PART A

1. A boy holds one end of a rope of length l and the other end is fixed to a thin pole of radius r ($r << l$). Keeping the rope taut, the boy goes around the pole causing the rope to get wound around the pole. Each round takes 10 s. What is the speed (in units of s^{-1}) with which the boy approaches the pole?

   (a) $\frac{\pi r}{5}$ (b) $\frac{\pi l}{5}$ (c) $20\pi(r+l)$ (d) $\frac{20\pi(l-r)}{5}$

2. The smallest square floor which can be completely paved with tiles of size 8 × 6, without breaking any tile, needs n tiles. Find n.

   (a) 56 (b) 12 (c) 24 (d) 48

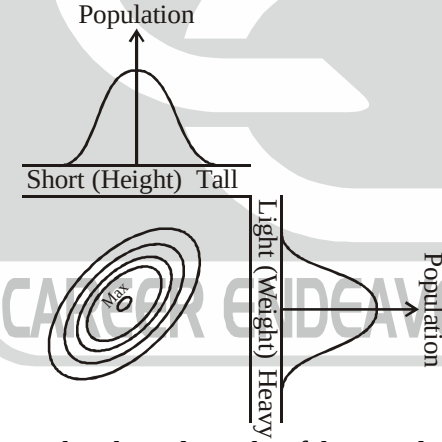
3. A 2 m long ladder is to reach a wall of height 1.75 m. The largest possible horizontal distance of the ladder from the wall could be

   (a) slightly less than 1 m (b) slightly more than 1 m
   (c) 1 m (d) 1.2 m

4. A rectangular flask of length 11 cm, width 8 cm and height 20 cm has water filled up to height 5 cm. If 21 spherical marbles of radius 1 cm each are dropped in the flask, what would be the rise in water level?

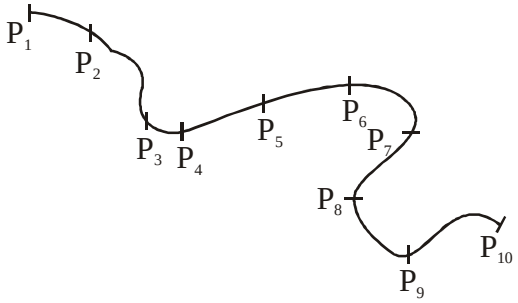
   (a) 8.8 cm (b) 10 cm (c) 1 cm (d) 0 cm

5. Contours in the bivariate (weight, height) graph connect regions of approximately equal populations. Which of the following interpretations is correct?



   (a) There is no correlation between height and weight of the population
   (b) Heavier individuals are likely to be taller than lighter individuals
   (c) Taller and lighter individuals are more in number than taller heavier individuals
   (d) There are no individuals of medium weight and medium height

6. A path between points P_1 and P_{10} on a level ground is shown, and positions of a moving object at 1 second intervals are marked. Which of the following statements is correct?



(a) The motion is uniform
(b) The speed between P_3 and P_4 is greater than that between P_5 and P_6
(c) The speed of P_1 to P_2 increases because of downward slope
(d) The section P_3 to P_4 is covered at the slowest speed

7. A new type can be used for at most 90 km. What is the maximum distance (in km) that can be covered by a three wheeled vehicle carrying one spare wheel, all four tyres being new?
(a) 180 (b) 90 (c) 120 (d) 270

8. A plate of $5m \times 2m$ size with uniform thickness, weighing 20 kg, is perforated with 1000 holes of $5cm \times 2cm$ size. What is the weight of teh plate (in kg) after perforation?
(a) 10 (b) 2 (c) 19.8 (d) 18

9. What is the maximum number of cylindrical pencils of 0.5 cm diameter that can be stood in a square shaped stand of 5 cm × 5 cm inner cross section?
(a) 99 (b) 121 (c) 100 (d) 105

10. The sum of two numbers is equal to sum of square of 11 and cube of 9. The larger number is $(5)^2$ less than sqaure of 25. What is the value of the sum of twice of 24 percent of the smaller number and half of the larger number?
(a) 415 (b) 400 (c) 410 (d) 420

11. What is the volume of soil in an open pit of size 2 m × 2 m × 10 cm?
(a) 40 m^3 (b) 0.4 m^3 (c) 0 m^3 (d) 4.0 m^3

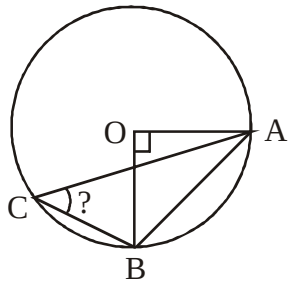
12. For which values of A and B is $\sin A = \cot B$?
(a) $A = B = 0$ (b) $A = B = \frac{\pi}{2}$ (c) $A = 0, B = \frac{\pi}{2}$ (d) $A = \frac{\pi}{2}, B = 0$

13. For which one of the following statements is the converse NOT true?
(a) If a patient dies even with excellent medical care, he likely had terminal illness.
(b) If a person gets employed, he has good qualifications.
(c) If an integer is even, it is divisible by two.
(d) If an integer is odd, it is not divisible by two.

14. Four small squares of side x are cut out of a square of side 12 cm to make a tray by folding the edges. What is the value of x so that the tray has the maximum volume?
(a) 6 cm (b) 2 cm (c) 3 cm (d) 4 cm

15. Two runners A and B start runnign from diametrically opposite points on a circular track in the same direction. If A runs at a constnat speed of 8 km/h and B at a constant speed of 6 km/h and A catches up with B in 30 minutes what is the length of the track?
(a) 1 km (b) 4 km (c) 3 km (d) 2 km

16. Three-quarters of a circle is shown in the figure; OA and OB are two radii perpendicular to each other. C is a point on the circle.



What is angle ACB?
(a) Cannot be determined (b) 30°
(c) 60° (d) 45°

17. If a plant with green leaves is kept in a dark room with only green light ON, which one of the following would we observe?
(a) The plant appears brighter than the surroundings
(b) The plant appears darker than the surroundings
(c) We cannot distinguish the plant from the surroundings
(d) It will have above normal photosynthetic activity

18. A person purchases two chains from a jeweller, one weighing 18 g made of 22 carat gold and another weighing 22 g made of 18 carat gold. Which one of the following statements is correct?

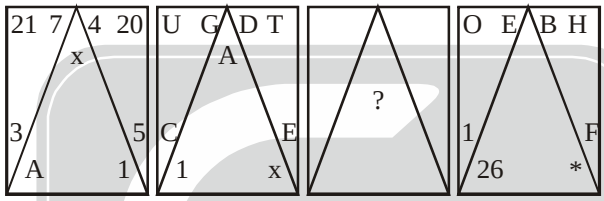
(a) 22 carat chain contains $\frac{2}{11}$ times more gold than 18 carat chain

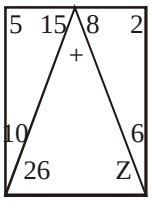
(b) 22 carat cahin contains $\frac{1}{11}$ times more gold than 18 carat chain

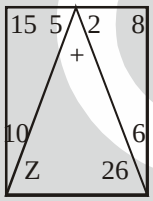
(c) Both chains contain the same quantity of gold

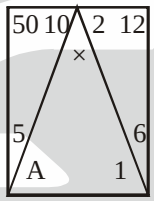
(d) 18 carat chain contains $\frac{2}{11}$ times more gold than 22 carat chain

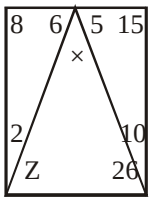
19. Find the missing pattern



(a) 

(b) 

(c) 

(d) 

20. There are small and alrge bacteria of the same species. If S is surface area and V is volume, then which of the following is correct?

