PART – A

1. If the product of three consecutive positive integers is equal to their sum, then what would be the sum of their squares?

1. 9 2. 14 3. 16 4. 24

2. A tall metal cylinder is filled end-to-endwith n snugly fitting spherical wax balls of diameter d. If the balls melt completely, the volume fraction occupied by the melted wax is

1. independent of both *d* and *n*
2. dependent on both *d* and *n*
3. independent of *d*, but dependent on *n*
4. dependent on *d*, but independent of *n*

3. Some fisherman caught some fish. No one caught more than 20 fish. a_1 number of fisherman caught at least one fish among them, a_2 number of fisherman caught at least two fish among them, and so on and a_{20} number of fishermen caught exactly 20 fish among them. How many fish were caught?

1. $a_1 + a_2 + a_3 + \ldots\ldots + a_{20}$
2. $a_1 + 2a_2 + 3a_3 + \ldots + 20a_{20}$
3. $20(a_1 + a_2 + a_3 + \ldots + a_{20})$
4. $20(a_1 + 2a_2 + 3a_3 + \ldots + 20a_{20})$

4. N is a two digit number such that the product of its digits when added to their sum equals N. The unit digit of N would be

1. 1 2. 7 3. 8 4. 9

5. If $P + \frac{1}{Q} = 1$ and $Q + \frac{1}{R} = 1$, then what is PQR?

1. -1 2. 2 3. – 2 4. cannot be calculated

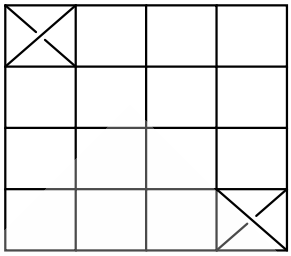
6. What is the remainder when 3^{256} is divided by 5?

1. 1 2. 2 3. 3 4. 4

7. If equal weight of 22 carat gold (alloy of 22 parts gold and 2 parts copper by weight) and 24 carat gold (pure gold) are mixed to form an alloy, what will be the weight proportion of copper in the alloy?

1. $\frac{1}{2}$ 2. $\frac{1}{8}$ 3. $\frac{1}{12}$ 4. $\frac{1}{24}$

8.



A $4m \times 4m$ floor needs to be covered by tiles of size $2m \times 1m$. Two diagonally opposite corners of size $1m \times 1m$ should be left uncovered. How many tiles are required to complete the job without breaking the tiles of overlapping them?

1. 6 2. 7
3. 8 4. Impossible to cover

9. If 42 → 26, 71 → 78, 33 → 16, then 62 →

1. 68 2. 54 3. 38 4. 39

10. A shopkeeper sells a field and a notebook for Rs 27 to the first customer, a notebook and a pen for Rs 31 to the second customer and a pen and file for Rs. 29 to the third customer. The prices of the items are rounded in rupees. Which of the following inferences is correct?

1. The pen is the costliest of the three
2. The file is the costliest of the three
3. The notebook is the costliest of the three
4. The shopkeeper sold the different items to different customers at different rates.

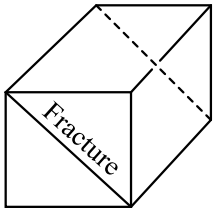
11. If NET14 &NET15 are five digit numbers such that their sum = 157229, then N + E + T would be

1. 15 2. 21 3. 25 4. 72

12. A cylindrical cake is to be cut into 16 equal pieces. What is the minimum number of cuts required to do so?

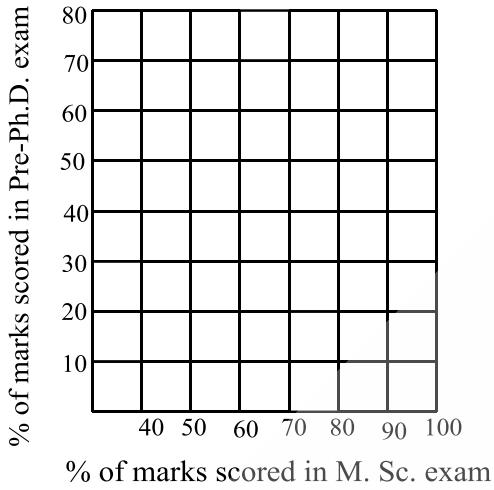
1. 9 2. 3 3. 8 4. 5

13. The diagram shows a cubic block of marble ($1 \times 1 \times 1$ m^3) having a planar fracture. What is the maximum number of slabs sized $20 \times 20 \times 5$ cm^3 that can be cut from this block avoiding the fracture?



1. 200 2. 300 3. 400 4. 500

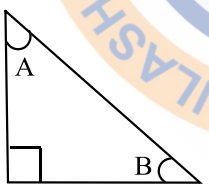
14.



Pre-Ph.D. exam score of 10 students are plotted against their M.sc. narks. Which of the following is true?

1. Two students have scored better in Pre-Ph.D. than their M.Sc exam.
2. All those students who scored 50% in pre-Ph.D. scored more percentage of marks in their M.Sc. exam.
3. Two students scored the same percentage of marks in their Pre-Ph.D. and M.Sc
4. The student who scored maximum in M.Sc. is the only student to get maximum in Pre-Ph.D. exam.

15. With reference to the right-angled triangle shown, what is the value of sin(A)cos(B) + cos(A)sin(B)?



1. -1/2 2. 1 3. +1/2 4. – 1

16. Consider a square of side *a*. Fit the largest possible circle inside it and largest possible square inside the circle. What is the side length of the innermost square?

1. $a/\pi\sqrt{2}$ 2. $a/2$ 3. $a/2\sqrt{2}$ 4. $a/\sqrt{2}$

17. Walking from my home at a speed of 5 km/h I am 8 minutes late in reaching my office. If I walk at a speed of 8 km/h I reach 5 minutes late. How far is my office from the house?

1. 2 km 2. 1/3 km 3. 2/3 km 4. 1/2 km

18. A, B and C are three distinct digits. If they are added as below,

	A	B	C
+	A	B	C
+	A	B	C
	C	C	C

find out the value of A, B and C

1. A = 3, B = 4, C = 5
2. A = 2, B = 3, C = 1
3. A = 5, B = 1, C = 3
4. A = 1, B = 8, C = 5

19. A tight fitting band is wrapped around the Equator. Another circular band whose length is 15 m more lies at a certain height over the first band. A group of human beings attempt to pass under the longer band. Can they walk under it?
(Earth's circumference is roughly 40,000 km. The height of human beings is between 1 & 2 m)

1. Yes
2. No
3. Can not be determined
4. Only those with height less than 1.7 m

20. L is the tallest and eldest of a group of five people K, L, M, N and P. M is elder to N and shorter than K. M and P are of same age and P is taller than K. N and K are of same height and K is younger to P. Which of the following inferences is certain?

