed for clarity)

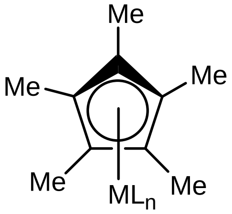
(a) Oxidation state of iron changed from Fe^{III} to Fe^{IV}.
(b) Porphyrin ring is oxidized by one electron
(c) $\pi - \pi^*$ transition appears in the visible region
(d) Fe^{IV} is coordinated with anionic tyrosinate ligand in axial position.

111. The reactive position of nicotinamide adenine dinucleotide (NAD) in biological redox reactions is
(a) 2-position of the pyridine ring
(b) 6-position of the pyridine ring
(c) 4-position of the pyridine ring
(d) 5-position of the pyridine ring

112. The electrophile Ph_3C^+ reacts with $\left[\left(\eta^5-C_5H_5\right)Fe\left(CO\right)_2\left(CDMe_2\right)\right]^+$ to give a product A. The product A is formed because
(a) Fe is oxidised
(b) alkyl is susbtituted with Ph_3C
(c) Fe-Ph bond is formed
(d) Alkyl is converted to alkene

113. Subsitution of L with other ligands will be easiest for the species

(a)


(b)


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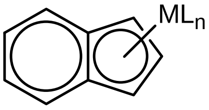

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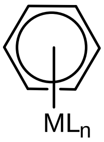
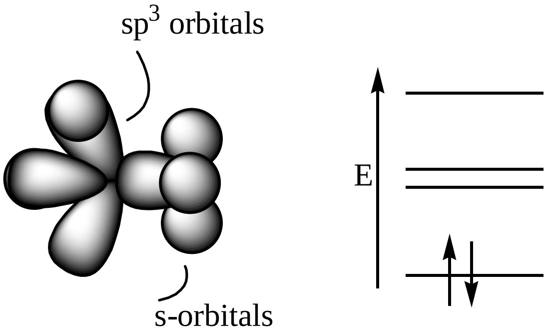


114. Among the following, the correct statement is
(a) CH is isolobal to $Co(CO)_3$
(b) CH_2 is isolobal to $Ni(CO)_2$
(c) CH is isolobal to $Fe(CO)_4$
(d) CH_2 is isolobal to $Mn(CO)_4$

115. $MnCr_2O_4$ is likely to have a normal spinel structure because
(a) Mn^{2+} will have a LFSE in the octahedral site whereas the Cr^{3+} will not
(b) Mn is +2 oxidation state and both the Cr are in +3 oxidation state.
(c) Mn is +3 oxidation state and 1 Cr is in +2 and the other is in +3 state.
(d) Cr^{3+} will have a LFSE in the octahedral site whereas the Mn^{2+} ion will not.

116. The ground state forms of Sm^{3+} and Eu^{3+} respectively, are
(a) $^7F_0$ and $^6H_{5/2}$
(b) $^6H_{5/2}$ and $^7F_0$
(c) $^2F_{5/2}$ and $^5I_4$
(d) $^7F_6$ and $^2F_{7/2}$

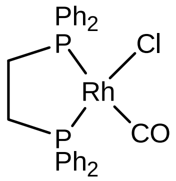
117. The orbital interactions shown below represent

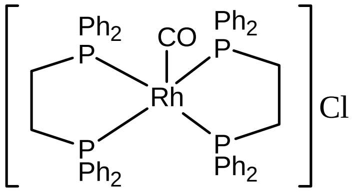


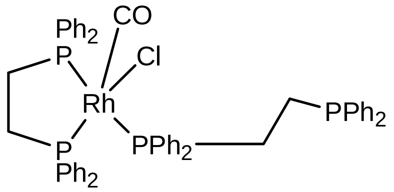
(a) CH_3–Al interactions in $Al_2(CH_3)_6$
(b) B–H interactions in B_2H_6
(c) CH_3–Li interaction in $Li_4(CH_3)_4$
(d) CH_3CH_2–Mg interactions in $EtMgBr.(OEt_2)_2$