(a) $S_{small} > S_{large}$ (b) $V_{small} > V_{large}$

(c) $(S/V)_{small} > (S/V)_{large}$ (d) $(S/V)_{small} < (S/V)_{large}$

PART B

21. Among the following nuclear reactions of thermal neutrons, the cross section is highest for

(a) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{92}U^{235} + {}_{0}n^{1}$ (b) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{92}U^{236}$

(c) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{92}Th^{232} + {}_{2}He^{4}$ (d) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{36}Kr^{94} + {}_{56}Ba^{140} + 2\ {}_{0}n^{1}$

22. Spectrophotometric monitoring is **not** suitable to determine the end point of titration of
(a) oxalic acid vs potassium permanganate (b) iron(II) vs 1, 10-phenanathroline
(c) cobalt(II) vs eriochrome black T (d) nickel (II) vs dimethylglyoxime

23. The first ionization energy is the lowest for
(a) Br (b) Se (c) P (d) As

24. Among ClO_3^-, XeO_3 and SO_3, species with pyramidal shape is/are?

(a) ClO_3^- and X_eO_3 (b) X_eO_3 and SO_3 (c) ClO_3^- and SO_3 (d) SO_3

25. The role of BF_3 as an industrial plymerization catalyst is to generate
(a) carbanion (b) carbocation (c) organic radical (d) cation radical

26. For the following complexes, the increasing order of magnetic moment (spin only value) is

A. $[TiF_6]^{3-}$ B. $[CrF_6]^{3-}$ C. $[MnF_6]^{3-}$ D. $[CoF_6]^{3-}$

(a) D < A < B < C (b) C < A < D < B (c) B ≈ A < D < C (d) A < B < C ≈ D

27. The correct statement for cytochrome *c* is
(a) It is a non-heme protein
(b) The coordination numer of iron in cytochrome *c* is five
(c) It is a redox protein and an electron carrier
(d) It can store or carry dioxygen

28. Geometries of SNF_3 and XeF_2O_2, respectively, are
(a) square planar and square planar (b) tetrahedral and tetrahedral
(c) square planar and trigonal bipyramidal (d) tetrahedral and trigonal bipyramidal

29. The IR spectrum of $Co(CO)_4H$ shows bands at 1221, 2062, 2043 and 1934 cm^{-1}. The V_{Co} - D (in $cm^{-1)}$ expected in the spectrum of $Co(CO)_4D$ is
(a) 2111 (b) 1396 (c) 2053 (d) 1910

30. In trigonal prismatic ligand field, the most stabilized *d* orbital is

(a) d_z^2 (b) d_{xy} (c) d_{xz} (d) d_{yz}

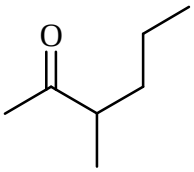
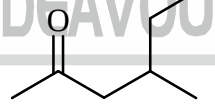
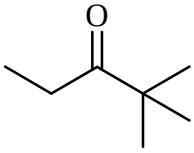
31. The most **unstable** complex on the basis of electro-neutrality principle among the following is

(a) $\left[Al(OH_2)_6\right]^{3+}$ (b) $\left[Al(NH_3)_6\right]^{3+}$ (c) $[AlF_6]^{3-}$ (d) $\left[Al(NCCH_3)_6\right]^{3+}$

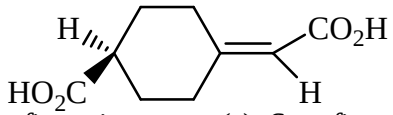
32. The band in the electronic spectrum of I_2 appearing at 520 nm will undergo maximum blue shift in
(a) water (b) hexane (c) benzene (d) methanol

33. **Mismatch** among the following is
(a) Sharp transition and fluorescence in lanthanides (b) Broad bands and *d-d* transitions
(c) Very high spin-orbit coupling and transition elements
(d) Charge transfer and molar absorptivity of the order of 10^4 L mol^{-1} cm^{-1}

34. Among the following, the compound that gives base peak at m/z 72 in the El mass spectrum is

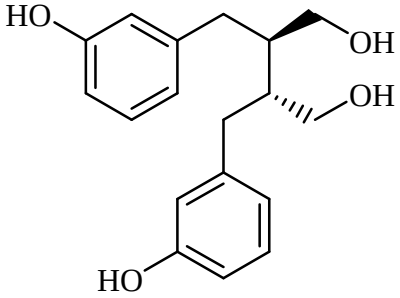
(a)  (b)  (c)  (d) 

35. The following molecule has



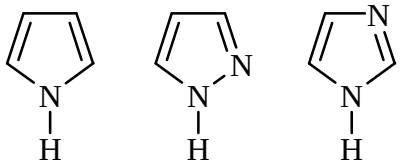
(a) plane of symmetry (b) *R* configuration (c) *S* configuration (d) centre of symmetry

36. The following natural product Enterodiol is a



(a) terpene (b) steroid (c) lignan (d) alkaloid

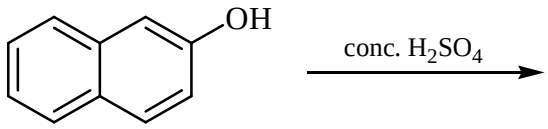
37. The correct order of basicity for the following heterocycles is

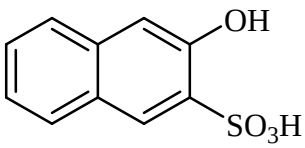


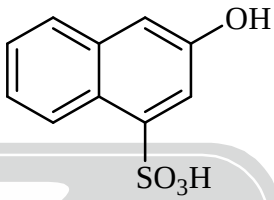
A B C

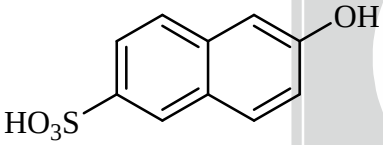
(a) A > C > B (b) C > A > B (c) C > B > A (d) B > A > C

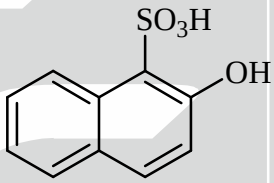
38. The kinetic product formed in the following reaction is



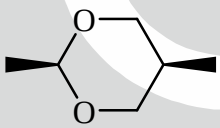
(a) 

(b) 

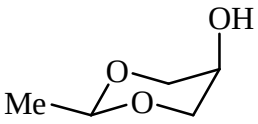
(c) 

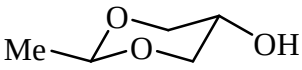
(d) 

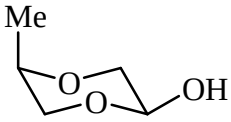
39. Among the structures given below, the one that corresponds to the most stable conformation of compound A is

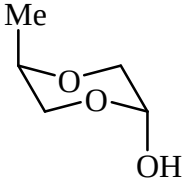


A

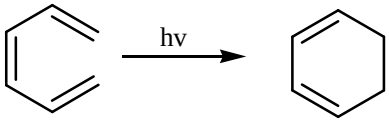
(a) 

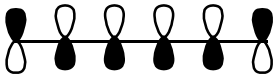
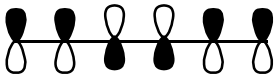
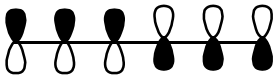
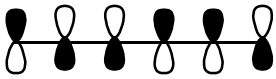
(b) 

(c) 

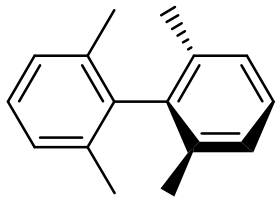
(d) 

40. According to Frontier Moleculaor Orbital (FMO) Theory, the Highest Occupied Molecular Orbital (HOMO) of hexatriene in the following reaction is



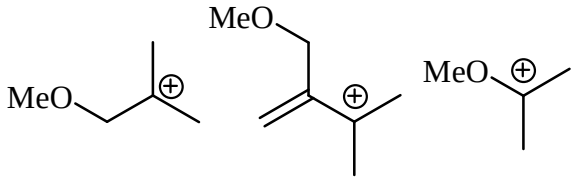
(a) 
(b) 
(c) 
(d) 

41. The number of signals observed in the proton decoupled ^{13}C NMR spectrum of the following compound is



(a) Five (b) Six (c) Ten (d) Thirteen

42. The correct order of stability of the following carbocations is



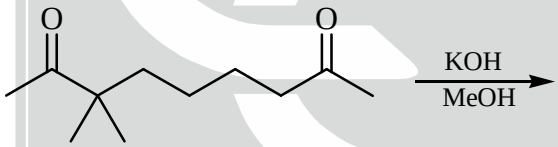
(A) (B) (C)

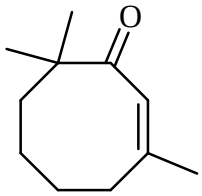
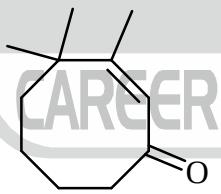
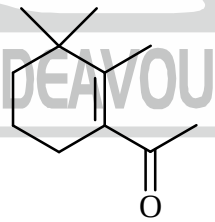
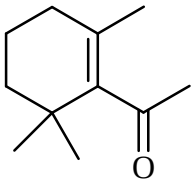
(a) A > C > B (b) B > C > A (c) C > A > B (d) C > B > A

43. An optically pure organic compound has specific rotation of +40°. The optical purity of the sample that exhibits specific rotation of +32° is

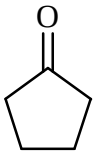
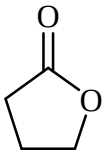
(a) 8% (b) 12% (c) 20% (d) 80%

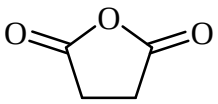
44. The major product formed in the following reaction is



(a) 
(b) 
(c) 
(d) 