1. P is taller than M 2. N is the youngest
3. N is elder to P 4. N is elder to K

PART- B

21. The calculated and observed magnetic moments (in B.M.) of aqua complex of a lanthanide ion are 0 and ~3.5, respectively. The lanthanide ion is

1. Pm^{3+} 2. Pr^{3+} 3. Eu^{3+} 4. Sm^{3+}

22. The compound that gives a basic solution in HF is;

1. AsF_5 2. PF_5 3. BF_3 4. BrF_3

23. Based on VSEPR theory, the predicted shapes of $[XeF_5]^-$ and BrF_5, respectively, are

1. pentagonal planar and square pyramidal
2. square pyramidal and trigonal bipyramidal
3. trigonal bipyramidal and square pyramidal
4. square pyramidal and pentagonal planar

24. Both potassium and sulfuric acid form intercalation compounds with graphite. The graphite layers are

1. reduced in both the cases
2. oxidized in both the cases
3. oxidized in the case of potassium and reduced in the case of sulfuric acid
4. reduced in the case of potassium and oxidized in the case of sulfuric acid

25. The resonance Raman stretching frequencies (in cm^{-1}) of the bound O_2 species in oxy-hemerythrin and oxy-hemoglobin, respectively, are

1. ~850 and 1100 2. ~750 and 850
3. ~850 and 850 4. ~1100 and 850

26. CdS, HgS and BiI_3 are coloured due to

1. L → M charge transfer transitions
2. d → delectronic transitions
3. M → L charge transfer transitions
4. combination of L → M charge transfer and d → d electronic transitions.

27. Which one of the following pairs has two magic numbers for closed nuclear shells?

1. 8, 10 2. 10, 20 3. 50, 82 4. 82, 130

28. Identify the correct statements(s) for phosphorimetric measurement from the following:

A. It is done after a time delay when fluorescence, if present becomes negligible

B. Immobilization of analyte increases phosphorescence

C. Phosphorescence decreases in the presence of heavy atoms

Answer(s) is/are

1. A only 2. A and B
3. A and C 4. B and C

29. Choose the isoelectronic pair among the following:

(A) $[V(CO)_6]$, (B) $[Cu(\eta^5-C_5H_5)(CO)]$, (C) $[Co(CO)_4]^-$, (D) $[IrCl(CO)(PPh_3)_2]$

1. A and B 2. B and C
3. C and D 4. A and D

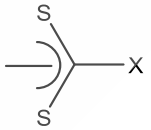
30. An organometallic fragment that is isolobal to CH_3^+ is

1. $[Fe(CO)_5]$ 2. $[Mn(CO)_5]$
3. $[Cr(CO)_5]$ 4. $[Ni(CO)_3]^+$

31. In vitro reaction of an excess of O_2 with free heme B in aqueous medium the end product is

1. hematin
2. $[O_2^-$ -Fe(III)-protoporphyrin-IX]
3. heme $B(O_2)$
4. oxoferrylprotoporphyrin-IX cation radical

32. Consider the following sulfur donor atom bearing bidentate ligand where X and name of ligands are given in following columns:



X	ligand name
A. NR_2	I. dithiocarbonate
B. OR	II. dithiocarbamate
C. O^-	III. xanthate
D. SR	IV. Thioxanthate

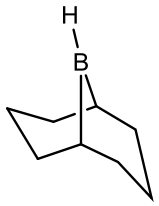
Correct match of entries given in two columns is

1. A-II; B-III; C-I; D-IV
2. A-III; B-II; C-IV; D-I
3. A-I; B-II; C-III; D-IV
4. A-IV; B-I; C-II; D-III

33. The relative rates of water exchange for the hydrated complexes of (a) Ni^{2+}, (b) V^{2+} and (c) Cr^{3+} ions follow the trend

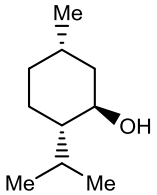
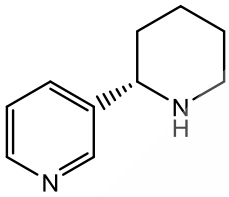
1. (a) > (b) > (c) 2. (a) < (b) < (c)
3. (a) > (b) < (c) 4. (a) < (b) > (c)

34. The IUPAC name of the following compound is



1. 9-borabicyclo[3.3.1]nonane
2. 1-borabicyclo[3.3.1]nonane
3. 9-borabicyclo[3.3.0]octane
4. 1-borabicyclo[3.3.0]octane

35. The correct match of natural products in Column **I** with their biosynthetic precursors in Column **II** is

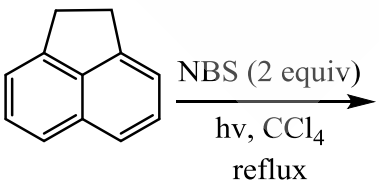
A	Column **I**	Column **II**
A		(i) L-Lysine
B		(ii) L-Ornithine
		(iii) Farnesyl pyrophosphate
		(iv) Geranyl pyrophosphate

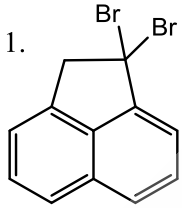
1. **A**: iv, **B**:i
2. **A**: iv, **B**, ii
3. **A**: iii, **B**:i
4. **A**: iii, **B**:ii

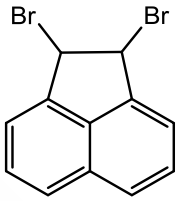
36. The correct order of pKa values for the following species is

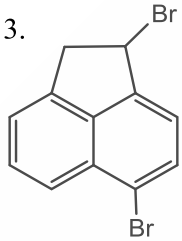
1. $PhNH_3^+ < i\text{-}Pr_2NH_2^+ < Ph_2NH_2^+$
2. $Ph_2NH_2^+ < PhNH_3^+ < i\text{-}Pr_2NH_2^+$
3. $i\text{-}Pr_2NH_2^+ < Ph_2NH_2^+ < PhNH_3^+$
4. $PhNH_3^+ < Ph_2NH_2^+ < i\text{-}Pr_2NH_2^+$

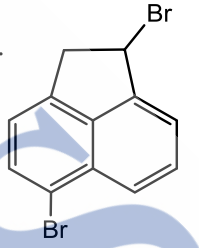
37. The major product formed in the following reaction is



1. 