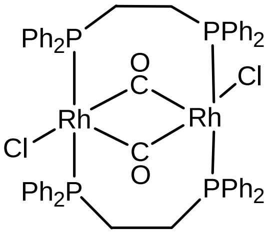
118. Compounds $K_2Ba[Cu(NO_2)_6]$ (A) and $Cs_2Ba[Cu(NO_2)_6]$ (B) exhibit tetragonal elongation and tetragonal compression, respectively. The unpaired electron in A and B are found respectively, in orbitals,
(a) d_z^2 and $d_{x^2-y^2}$
(b) $d_{x^2-y^2}$ and d_z^2
(c) d_z^2 and d_z^2
(d) $d_{x^2-y^2}$ and $d_{x^2-y^2}$

119. Reaction of $Ph_2PCH_2CH_2PPh_2$ with $[RhCl(CO)_2]_2$ in a 2:1 molar ratio gives a crystalline solid A. The IR spectrum of complex A shows ν_{CO} at 1985 cm^{-1}. The $^{31}P(^1H)$ NMR spectrum of A consists (^{103}Rh is 100% abundant and I = ½). The structure of complex A is

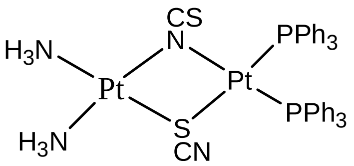
(a) 

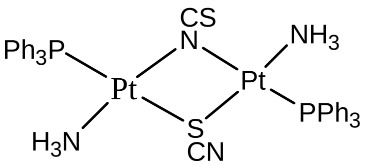
(b) 

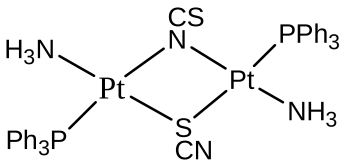
(c) 

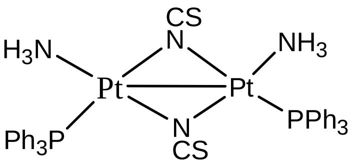
(d) 

120. The most appropriate structure for the complex $\left[Pt_2(NH_3)_2(NCS)_2(PPh_3)_2\right]$ is

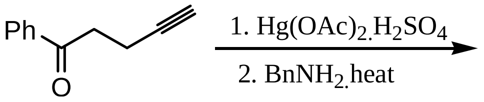
(a) 

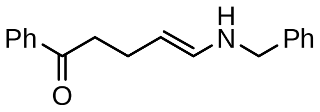
(b) 

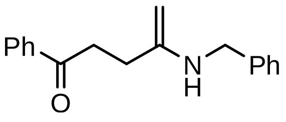
(c) 

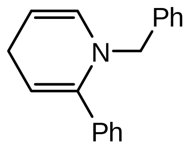
(d) 

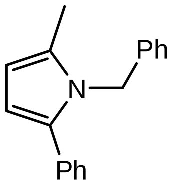
121. The major product formed in the following reaction sequence is



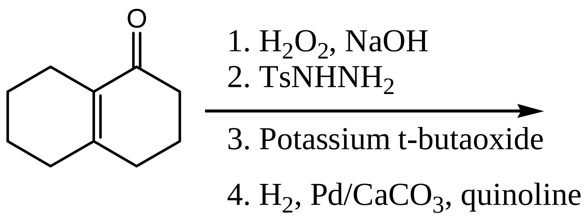
(a) 

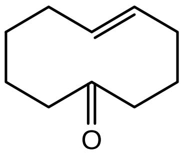
(b) 

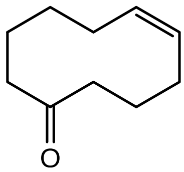
(c) 

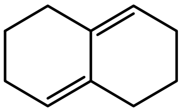
(d) 

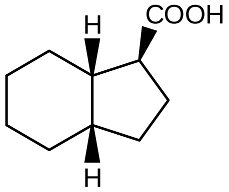
122. The major product formed in the following reaction sequence is