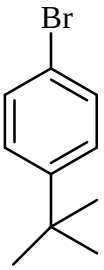
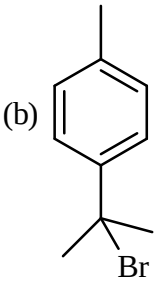
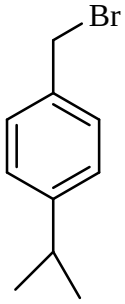
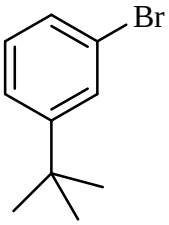
45. Correct match of the compounds in Column P with the IR stretching frequencies (cm^{-1}) in Column Q is

Column P	Column Q
I 	A 1865
II 	B 1770

III  C 1745

(a) I - B; II - C; III - A (b) I - C; II - A; III - B (c) I - C; II - B; III - A (d) I - A; II - C; III - B

46. The organic compound that displays following data is
^{1}HNMR (400 MHz): δ 7.38 (d), 7.25 (d), 1.29 (s) ppm

(a) 
(b) 
(c) 
(d) 

47. The molecule with a C_2 axis of symmetry among the following is
(a) BH_2Cl (b) CH_3Cl (c) NH_2Cl (d) $HOCl$

48. The molecule that will show Raman spectrum, but not IR spectrum, among the following is
(a) H_2 (b) HCl (c) $BrCl$ (d) CS_2

49. Boron in BCl_3 has
(a) *sp* hybridization (b) sp^2 hybridization (c) sp^3 hybridization (d) no hybridization

50. The number of degenerate spatial orbitals of a hydrogen-like atom with principal quantum number $n = 6$ is
(a) 12 (b) 6 (c) 72 (d) 36

51. If $\left[\hat{A},\hat{B}\right]=0$ and $\left[\hat{A},\hat{C}\right]=0$, then which of the following **necessarily** holds: $\left[\hat{A},\hat{B}\text{ and }\hat{C}\text{ are operators}\right]$
(a) $\left[\hat{B},\hat{C}\right]=0$ (b) $\left[\hat{A},\widehat{BC}\right]=0$ (c) $\left[\hat{B},\widehat{AC}\right]=0$ (d) $\left[\hat{C},\widehat{AB}\right]=0$

52. The correct statement among the following is ($\hat{A}$ is a hermitian operator)
(a) The eigenvalues of $\widehat{A^2}$ can be negative.
(b) The eigenvalues of $\widehat{A^2}$ are always positive
(c) No eigenvalues of $\hat{A}$ is an eigenfuncation of $\widehat{A^2}$.
(d) The eigenvalues of $\widehat{A^2}$ can be complex.

53. If the atoms/ions in the crystal are taken to be hard spheres touching each other in the unit cell, then the fraction of volume occupied in the body centered cubic structure is
(a) $\sqrt{3}\pi$ (b) $\frac{\sqrt{2}\pi}{6}$ (c) $\frac{\pi}{6}$ (d) $\frac{\sqrt{3}\pi}{8}$

54. Repeated measurements of *Pb* in a lake water sample gave 3.2, 5.2 and 7.2 *ppb* of *Pb*. Standard deviation int eh measurement of *Pb* is
(a) 2 *ppb* (b) 4 *ppb* (c) 0 *ppb* (d) $\sqrt[2]{2}$ *ppb*

55. The stability of lyophobic colloids is a consequence of the
(a) electrical double layer at the surface of the particles.
(b) van der Waals force between the particles.
(c) small particle size.
(d) shape of the particles.

56. The equivalent conductance at infinite dilution of a strong electrolyte (Λ_0) can be obtained from the plot of

(a) Λ vs. C (b) Λ vs. $\sqrt{C}$ (c) Λ vs. C^2 (d) Λ vs. $\frac{1}{C}$

57. The number-average molar mass $(\bar{M}_n)$ for a monodisperse polymer is related to the weight-average molar mass $(\bar{M}_w)$ by the relation

(a) $\bar{M}_n = \frac{\bar{M}_w}{3}$ (b) $\bar{M}_n = \frac{\bar{M}_w}{4}$ (c) $\bar{M}_n = 2\bar{M}_w$ (d) $\bar{M}_n = \bar{M}_w$

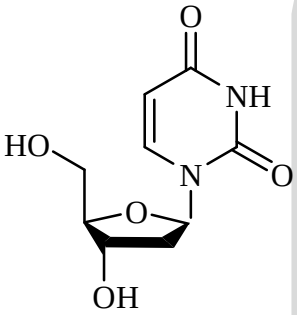
58. For a sequence of consecutive reactions, $A \xrightarrow{k_1} I \xrightarrow{k_2} P$ the concentration of I would be, by steady state approximation.

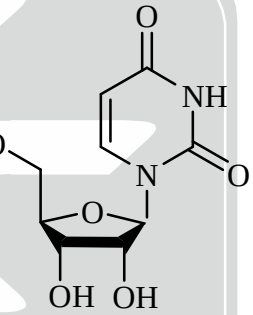
(a) $k_1[A]$ (b) $(k_1 + k_2)[A]$ (c) $k_1 k_2 [A]$ (d) $\frac{k_1}{k_2}[A]$

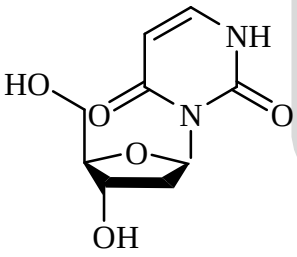
59. Enthalpy is equal to

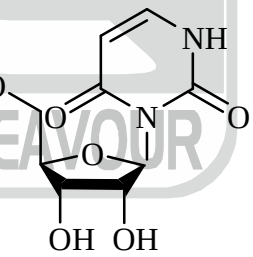
(a) $TS + PV + \sum u_i n_i$ (b) $TS + \sum u_i n_i$ (c) $\sum u_i n_i$ (d) $PV + \sum u_i n_i$

60. The structure of ribonucleoside uridine is

(a) 

(b) 

(c) 

(d) 

PART C

61. The peak area of differential thermal analysis curve is proportional to one or more of the following:

A. mass loss

B. mass of the sample

C. heat of decomposition/phase change

The correct answer is

(a) A only (b) B only (c) A and C (d) B and C

62. To determine the bond parameters at 25°C, electron diffraction is generally unsuitable for both

(a) O_3 and NO_2 (b) Sulfur and dry ice (c) NO_2 and sulfur (d) O_3 and dry ice

63. Match lanthanides in Column I with their properties in Column II

Column I	**Column II**
A. Lu	(i) Reagent in oxidation state IV
B. Eu	(ii) Ml_2 of metallic lustre
C. Ce	(iii) Diamagentic M(III)
D. Tb	(iv) Pink in oxidation state III

Correct match is

(a) A-(iii), B-(ii); C-(i); D-(iv) (b) A-(ii), B-(iii); C-(iv); D-(i)
(c) A-(iv), B-(ii); C-(i); D-(iii) (d) A-(iii), B-(ii); C-(iv); D-(i)

64. Among the following species isolobal to CH_2 are

A. $CpCr(CO)_2$ B. CpCu C. $Ni(CO)_2$ D. $Cr(CO)_4$
E. $Fe(CO)_4$

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

65. Choose the **incorrect** statement for the phosphomolybdate anino, $[PMO_{12}O_{40}]^{3-}$.

(a) It has a Keggin structure.
(b) Phosphorus is in +5 oxidation state.
(c) It is extremely basic.
(d) It forms crystalline precipitates with $[R_4N]^+$ (R = bulky alkyl or aryl group)

66. Consider the following statement(s) for actinides (**An**):

A. Oxidation states greater than +3 are more frequent in **An** compared to lathanides **(Ln)**
B. Some **An**(III) ions show *d-d* transitions
C. UO_2^{2+} and PuO_2^{2+} are stable
D. Some of actinides do not have radioactive isotopes

The correct answer is

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

67. According to Bent's rule, for *p*-block elements, the correct combination of geometry around the central atom and position of more electro-negative substituent is

(a) Trigonal bipyramidal and axial (b) Triogonal bipyramidal and equatorial
(c) Square pyramidal and axial (d) Square pyramidal and basal

68. Allred-Rochow electronegativity of an element is

A. directly proportional to the effective nuclear charge
B. directly proportional to the covalent radius
C. inversely proportional to the square of the covalent radius
D. directly proportional to the square of the effective nuclear charge

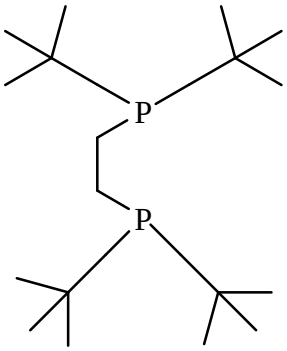
The correct answer is

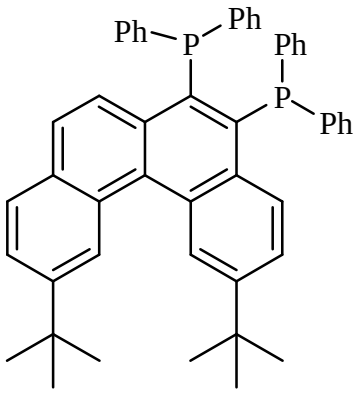
(a) A and B (b) A and C (c) B and C (d) A and D