2. 

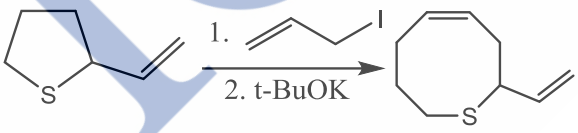
3. 

4. 

38. ^{13}C NMR spectrum of DMSO-d_6 gives a signal at δ 39.7 ppm as a

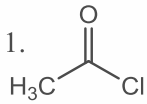
1. singlet
2. triplet
3. quintet
4. septet

39. Following reaction is an example of

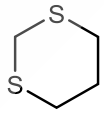


1. Ramberg-Backlund reaction
2. [2,3]-sigmatropic shift
3. [3,3]-sigmatropic shift
4. Pummerer rearrangement

40. Among the following, the synthetic equivalent of acetyl anion is

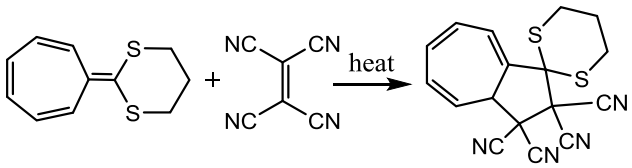
1. 

2. CH_3CN

3. 

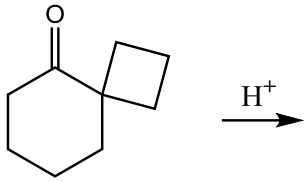
4. $CH_3CH_2NO_2$

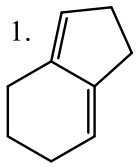
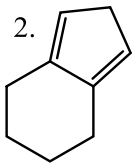
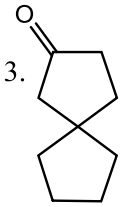
41. Following reaction is an example of

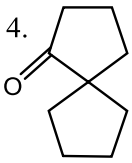


1. [3+2] cycloaddition
2. [4+2] cycloaddition
3. [6+2] cycloaddition
4. [8+2] cycloaddition

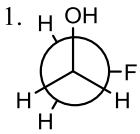
42. The major product of the following reaction is

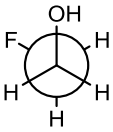


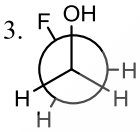
1. 
2. 
3. 

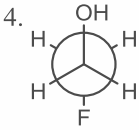
4. 

43. The most stable conformation of 2-fluoro-ethanol is

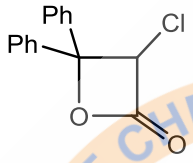
1. 

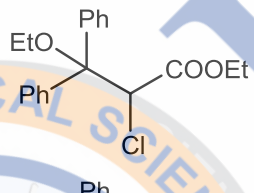
2. 

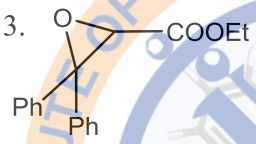
3. 

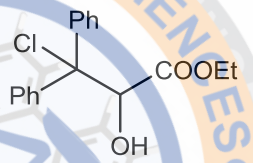
4. 

44. The major product formed in the sodium ethoxide mediated reaction between benzophenone and ethyl chloroacetate is

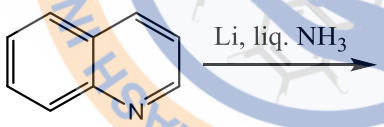
1. 

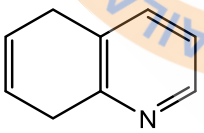
2. 

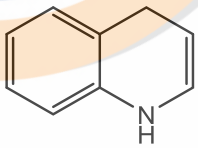
3. 

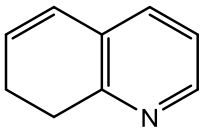
4. 

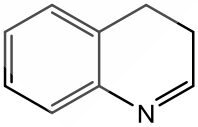
45. The major product formed in the following reaction is



1. 

2. 

3. 

4. 

46. Among the following, the natural product that is a steroid and contains an α,β-unsaturated ketone is

1. estrone
2. prostaglandin
3. cortisone
4. morphine

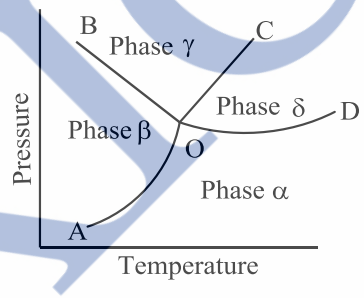
47. Which of the functions below is a common eigenfunction of $\frac{d}{dx}$ and $\frac{d^2}{dx^2}$ operators?

1. cos x
2. kx
3. e^{ix}
4. e - x^2

48. A phase transition process is always

1. isothermal –isoentropic
2. isochoric –isothermal
3. isobaric – isochoric
4. isothermal – isobaric

49. A one-component system with the associated phase diagram (see the figure) is not possible because



1. OB has a negative slope
2. OC has a positive slope
3. Both OB andOC are linear
4. OB, OC and OD cannot all coexist, given OA

50. Consider a particle in its ground state confined to a one-dimensional box in the interval (0, 8). The probability of finding it between 4.0 - $\frac{\delta}{2}$and 4.0 + $\frac{\delta}{2}$ is close to (δ is sufficiently small so that the wavefunction can be taken as a constant in this interval)

1. $\frac{\delta}{4}$
2. $\frac{\delta}{3}$
3. $\frac{\delta}{2}$
4. δ

51. The v =0 to 1 vibration-rotation spectrum of a diatomic molecule exhibits transitions for R(0), R(1), P(1) and P(2) lines at 2242,2254,2216 and 2203 cm^{-1}, respectively. From this data, we can conclude that the molecule

1. has rigid rotation and harmonic vibration
2. has anharmonic vibration
3. has rotational-vibrational interaction

4. is affected by nuclear spin-statistics

52. Consider aqueous solutions of two compounds A and B of identical concentrations. The surface tension of the solution of A is smaller than that of pure water while for B it is greater than that of pure water under identical conditions. From this one infers that
1. surface concentration of A is smaller than its bulk concentration
2. surface concentration of B is larger than its bulk concentration
3. surface concentration of A is larger than that of B
4. surface concentration of A is smaller than that of B