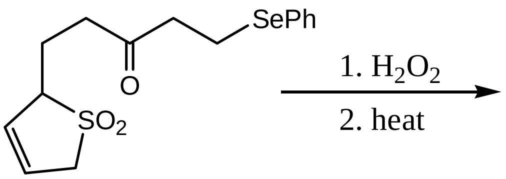
(a) 

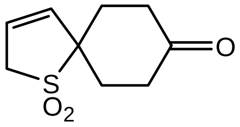
(b) 

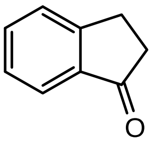
(c) 

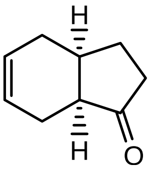
(d) 

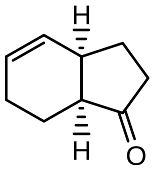
123. The major product formed in the following reaction sequence is



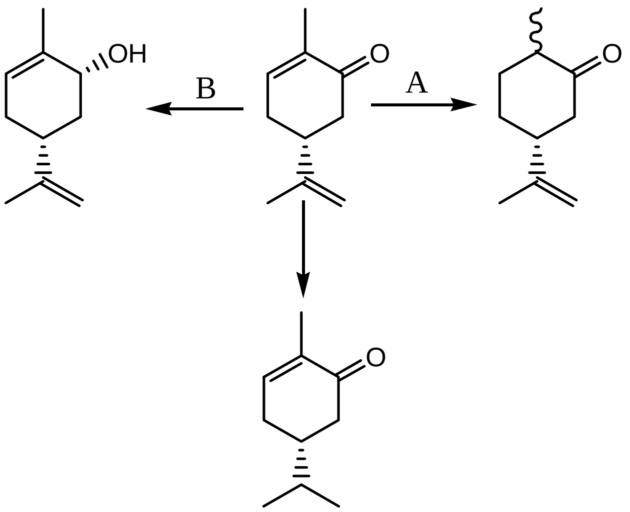
(a) 

(b) 

(c) 

(d) 

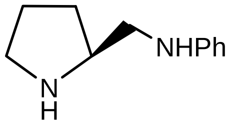
124. The most suitable reagent combination of A-C, required in the following conversions are

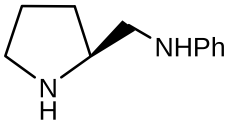


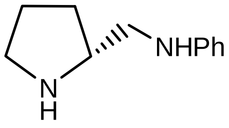
(a) A = Li/liq. NH_3; B = $NaBH_4$, $CeCl_3.7H_2O$; C = H_2, $(Ph_3P)_3RhCl$.
(b) A = Li/liq. NH_3; B = $NaBH_4$, $CeCl_3.7H_2O$; C = H_2, 10% Pd/C.
(c) A = $NaBH_4$, $CeCl_3.7H_2O$; B = Li/liq. NH_3; C = H_2, $(Ph_3P)_3RhCl$.
(d) A = $NaBH_4$, $CeCl_3.7H_2O$; B = Li/liq. NH_3; C = H_2, 10% Pd/C

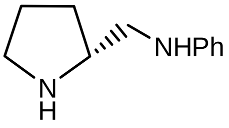
125. The major product B formed in the following reaction sequence, and overall yield of its formation are

$$(S)-\text{glutamic acid}\xrightarrow[\substack{180°C\\60\%}]{\text{aniline}}A\xrightarrow[80\%]{LiAlH_4}B$$

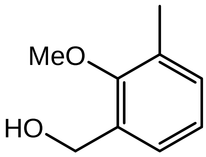
(a)  and 48%

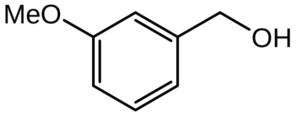
(b)  and 70%

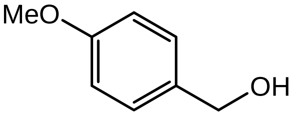
(c)  and 48%

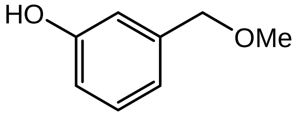
(d)  and 70%

126. An organic compound ($C_6H_{10}O_2$), which does not change the color of ferric chloride solution, exhibited the following ^{1}H NMR spectral data: δ 7.3 (1H, t, J = 8 Hz), 7.0 (1H, d, J = 8 Hz), 6.95(1H, s), 6.9 (1H, d, J = 8 Hz) 5.3 (1H, brs, D_2O exchangeable), 4.6 (2H, s), 3.9 (3H, s). Structure of the compound is