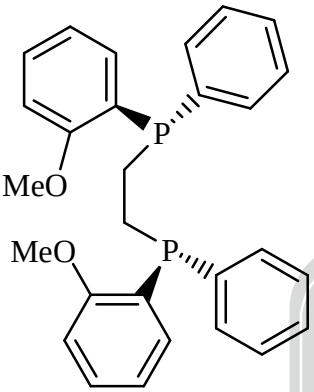
69. Br_2 with propanone forms a charge transfer complex and l_2 forms triiodide anion with I^-. This implies that

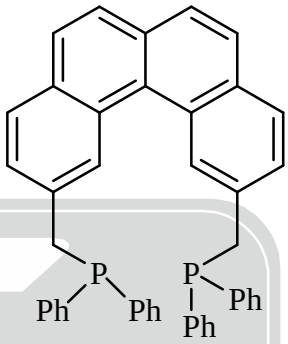
(a) both Br_2 and I_2 act as bases (b) both Br_2 and I_2 act as acids
(c) Br_2 acts as an acid and I_2 acts as a base (d) Br_2 acts as a base and I_2 acts an an acid

70. In the complex [Pd(L-L)(Me)(Ph)], the bisphosphine (L-L) that **does not** allow reductive elimination of PhMe, is

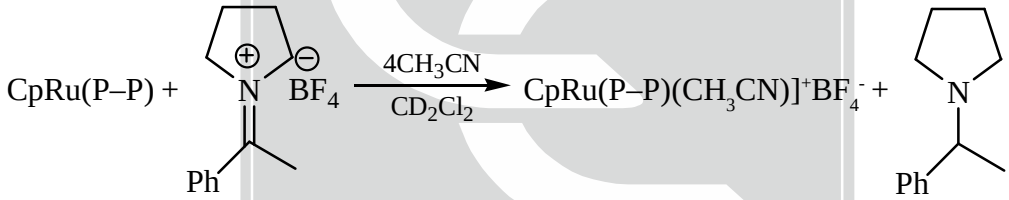
(a) 

(b) 

(c) MeO 

(d) 

71. In the reaction given below, the bisphosphine (P-P) that is in effective for transfer hydrogenation reaction is



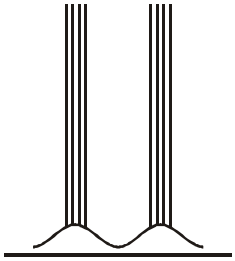
(a) Diphenylphosphinomethane (b) 1, 2-Diphenylphosphinoethane
(c) 1, 3-Diphenylphosphinopropane (d) 1, 4-Diphyenylphosphinobutane

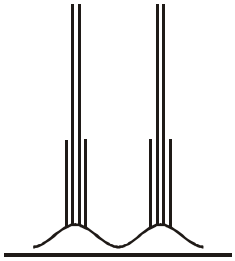
72. For high spin and low spin d^6 octahedral complexes (ML_6), the generally observed spin allowed transitions, respectively, are
(a) two and one (b) one and two (c) zero and one (d) two and two

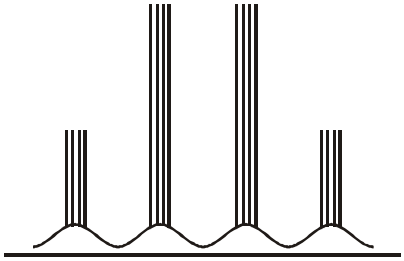
73. The reactions given below,
A. $Cl_2 + 2H_2O \rightarrow HOCl + H_3O^+ + Cl^-$
B. $Cl_2 + 2NH_3 \rightarrow NH_2Cl + NH_4 + Cl^-$
are examples of
(a) disproportionation only (b) disproportionation (A) and solvation (B)
(c) solvation (A) and disproportionation (B) (d) solvalysis as well as disproportionation

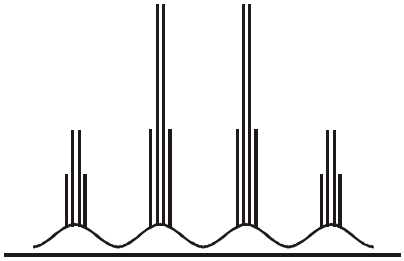
74. According to Wade's rules, the *cluster type and geometry* of $[Sn_9]^{4-}$, respectively, are
(a) *closo* and tricapped trigonal prismatic (b) *nido* and monocapped square-antiprismatic
(c) *arachno* and heptagonal bipyramidal (d) *closo* and monocapped square antiprismatic

75. Assuming ${}^1J_{PH} > {}^1J_{PB}$, the expected ^{31}P NMR spectrum of $H_3P: {}^{11}BCl_3$ [for ^{11}B, I = 3/2] is

(a) 

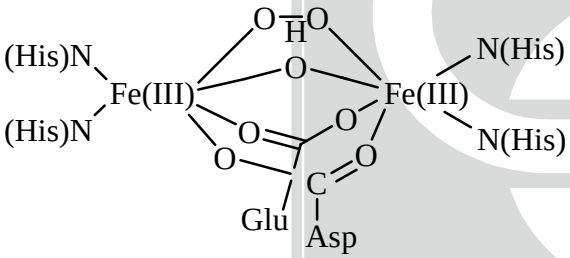
(b) 

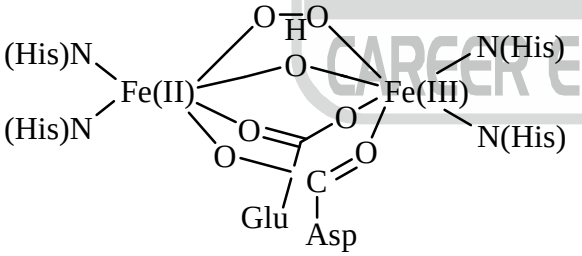
(c) 

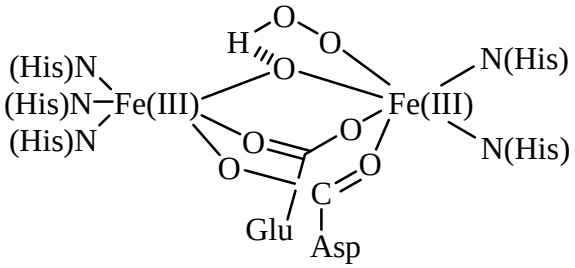
(d) 

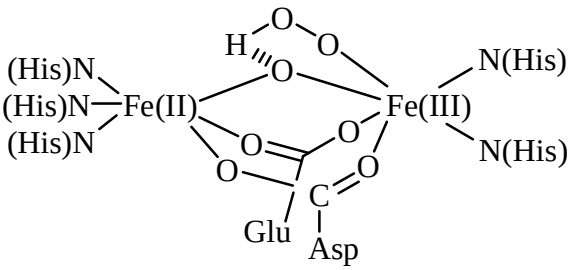
76. The geometry around Cu and its spin state for K_3CuF_6 and $KCuL_2$, [$H_2L = H_2NCONHCONH_2$], respectively are:
(a) (octahedral, high-spin) and (square planar, low-spin)
(b) (octahedral, low-spin) and (square planar, low-spin)
(c) (trigonal prismatic, high-spin) and (tetrahedral, high-spin)
(d) (trigonal prismatic, low-spin) and (tetrahedral, high-spin)

77. The active site structure for oxy-hemerythrin is:

(a) 

(b) 

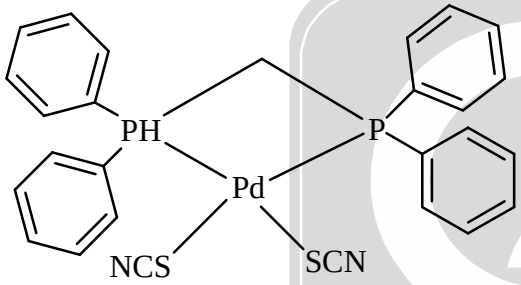
(c) 

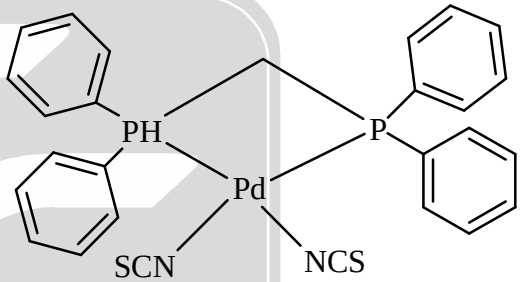
(d) 