53. For a monodisperse polymer, the number-average molar mass ($\bar{M}_n$) and weight-average molar mass ($\bar{M}_w$) are related according to
1. $\bar{M}_w<\bar{M}_n$ 2. $\bar{M}_w = \bar{M}_n$
3. $\bar{M}_w>\bar{M}_n$ 4. $\bar{M}_w< \log \bar{M}_n$

54. An intense purple colour (Plasmon band) is exhibited by a colloid consisting of spherical
1. silver particles of 10 mm diameter
2. silicon particles of 5 mm diameter
3. gold particle of 5 nm diameter
4. iron particles of 3 mm diameter

55. The correct statements for any cyclic thermodynamic process is
1. $\oint dq = 0$ 1. $\oint dw = 0$
3. $\oint dU = 0$ 4. $\oint V dq = 0$

56. Metallic silver crystallizes in face-centred-cubic lattice structure with a unit cell of length 40 nm. The first order diffraction angle of X-ray beam from (2,1,0) plane of silver is 30^0. The wavelength of X-ray used is close to
1. 11 nm 2. 18 nm 3. 25 nm 4. 32 nm

57. If the pre-exponential factor in Arrhenius equation is $1.6 \times 10^{12}s^{-1}$, the value of the rate constant at extremely high temperature will be close to
1. $1.6 \times 10^{12}s^{-1}$ 2. $4.2 \times 10^{12}s^{-1}$
3. $2.4 \times 10^{9}s^{-1}$ 4. $1.2 \times 10^{6}s^{-1}$

58. In kinetic study of a chemical reaction, slopes are drawn at different times in the plot of concentration of reactants versus time. The magnitude of slopes with increase of time
1. remains unchanged
2. increases
3. decreases
4. increases and decreases periodically

59. The electrochemical cell potential (E), after the reactants and products reach equilibrium, is (E^o is the standard cell potential and n is the number of electrons involved)
1. $E = E^o + nF/RT$ 2. $E = E^o – RT/nF$
3. $E = E^o$ 4. $E = 0$

60. For the electronic configuration $1s^2 2s^2 2p^4$, two of the possible term symbols ate ^1S and ^3P. The remaining terms is
1. ^1D 2. ^1F 3. ^3D 4. ^3F

PART- C

61. Match items in column A with items in column B

	Column A		Column B
I:	$SbF_5 + BrF_3 \rightarrow [BrF_2]^+ + [SbF_6]^-$	a	Lewis acid behaviour of BrF_3
II:	$[BrF_2][SbF_6] + Ag[BrF_4] \rightarrow Ag[SbF_6] + 2BrF_3$	b	Lewis base behaviour of BrF_3
III:	$KF + BrF_3 \rightarrow K^+ + [BrF_4]^-$	c	Self ionisation
IV:	$2BrF_3 \rightarrow [BrF_2]^+ + [BrF_4]^-$	d	Neutralisation

The correct answer is
1. I – a; II – b; III – c; IV - d
2. I – b; II – d; III – c; IV - a
3. I – c; II – d; III – b; IV - a
4. I – b; II – d; III – a; IV – c

62.Mössbauer spectrum of complex [Fe(1, 10-phenanthroline)$_2$(NCS)$_2$] shows two lines at 300 K, four lines at 186 K, and again two lines at 77 K. This can be attributed to
A. change in the coordination mode of NCS
B. change in the spin-state of iron
C. cis-trans isomerisation
D. change in metal-ligand bond distances
The correct statements are
1. A and B 2. B and C
3. A and C 4. B and D

63. $(R_3Ge)_2$ on photolysis gives a radical which shows ESR spectrum. The ESR signals carrying the signature of ^{73}Ge (I = 9/2) are in terms of

1. Nine lines 2. Ten lines
3. Two lines 4. One lines

64. Choose the correct statement for magnitude of threshold energy of an endoergic nuclear reaction between stationary nucleus and a moving projectile.

1. It is greater than '|Q|' of nuclear reaction.
2. It has to be more than kinetic energy of a projectile.
3. It is less than '|Q|' of nuclear reaction.
4. It has to be equal to kinetic energy of a projectile.

65. Identify correct statements from the following:

A. Area of differential thermal analysis peak is proportional to amount of sample
B. Area of differential thermogravimetric analysis curve is proportional to mass loss.
C. Phase transition cannot be studied with differential scanning calorimetry.
D. Simultaneous determination of two metal ions is possible with thermogravimetric analysis

Answer is

1. A, B and C 2. A, B and D
3. B, C and D 4. A, C and D

66. Consider following statements for fission of ^{235}U with thermal neutrons.

A. The % of nuclei undergoing unsymmetrical fission is maximum.
B. In each fission, one thermal neutron is produced.
C. Magnitude of energy released per fission is of the order 200 Me V

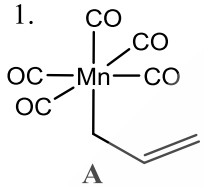
Correct statement(s) is/are

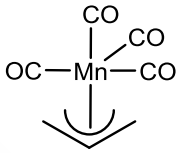
1. A and B 2. A and C
3. B and C 4. C only

67. Addition of two electrons to the bismuth cluster Bi_5^{3+} results in a change of structure type from

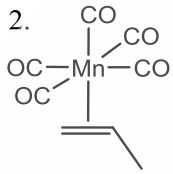
1. closo to nido 2. nido to arachno
3. closo to arachno 4. arachno to hypho

68. Reaction of $Na[Mn(CO)_5$ with $H_2C{=}CHCH_2Cl$ gives **A** along with NaCl. Photolysis of compound **A** results in compound **B** together with elimination of CO. The correct structural formulations of compounds **A** and **B** are respectively,

1. 

A ,


B

2. 

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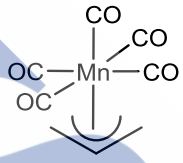
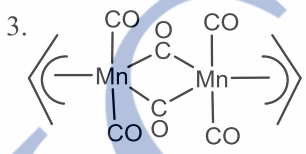
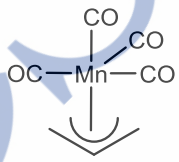
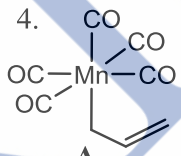


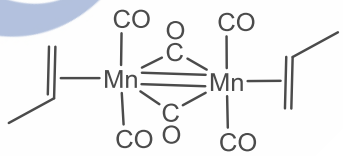
B

3. 

A ,


B

4. 