(a) 

(b) 

(c) 

(d) 

127. Methyl 4-oxopentanoate exchibited signals at δ 208, 172, 51, 37, 32 and 27 ppm in its ^{13}C NMR spectrum. The signals due to the methoxy, C1, C4 and C5 carbons are

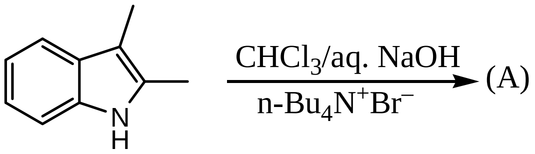
(a) OMe –32; Cl–208; C4-172; C5-51

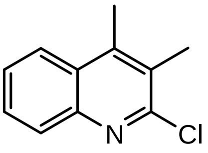
(b) OMe-51; Cl-208; C4-172; C5-32

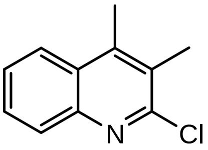
(c) OMe-32; Cl-172; C4-208; C5-51

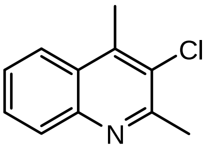
(d) OMe-51; Cl-172, C4-208; C5-32

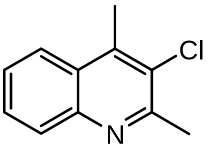
128. In the following reaction, the intermediate and the major product A are



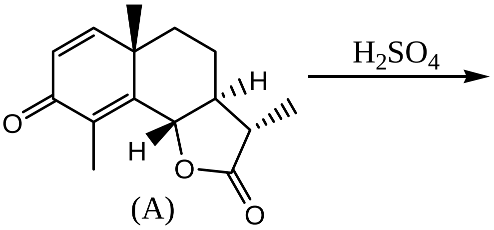
(a) :CHCl and 

(b) :CCl$_2$ and 

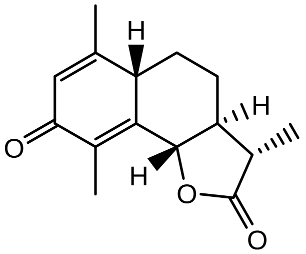
(b) :CHCl and 

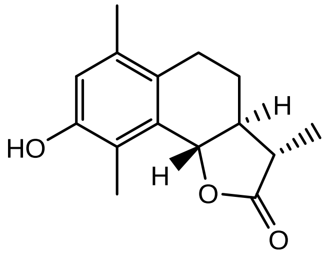
(d) :CCl$_2$ and 

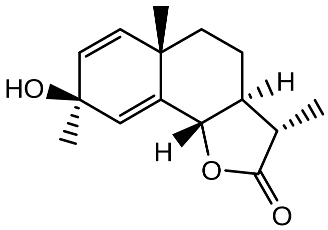
129. The major product formed in the sulfuric acid mediated rearrangement of the sesquiterpene santonin A is

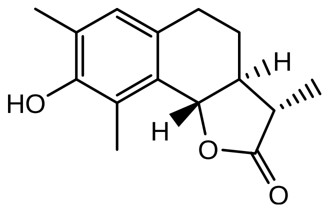


(A)

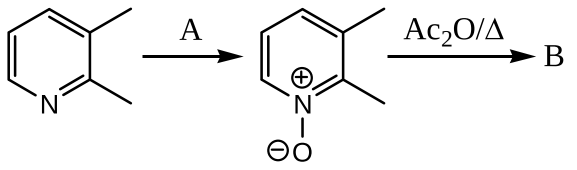
(a) 