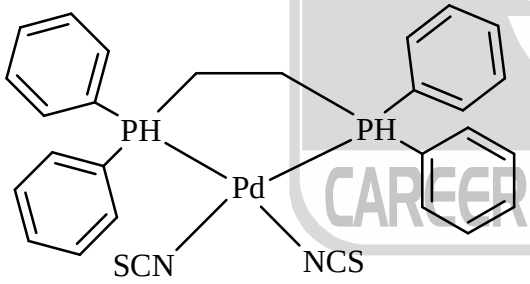
78. Consider the following statements with respect to the base hydrolysis of $[CoCl(NH_3)_5]^{2+}$ to $[Co(NH_3)_5(OH)]^{2+}$.
A. One of the ammonia ligands acts as a Bronsted acid.
B. The entering group is water.
C. A heptacoordinated Co^{3+} species is an intermediate.
The correct statement(s) is/are
(a) A and B (b) A and C (c) B and C (d) C only

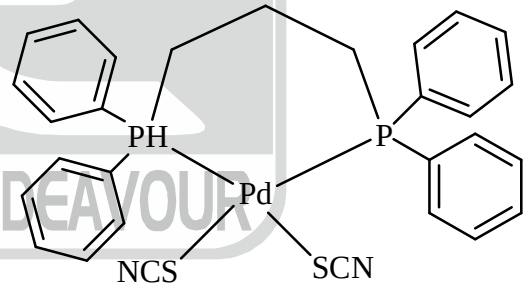
79. The number of inorganic sulfides in cubane like ferredoxin and their removal method, respectively, are
(a) eight and washing with an acid (b) four and washing with a base
(c) eight and washing with a base (d) four and washing with an acid

80. Considering the ambidentate behaviour of thiocyanante ion, the most stable structure among the following is

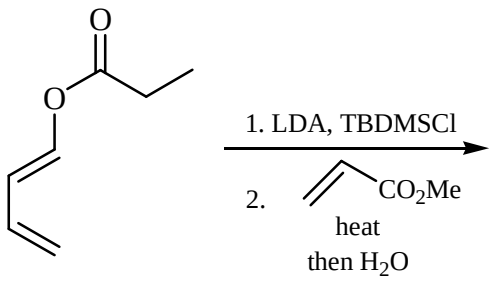
(a) 

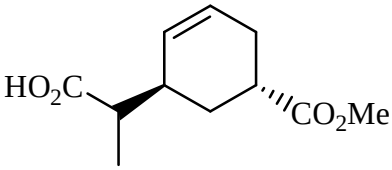
(b) 

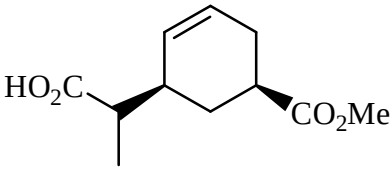
(c) 

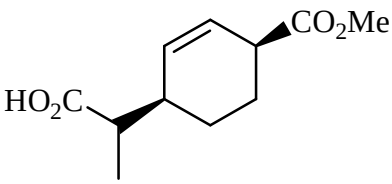
(d) 

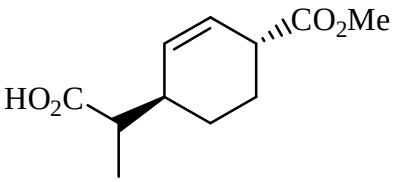
81. Major product of the following reaction is



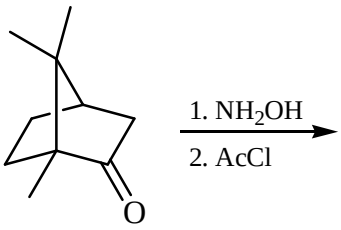
(a) 

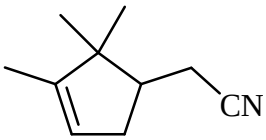
(b) 

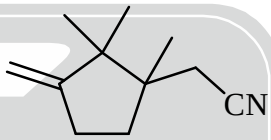
(c) 

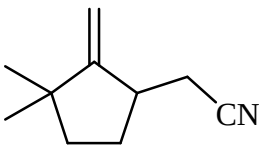
(d) 

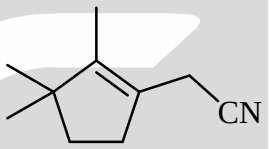
82. Major product in the following reaction is



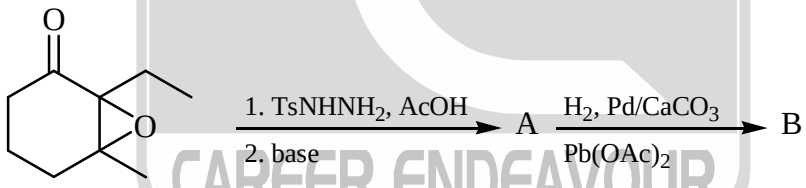
(a) 

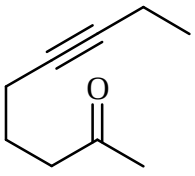
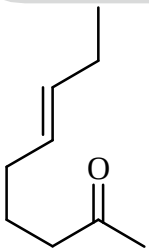
(b) 

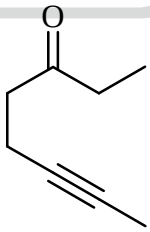
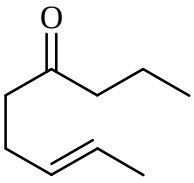
(c) 

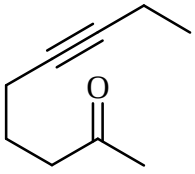
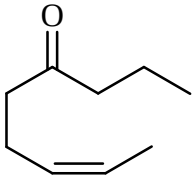
(d) 

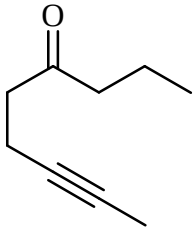
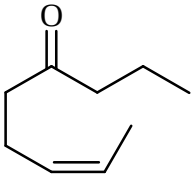
83. Major products A and B of the following reaction sequence are



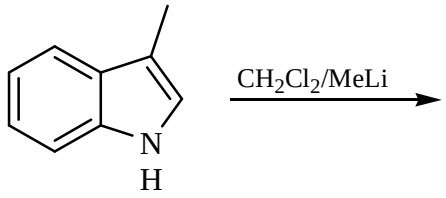
(a) A =  B = 

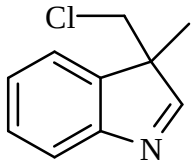
(b) A =  B = 

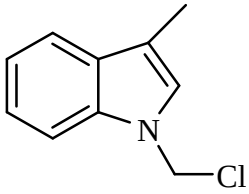
(c) A =  B = 

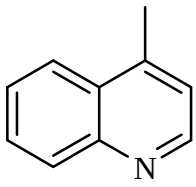
(d) A =  B = 

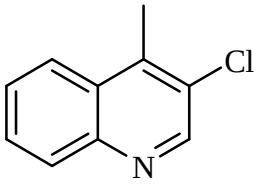
84. The major product formed in the following reaction is



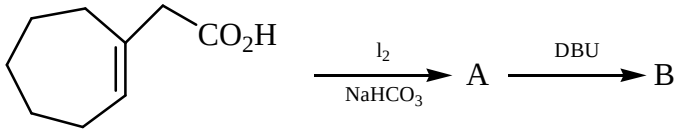
(a) 

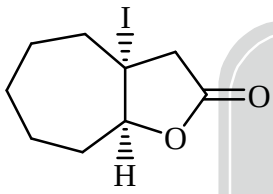
(b) 

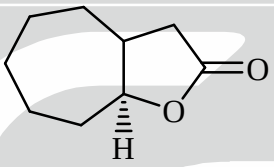
(c) 

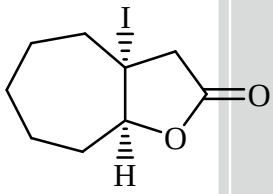
(d) 

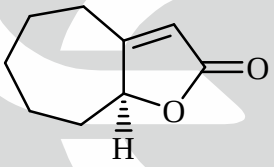
85. Major products A and B of the following reaction sequence are

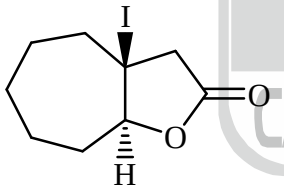


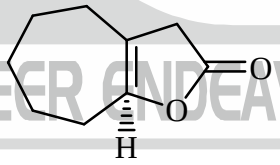
(a) A = 

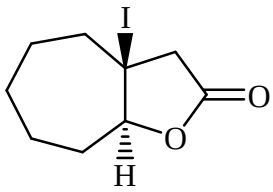
B = 

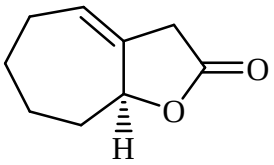
(b) A = 

B = 

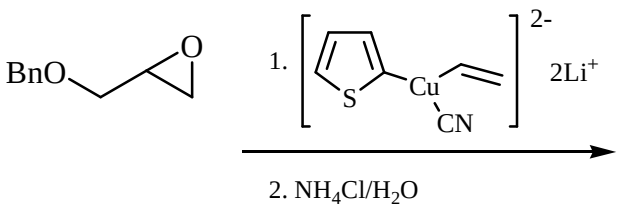
(c) A = 

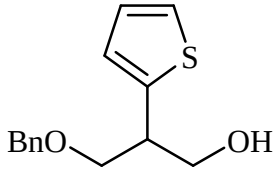
B = 

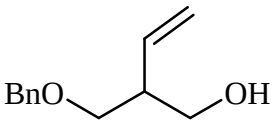
(d) A = 

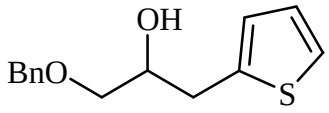
B = 

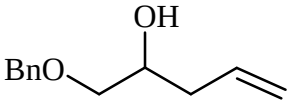
86. The major product formed in the following reaction is