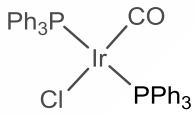
A ,


B

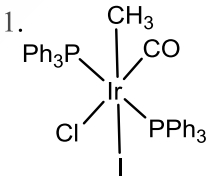
69. A copper(II) complex having distorted octahedral geometry shows an absorption band at 625 nm. Given spin-orbit coupling of the complex as – 625 cm^{-1}, the μ_{eff} (in B.M.) is

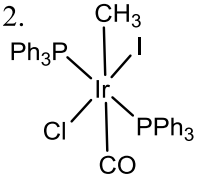
1. 1.73 2. 1.81 3. 1.63 4. 1.93

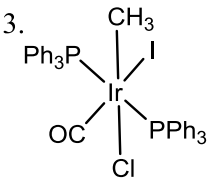
70. Identify the product in the reaction between

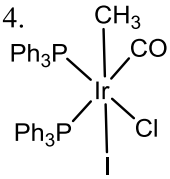


and CH_3I going at room temperature via S_N^2 mechanism

1. 

2. 

3. 

4. 

71. Addition of $NaBH_4$ to $[\eta^5\text{-Cp})Fe(\eta^6 –C_6H_6)]^+$ will give

1. $[\eta^5 –Cp)Fe(H)_2]^-$
2. $[\eta^5 –Cp)Fe(H)(\eta^6 –C_6H_6)]$
3. $[\eta^5 –Cp)Fe(\eta^6 –C_6H_6)]$
4. $[\eta^5 –Cp)Fe(\eta^5 –C_6H_7)]$

72. The μ_{eff} of $[Fe(S_2CNEt_2)_3]$ changes with temperature with the involvement of two electronic states. The states are

1. low spin $^2T_{2g}$ and high-spin $^6A_{1g}$
2. low spin $^1A_{1g}$ and high-spin $^3T_{2g}$
3. low spin ^2E_g and high-spin $^6A_{1g}$
4. low spin $^2T_{2g}$ and high-spin $^4T_{1g}$

73. Match the items in the three columns.

Complex (column 1)	Color (column 2)	Absorption max (λ_{max}, nm) (column 3)
A. $[Ni(H_2O)_6(NO_3)_2$	I. Blue	X. 675
B. $[Ni(NH_3)_6](NO_3)_2$	II. Green	Y. 565
C. $[Ni(en)_3](NO_3)_2$	III. violet	Z. 615

The correct answer is

1. A-II-X; B-I-Z; C-III-Y
2. A-I-X; B-II-Y; C-III-Z
3. A-III-Y; B-I-Z; C-II-X
4. A-I-X; B-II-Z; C-III-Y

74. Mass fragment of $[IrCl]^+$ in mass spectrometry shows three mass peaks at m/z = 226, 228, and 230. Given that natural abundances of ^{191}Ir, ^{193}Ir, ^{35}Cl, and ^{37}Cl are 37%, 63%, 76%, and 24% respectively, the intensities of the mass peaks are in the order

1. 49.5: 100: 26.6
2. 100: 49.5: 26.6
3. 26.6: 100:49.5
4. 26.6: 49.5: 100

75. The $^{31}P\{^1H\}$ NMR spectrum of 2,2,6,6-$N_4P_4Cl_4(NMe_2)_4$ is expected to show

1. two triplets
2. two doublets
3. one doublets and one triplet
4. one quartet and one doublet

76. The number of bonding molecular orbitals and the number of available skeletal electrons in $[B_6H_6]^{2-}$, respectively, are

1. 7 and 14
2. 6 and 12
3. 18 and 12
4. 11 and 14

77. The compound N_2F_2 has two isomers. Choose the correct option from the following

1. both isomers possess σ_v plane
2. both isomers possess σ_h plane
3. one isomer has a σ_h plane while the other has a σ_v plane
4. none of them have a σ_h plane

78. Consider the following statements for metallothioneins:

A. they contain about 30% cysteine residues
B. they prefer to bind soft metal ions such as Cd(II), Hg(II) and Zn(II)
C. they are involved in electron transfer reactions
D. they are low molecular weight proteins

Correct statements are

1. A, B and C
2. A, B and D
3. A, C and D
4. B and C

79. Consider the following statements for deoxy-hemerythrin and deoxy-hemocyanin:

A. they are involved in O_2 transport in biological systems
B. they contain two metal ions in their active site
C. active site metal centres are bridged by amino acid residues
D. they prefer to bind only one O_2 per active site

The correct statements are

1. A, B and D
2. A, C and D
3. B, C and D
4. A and C

80. Consider the following statements for octahedral complexes, (a) $[CrF_6]^{3-}$, (b) $[Cr(ox)_3]^{3-}$ and (c) $[Cr(en)_3]^{3+}$:

A. their d→d transitions are at 14900, 17500, and 21800 cm^{-1}, respectively
B. their spin-only magnetic moments are same
C. two of them have optical isomers
D. all of them show Jahn-Teller distortion

The correct statements are

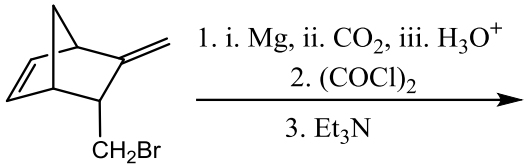
1. A, B and C
2. A, C and D
3. B, C and D
4. B and D

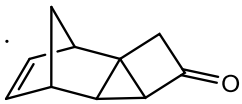
81. The specific rotation $[\alpha]_D$ for (S)–(+)-2-butanol is 10° mL/g dm. The observed optical rotation (α_{obs}) of a sample composed of a mixture of (R)-and (S)-2-butanol is -0.45^o. If the cell path length is 0.6 dm and the concentration of 2-butanol in the sample is 0.15

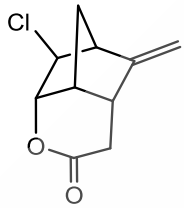
g/mL, the percentages of (R) and (S) enantiomers in the sample are

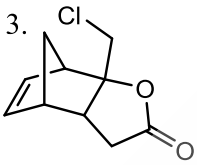
1. (R) = 25%, (S) = 75%
2. (R) = 40%, (S) = 60%
3. (R) = 60%, (S) = 40%
4. (R) = 75%, (S) = 25%

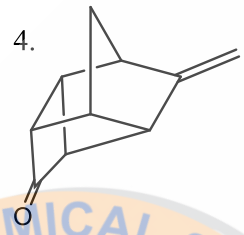
82. The major product formed in the following reaction is



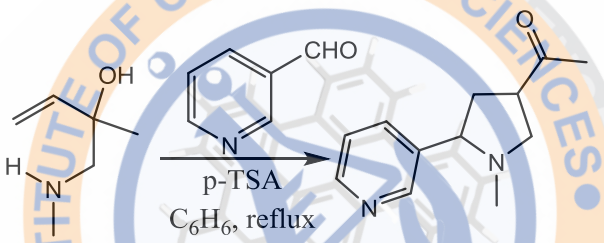
1. 