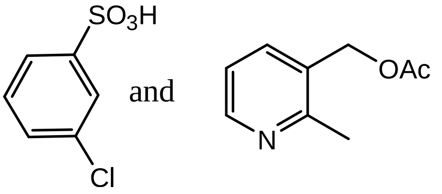
(b) 

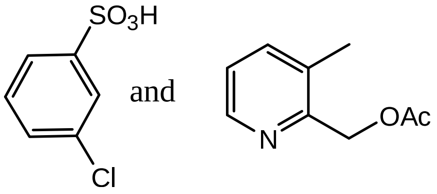
(c) 

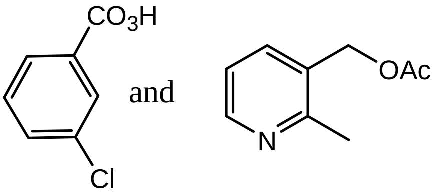
(d) 

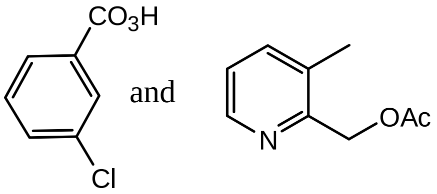
130. In the following transformation, the reagent A and the major product B, respectively, are



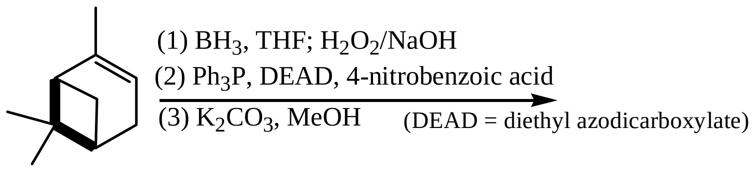
(a)


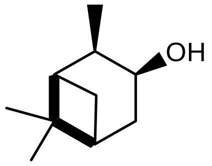
(b)


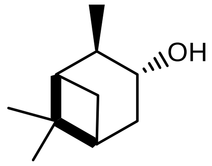
(c)


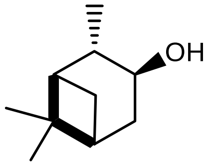
(d)


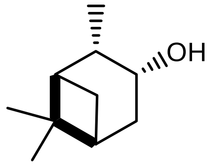
131. The major product formed in the following reaction sequence is



(a)


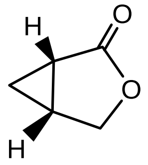
(b)


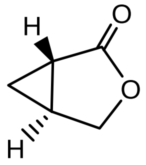
(c)


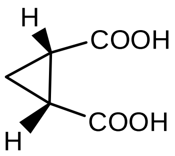
(d)


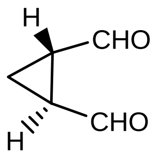
132. The major product formed in the following reaction sequence is

cis – but – 2ene –1, 4 – diol $\xrightarrow[\text{2. PCC, } CH_2Cl_2]{\text{1. } CH_2I_2\text{, Zn–Cu, } CH_2Cl_2}$

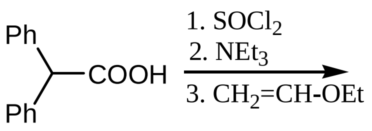
(a)


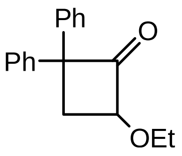
(b)


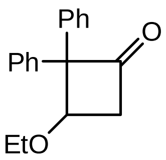
(c)


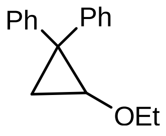
(d)


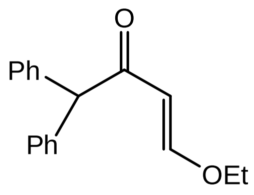
133. The major product formed in the following reaction sequence is



(a)


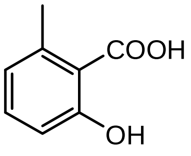
(b)