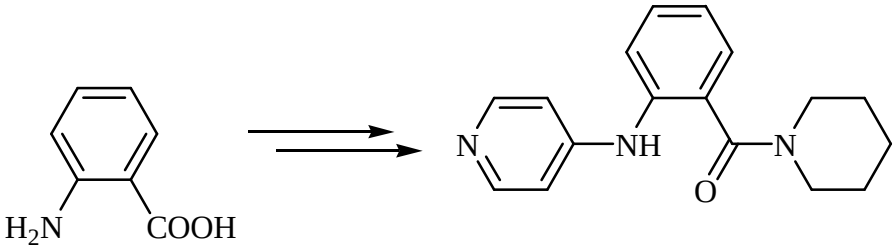
(a) 

(b) 

(c) 

(d) 

87. Correct sequence of reagents (i)-(iii) required for the conversion of A to B is

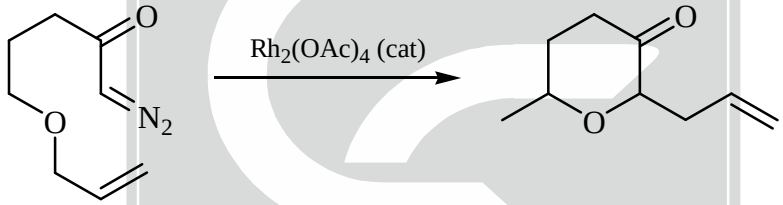


(A) (B)

A. Thionyl chloride, B. 4-Chloropyridine C. Piperidine

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

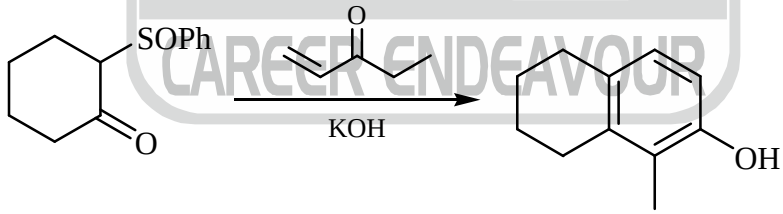
88. The following reaction involves



(a) [1, 2] sigmatropic rearrangement (b) [2, 3] sigmatropic rearrangement

(c) [3, 3] sigmatropic rearrangement (d) C-H insertion reaction

89. Correct sequence of steps involved in the following transformation is



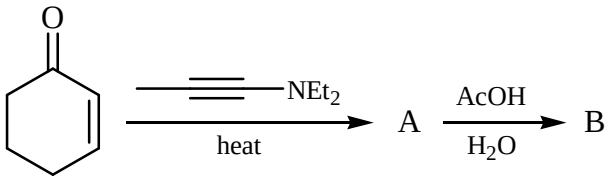
(a) Michael addition, aldol condensation, *syn*-elimination, keto-enol tautomerism

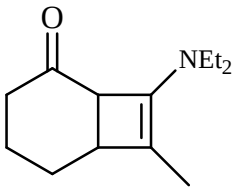
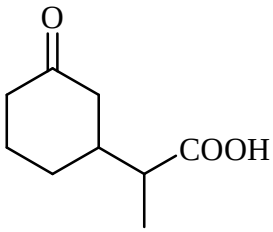
(b) aldol condensation, electrocyclic ring closing, *syn*-elimination, dehydrogenation

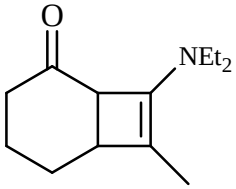
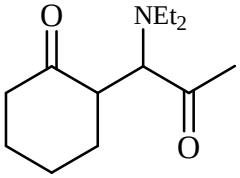
(c) Michael addition, Claisen condensation, *anti*-elimination, keto-enol tautomerism

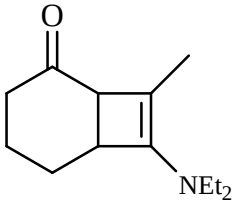
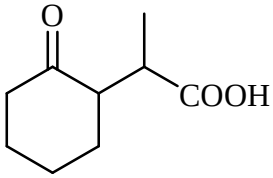
(d) Robinson annulation, dehydrogenation, *anti*-elimination

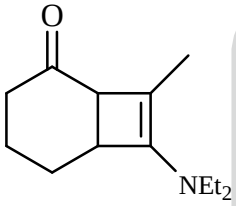
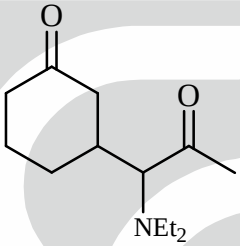
90. The major products **A** and **B** in the following reaction sequence are



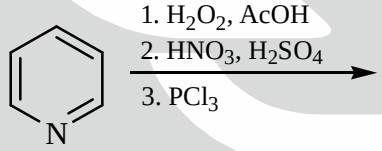
(a) A =  B = 

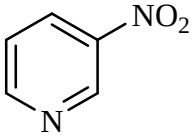
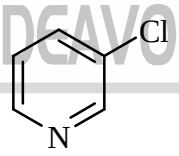
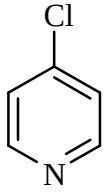
(b) A =  B = 

(c) A =  B = 

(d) A =  B = 

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

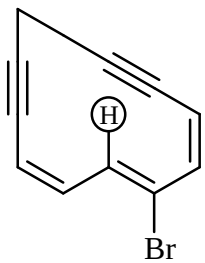


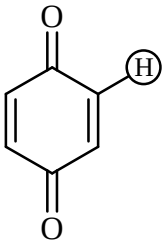
(a)  (b)  (c)  (d) 