2. 

3. 

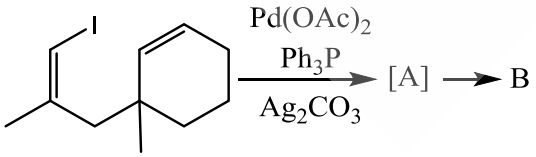
4. 

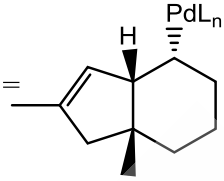
83. Following reaction involves

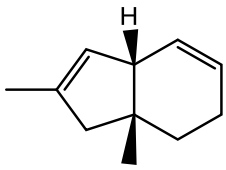


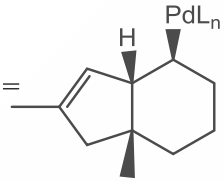
1. Claisen followed by Mannich reaction
2. aza-Cope followed by Mannich reaction
3. Claisen followed by aza-aldol reaction
4. aza-Cope followed by aza-aldol reaction

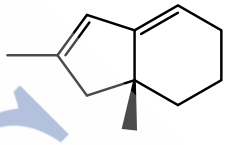
84. The intermediate**A** and major product **B** formed in the following reaction is

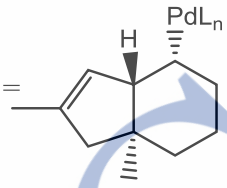


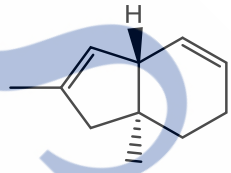
1. **A** = 

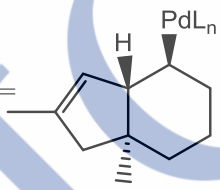
B = 

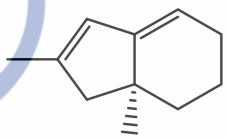
2. **A** = 

B = 

3. **A** = 

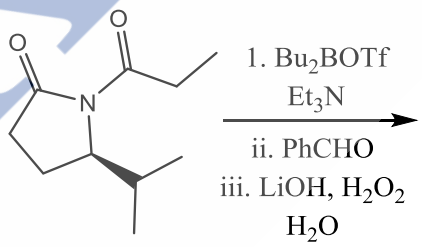
B = 

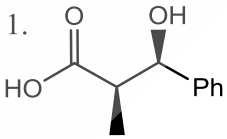
4. **A** = 

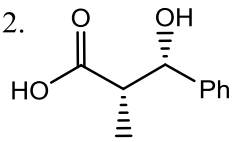
B = 

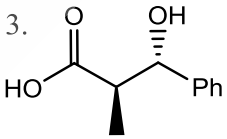
(L = ligand)

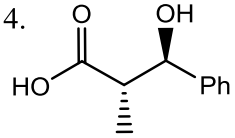
85. The major product formed in the following reaction is



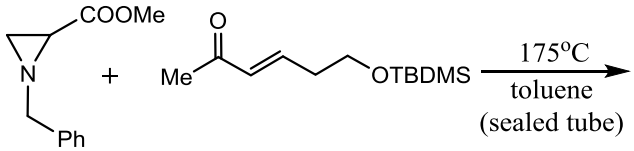
1. 

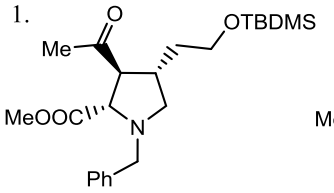
2. 

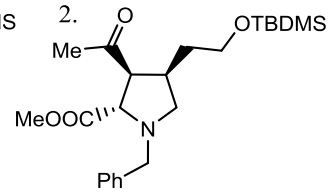
3. 

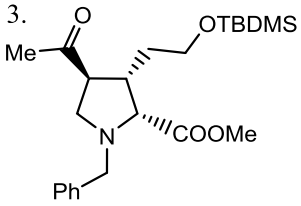
4. 

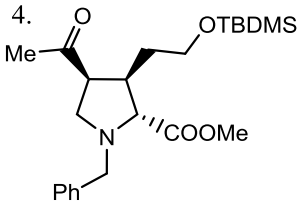
86. The major product formed in the following reaction is



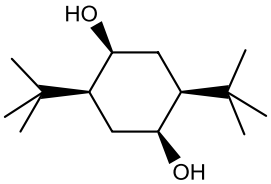
1. 

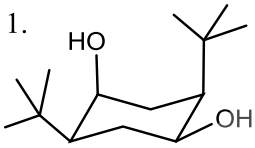
2. 

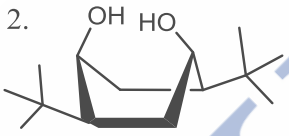
3. 

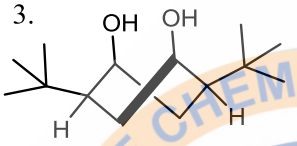
4. 

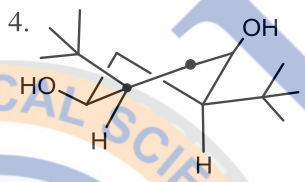
87. The most stable configuration for the following compound is



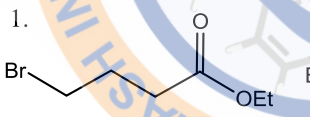
1. 

2. 

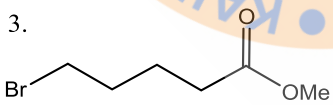
3. 

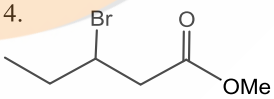
4. 

88. The correct structure of the compound based on the following characteristic spectral data is
IR: 1736 cm^{-1}
^{1}H NMR: δ 3.59 (s, 3H), 3.32 (t, 2H), 2.25 (t, 2H), 1.85 -1.7' (m, 2H), 1.73-1.62 (m, 2H) ^{13}C NMR: δ 174.0, 51.0, 32.9, 32.8, 31.0, 23.0

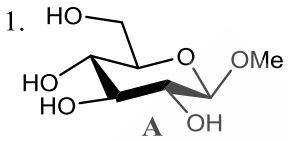
1. 