(c)


(d)


134. The peptide A on reaction with I-fluoro-2, 4-dinitrobenzene followed by exhaustive hydrolysis gave phenylalanine, alanine, serine and N-(2, 4-dinitrophenyl) glycine. On the other hand, pepetide A after two cycles of Edman degradation gave Phe-Ser as the product. The structure of the peptide A is
(a) Phe-Ser-Ala-Gly (b) Phe-Ser-Gly-Ala (c) Gly-Ala-Phe-Ser (d) Ala-Gly-Phe-Ser

135. The compound (B) (labeled) is precursor for biosynthesis of the natural product A. The labeled carbons in the product A are

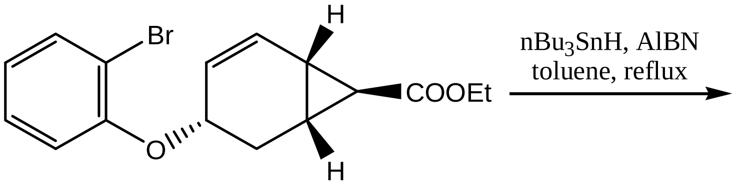


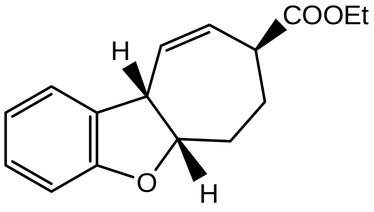
(A)

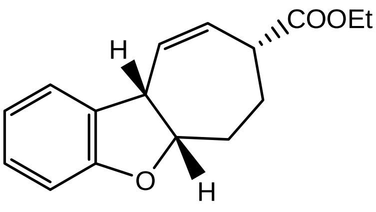
$Me^{14}COOH$
(B)

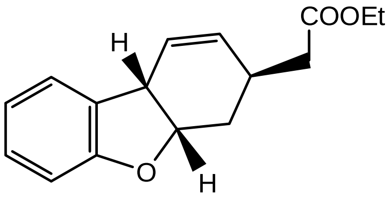
(a) C1, C3, C5 and Me
(b) C2, C4, C6 and Me
(c) C2, C4, C6 and COOH
(d) C1, C3, C5 and COOH

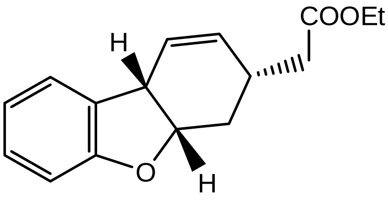
136. The major product formed in the following reaction sequence is



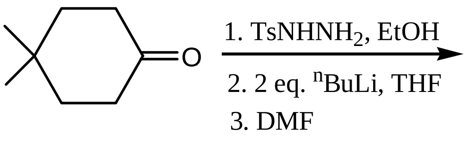
(a)


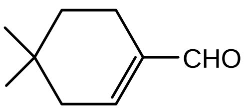
(b)


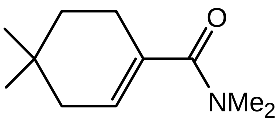
(c)


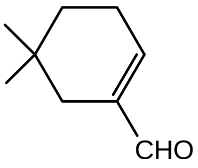
(d)


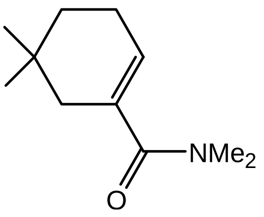
137. The major product formed in the following reaction sequence is



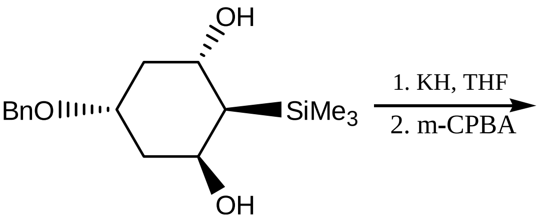
(a)