92. The number of optically active steroisomers possible for CH_3–CH(OH)–CH(OH)–CH(OH)–CH_3 is

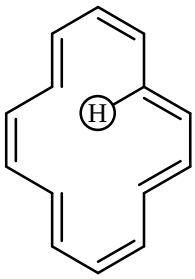
(a) two (b) four (c) six (d) eight

93. The correct match of the circled protons in Column P with ^1H NMR chemical shift (δ ppm) in Column Q is

P		Q
I		A 6.72

II 

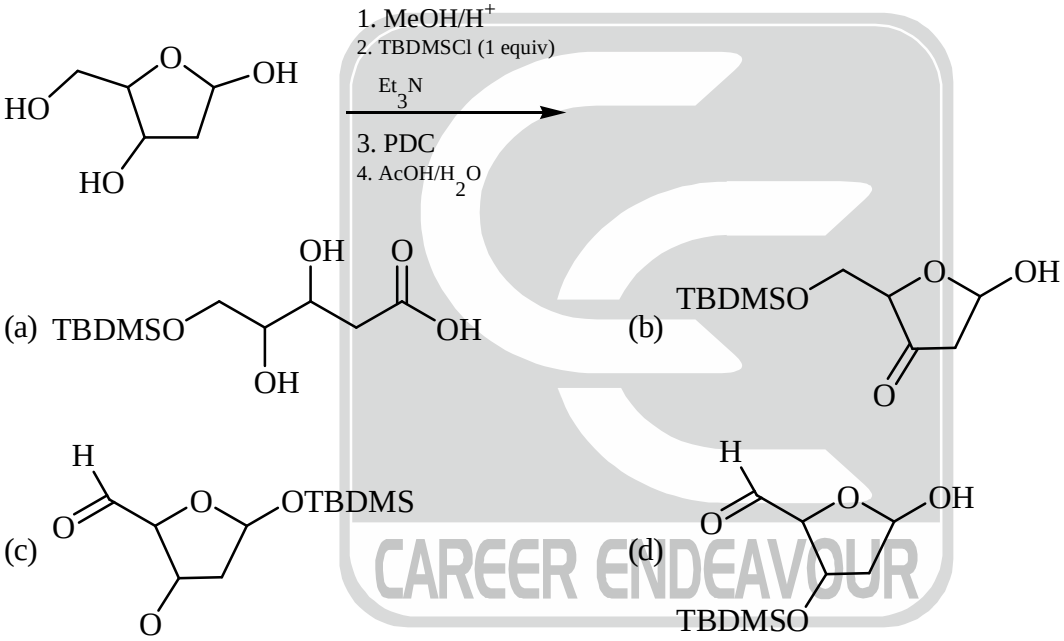
B 16.4

III 

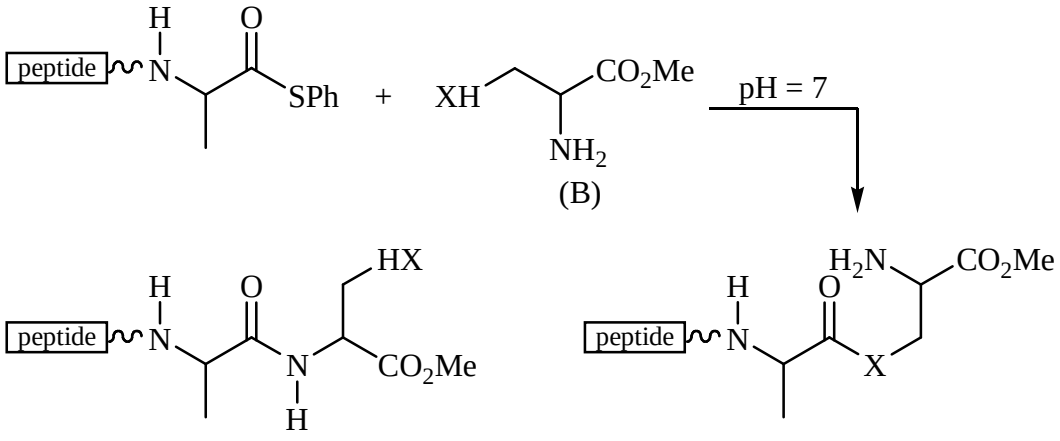
C –0.61

(a) I-A; II-B; III-C (b) I-B; II-A; III-C (c) I-B; II-C; III-A (d) I-C; II-B; III-A

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

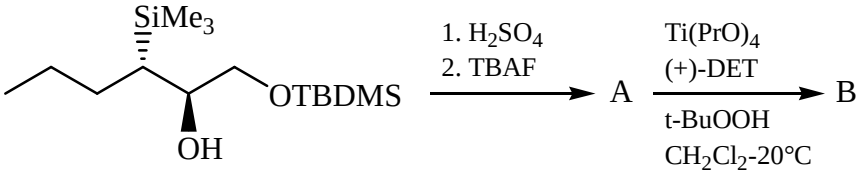


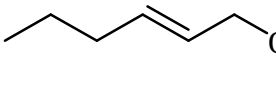
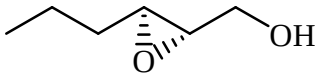
95. For the successful synthesis of peptide linkage leading to the product **A**, the side chain of the amino acid **D** should have

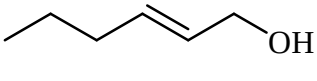
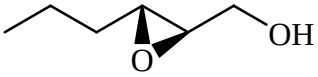


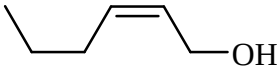
(a) XH = – OH (b) XH = –$(CH_2)_4$NH (c) XH = – *p* – (C_6H_4)OH (d) XH = –SH

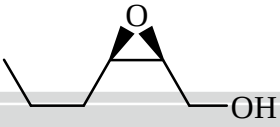
96. The major products **A** and **B** in the following reaction sequence are



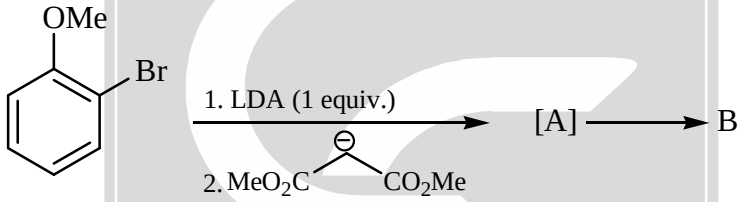
(a) A =  B = 

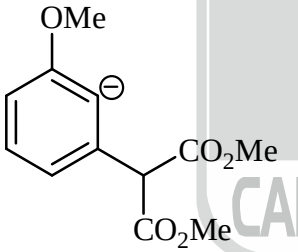
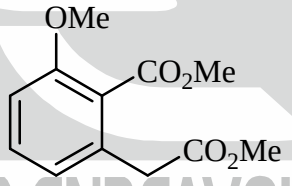
(b) A =  B = 

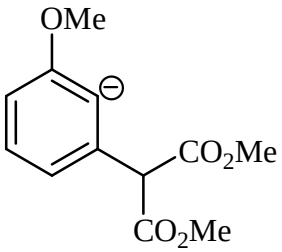
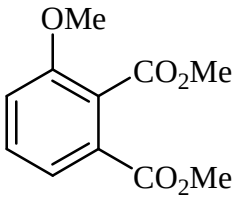
(c) A =  B = 

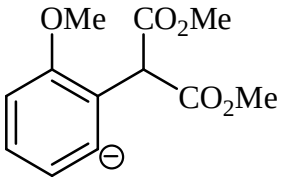
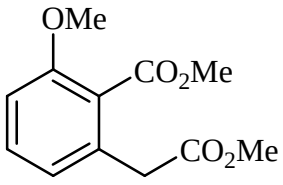
(d) A =  B = 

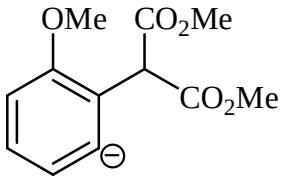
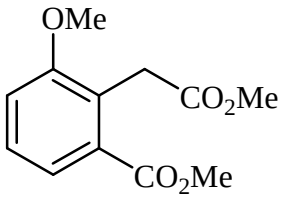
97. The intermediate **A** and the major product **B** in the following reaction are



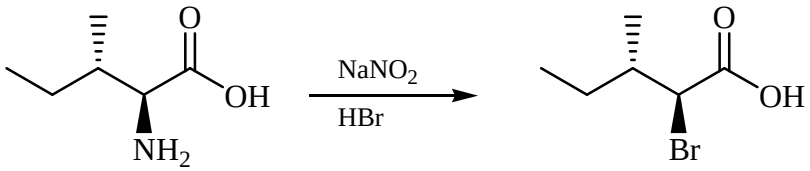
(a) A =  B = 

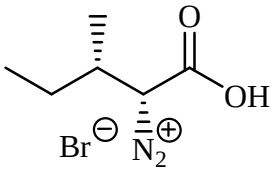
(b) A =  B = 

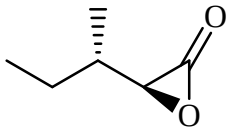
(c) A =  B = 

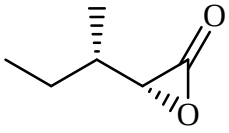
(d) A =  B = 

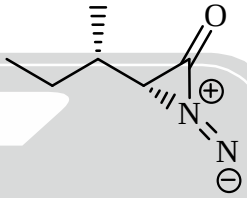
98. The correct intermediate which leads to the product in the following reaction is



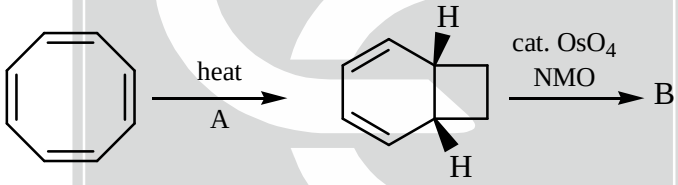
(a) 

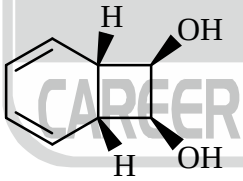
(b) 

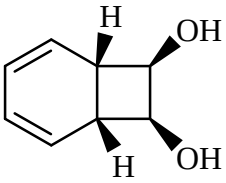
(c) 

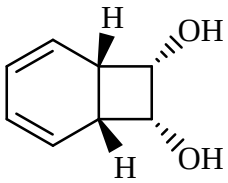
(d) 

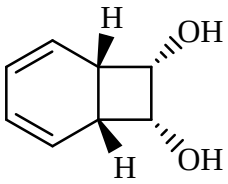
99. In the following transformation, the mode of electrocyclization **A** and the major product **B** are



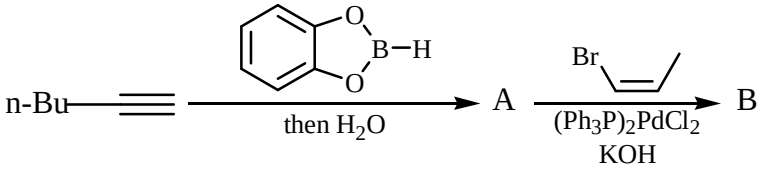
(a) A = (4n) e^-, dis B = 

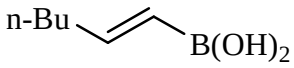
(b) A = (4n + 2) e^-, dis B = 

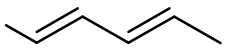
(c) A = (4n) e^-, con B = 

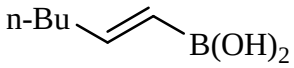
(d) A = (4n + 2) e^-, con B = 

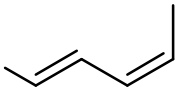
100. The major products **A** and **B** in the following reaction sequence are



(a) A = 

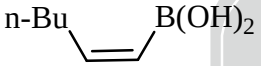
B = 

(b) A = 

B = 

(c) A = 

B = 

(d) A = 

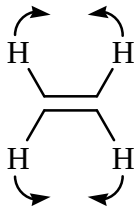
B = 

101. The correct statement about the symmetry of the eigenfunctions of a quantum of 1-D harmonic oscillator is
(a) All the eigenfunctions are only even functions, because the potential is an even function.
(b) All the eigenfunction are only odd functions, although the potential is an even function.
(c) The eigenfunctions have no odd-even symmetry.
(d) All the eigenfunctions are either odd or even functions, because the potential is an even function.