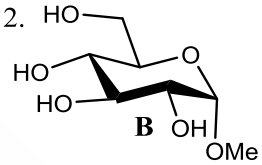
2. 

3. 

4. 

89. The major product formed in the reaction of D-glucose with $ZnCl_2$ in MeOH is a methyl glucopyranoside (**A** or **B**). The structure of this product and the molecular orbital interaction present between ring-oxygen and the anomeric C-O bond responsible for its stability, respectively, are

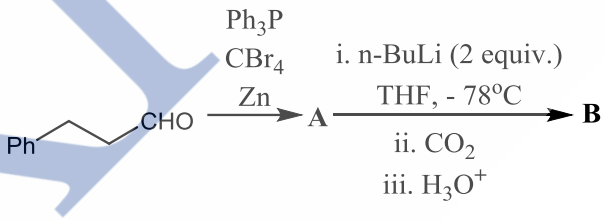
1. 

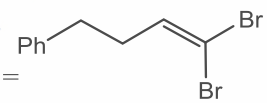
2. 

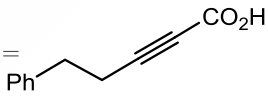
1. **A** and n → σ*
2. **A** and n → σ
3. **B** and n → σ*
4. **B** and n → σ

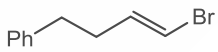
90. Among the following correct statement for nucleic acids is
1. Uracil is present in DNA
2. Uracil is present in RNA
3. Phosphorylation in RNA is at 2' and 5' positions
4. Normally three hydrogen bonds stabilize A-T base pair

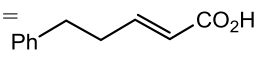
91. The major products **A** and **B** formed in the following reaction sequence are

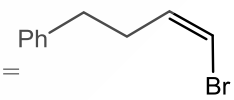


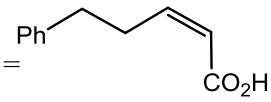
1. **A** = 

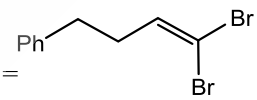
B = 

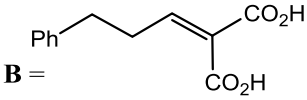
2. **A** = 

B = 

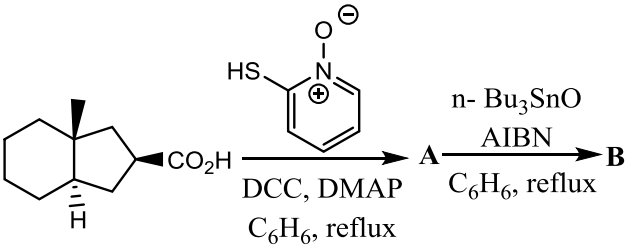
3. **A** = 

B = 

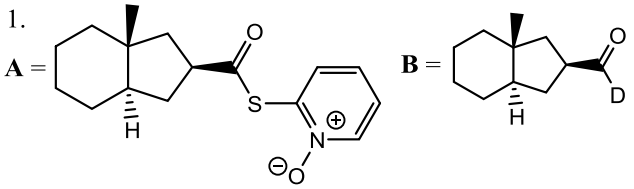
4. **A** = 

B = 

92. The intermediate **A** and product **B** formed in the following reaction sequence ar



1.



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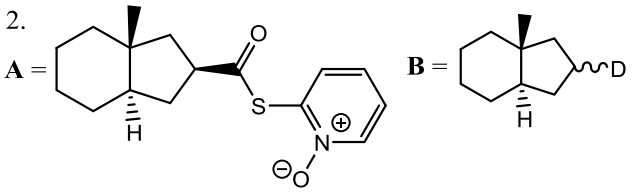

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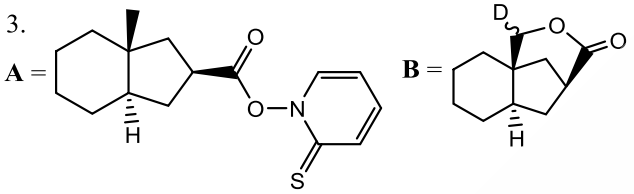

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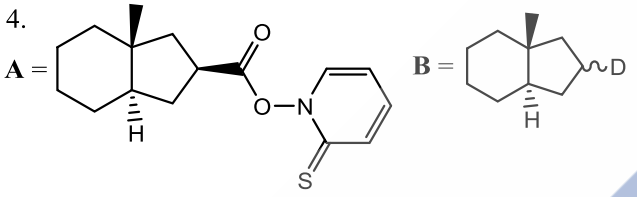
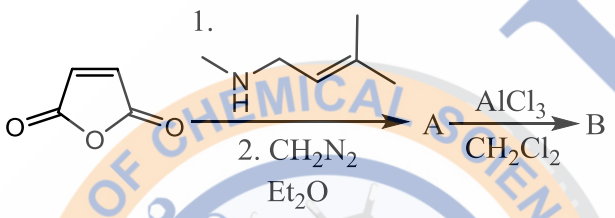
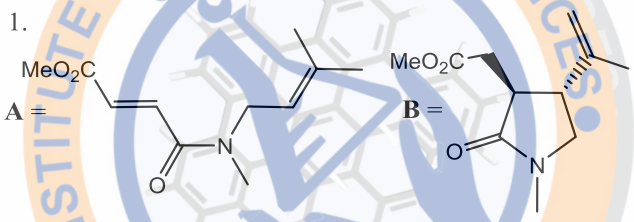


93. The major products **A** and **B** formed in the following reaction sequence are



1.