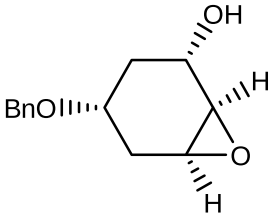
(b)


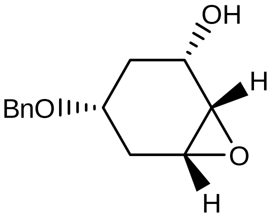
(c)


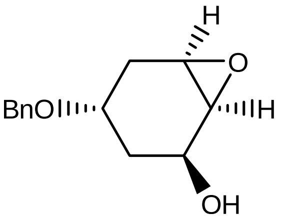
(d)


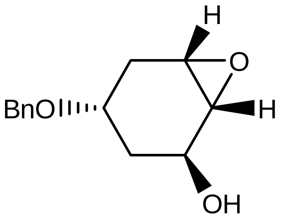
138. The major product formed in the following reaction sequence is



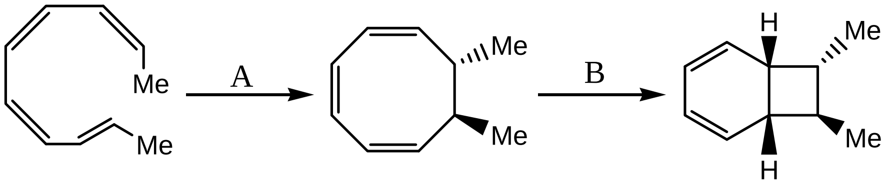
(a) 

(b) 

(c) 

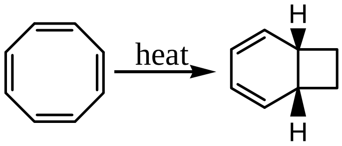
(d) 

139. The conditions A-B, required for the following pericyclic reactions are



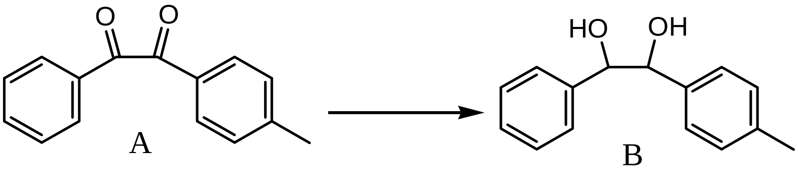
(a) A – Δ; B – Δ (b) A – hν; B – Δ (c) A – hν; B – hν (d) A – Δ; B – hν

140. The number of π electrons participating and the pericyclic mode in the following reaction are

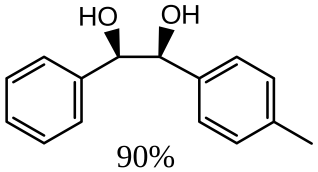


(a) 4 and conrotatory (b) 4 and disrotatory (c) 6 and conrotatory (d) 6 and disrotatory

141. Stereoselective reduction of the dione A with a chiral reducing agent provides the corresponding diol B in 100% diastereoselectivity and 90% ee favoring R, R configuration. The composition of the product is

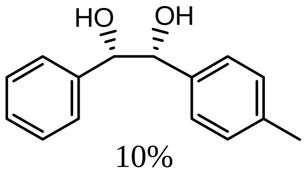


A B

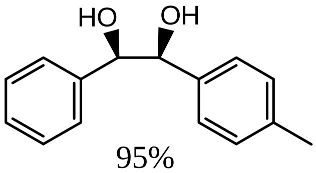
(a) 