102. The correct statement about the difference of second and first excited state energies (ΔE) of a particle in 1-D, 2-D square and 3-D cubic boxes with same length for each, is
(a) ΔE (1 – D box) = ΔE (2 – D box) = DE (3 – D box)
(b) ΔE (1 – D box) > ΔE (2 – D box) > DE (3 – D box)
(c) ΔE (1 – D box) > ΔE (2 – D box) = DE (3 – D box)
(d) ΔE (1 – D box) < ΔE (2 – D box) < DE (3 – D box)

103. A one-dimensional quantum harmonic oscillator is perturbed by a potential λx^3. The first order correction to the energy for the ground state ($\Delta E^{(1)}$) is
(a) $\Delta E^{(1)} > 0$ but < 1 (b) $\Delta E^{(1)} < 0$ (c) $\Delta E^{(1)} = 0$ (d) $\Delta E^{(1)} > 2$

104. The normal mode of ethylene represented, by the figure below, is



(a) only IR active
(b) only Raman active
(c) both IR and Raman active
(d) neither IR nor Raman active

105. The pair that contains a spherical top and a symmetric top, among the following, is
(a) CH_4, CH_2Cl_2 (b) CH_2Cl_2, CH_3Cl (c) CH_3Cl, CH_4 (d) $CH_4, C(CH_3)_4$

106. A part of the character table of a point group (of order 4) is given below.

	E	X_1	X_2	X_3
Γ_1	1	1	1	1
Γ_2	1	−1	1	−1
Γ_3	1	−1	−1	1
Γ_4	?	?	?	?

The four characters of Γ_4 are, respectively
(a) 1, 1, –1, –1 (b) 2, 0, 0, 1 (c) 1, i, i, 1 (d) 1, –i, i, –1

107. The electronic transition energy from $\pi_1 \rightarrow \pi_2$ in propenyl radical is 4.8 eV. Within the frame work of Huckel theory, the transitions energy from $\pi_1 \rightarrow \pi_3$ would be
(a) 2.4 eV (b) 4.8 eV (c) 9.6 eV (d) 14.4 eV

108. The g-factors of ^1H and ^{13}C are 5.6 and 1.4 respectively. For the same value of the magnetic field strength, if the ^1H resonates at 600 MHz, the ^{13}C would resonate at
(a) 2400 MHz (b) 600 MHz (c) 150 MHz (d) 38 MHz

109. The term symbol for the ground state of a metal ion is $^3P_2$. The residual entropy of a crystal of a salt of this metal ion at 0 K is
(a) $k_B \ln 1$ (b) $k_B \ln 3$ (c) $k_B \ln 5$ (d) $k_B \ln 7$

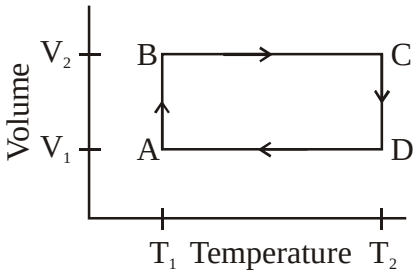
110. In stretching of a rubber band,
$dG = V\,dp - SdT + f\,dL$
Which of the following relations in true?

(a) $\left(\frac{\partial S}{\partial L}\right)_{p,T} = -\left(\frac{\partial f}{\partial T}\right)_{p,L}$ (b) $\left(\frac{\partial S}{\partial L}\right)_{p,T} = -\left(\frac{\partial f}{\partial V}\right)_{p,L}$

(c) $\left(\frac{\partial S}{\partial L}\right)_{p,T} = -\left(\frac{\partial V}{\partial T}\right)_{p,L}$ (d) $\left(\frac{\partial S}{\partial L}\right)_{p,T} = -\left(\frac{\partial f}{\partial p}\right)_{T,L}$

111. Four distinguishable molecules are distributed in energy levels E_1 and E_2 with degeneracy of 2 and 3, respectively. Number of microstates, with 3 molecules in energy level E_1 and one in energy level E_2, is
(a) 4 (b) 12 (c) 96 (d) 192

112. One mole of an ideal gas undergoes a cyclic process (ABCDA) starting from point A through 4 reversible steps as shown in the figure. Total work done in the process is



(a) $R(T_1 - T_2)\frac{V_2}{V_1}$ (b) $R(T_1 + T_2)\frac{V_2}{V_1}$ (c) $R(T_1 + T_2)\ln\frac{V_2}{V_1}$ (d) $R(T_2 - T_1)\ln\frac{V_2}{V_1}$

113. If the specific conductance of an electrolyte solution is $0.2\,\Omega^{-1}$ cm^{-1} and cell constant is 0.25 cm^{-1}, the conductance of the solution is

(a) 1.25 Ω^{-1} (b) 1.0 Ω^{-1} (c) 0.8 Ω^{-1} (d) 2.0 Ω^{-1}

114. The predicted electromotive force (emf) of the electrochemical cell

$Fe(s)/Fe^{2+}(aq)(0.01\,M)\,\|\,Cd^{2+}(aq)(0.01\,M)/Cd(s)$ is

$\left(E^0_{(Fe^{2+}/Fe)} = -0.447\text{ V and } E^0_{(Cd^{2+}/Cd)} = -0.403\text{ V}\right)$

(a) –0.850 V (b) +0.044 V (c) +0.0850 V (d) –0.044 V

115. A polymer has the following molar mass distribution

Number of molecules	Molar mass ($g.mol^{-1}$)
50	5000
75	6000

The calculated number average molar mass $(\bar{M}_n)$ of the polymer is

(a) 5200 (b) 5600 (c) 5800 (d) 6000

116. The separation of the (123) planes of an orthorhombic unit cell is 3.12 nm. The separation of (246) and (369) planes are, respectively,

(a) 1.56 nm and 1.04 nm (b) 1.04 nm and 1.56 nm
(c) 3.12 nm and 1.50 nm (d) 1.04 nm and 3.12 nm

117. The slope and intercept obtained from (1/Rate) against (1/substrate concentration) of an enzyme catalyzed reaction are 300 and 2×10^5, respectively. The Michaelis-Menten constants of the enzyme in this reaction is

(a) 5×10^6 M (b) $5 \times M^{-6}$ M (c) 1.5×10^3 M (d) 1.5×10^{-3} M

118. The pressure inside (P_{in}) a spherical cavity with a radius r formed in a liquid with surface tension γ is related to the external pressure (P_{out}) as

(a) $P_{in} = P_{out} - \frac{2\gamma}{r}$ (b) $P_{in} = P_{out} + \frac{2\gamma}{r}$ (c) $P_{in} = P_{out} - \frac{\gamma}{r}$ (d) $P_{in} = P_{out} + \frac{\gamma}{r}$

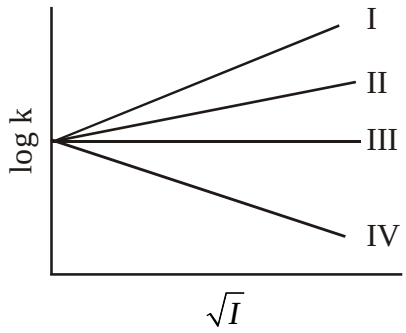
119. Reaction between A and B is carried out for different initial concentrations and the corresponding half-life times are measured. The data listed in the table:

Entry	$[A_0](\mu M)$	$[B]_0(\mu M)$	$t_{1/2}$(sec)
1	500	10	60
2	500	20	60
3	10	500	60
4	20	500	30

The rate can be represented as

(a) $k[A][B]$ (b) $k[A]^2$ (c) $k[A]^2[B]$ (d) $k[A][B]^2$

120. The plot of the rate constant vs. ionic strength of the reaction $A^{2+} + B^-$ follows the line (refer to the figure)



(a) I (b) II (c) III (d) IV