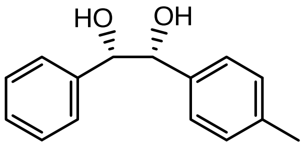
90%

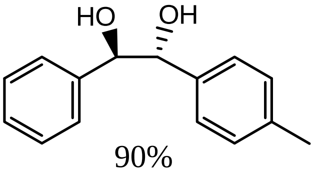
and

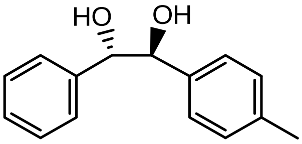


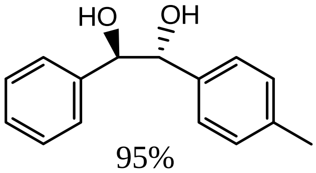
10%

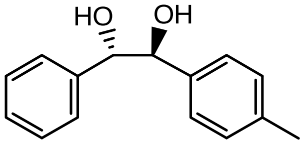
(b) 
95%

and 
05%

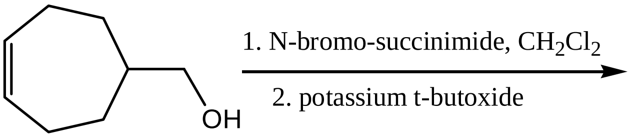
(c) 
90%

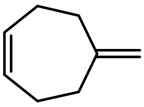
and 
10%

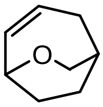
(d) 
95%

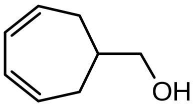
and 
05%

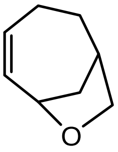
142. The major product formed in the following reaction sequence is



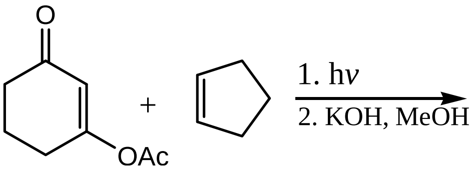
(a) 

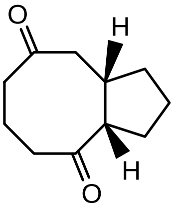
(b) 

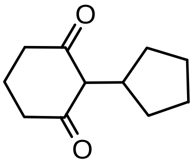
(c) 

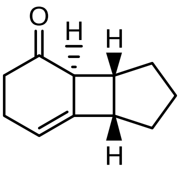
(d) 

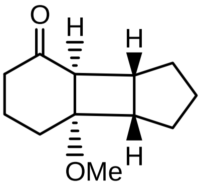
143. The major product formed in the following reaction sequence is



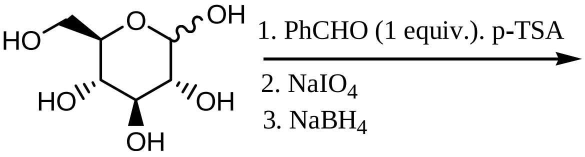
(a) 

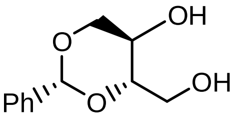
(b) 

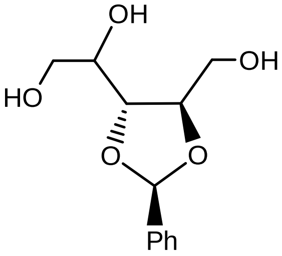
(c) 

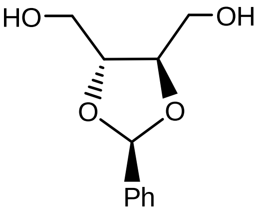
(d) 

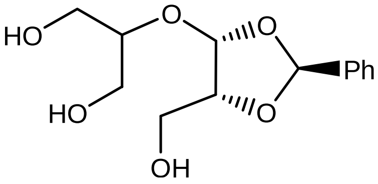
144. The major product formed in the following reaction sequence is



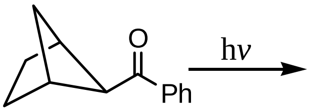
(a) 

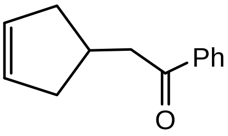
(b) 

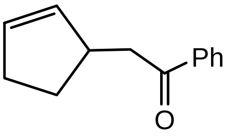
(c) 

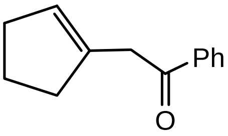
(d) 

145. The major product formed in the following photochemical reaction is



(a) 

(b) 

(c) 

(d)