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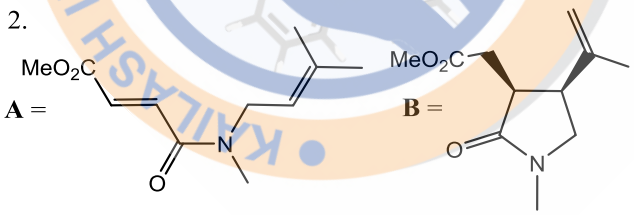

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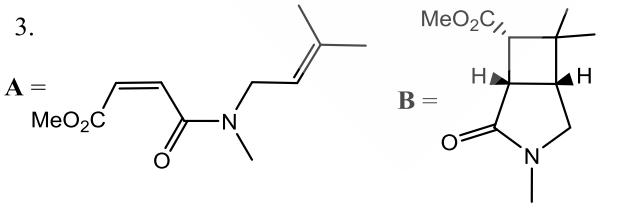

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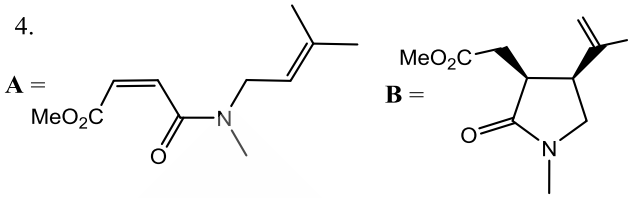
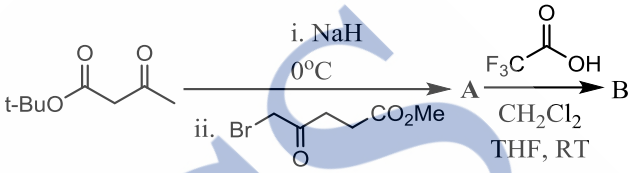
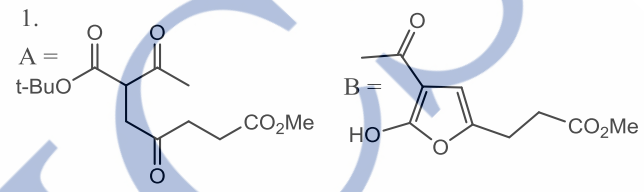


94. The major products **A** and **B** formed in the following reaction sequence are



1.



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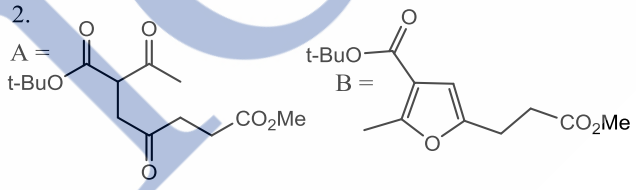

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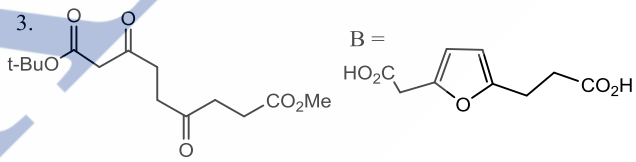

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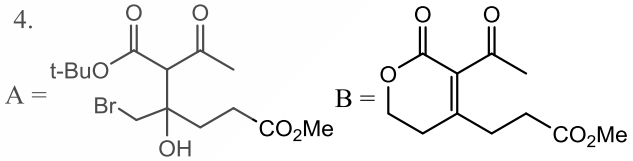
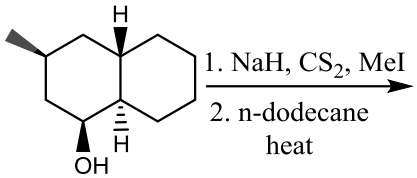
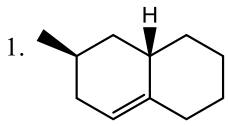


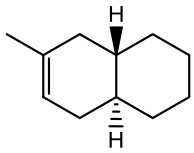
95. The major product formed in the following reaction is



1.



2.



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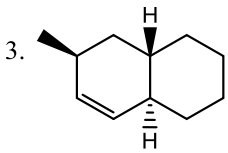

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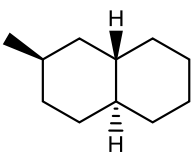
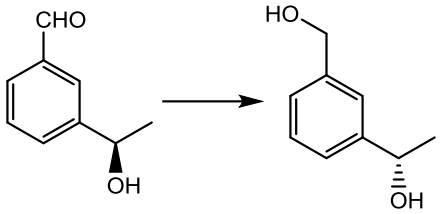
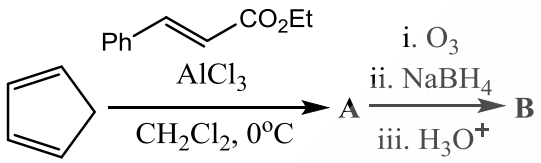


96. The correct combination of reagents to effect the following reaction is



1. a. $POCl_3$, pyridine; b. AgOAc; c. $LiAlH_4$
2. a. $NaBH_4$; b. Ph_3P, DEAD, $PhCO_2H$
3. Ph_3P, DEAD, $PhCO_2H$; b. $LiAlH_4$
4. a. PCC; b. L-selectride

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



1.
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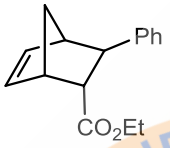
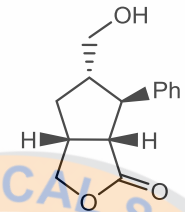


B =


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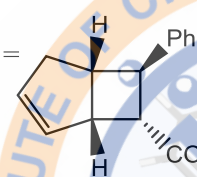

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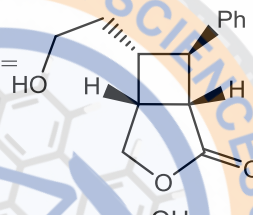

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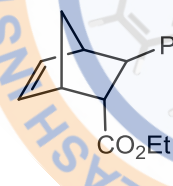

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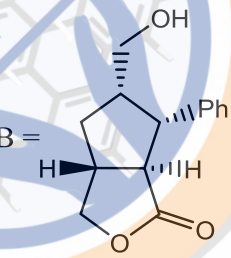
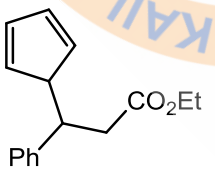
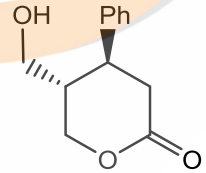
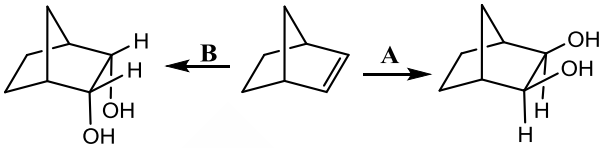


4.
A =


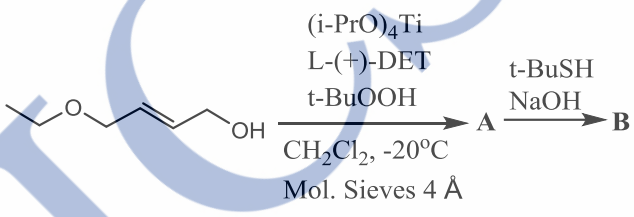
B =


98. The correct combination of reagents **A** and **B** to effect following transformations are

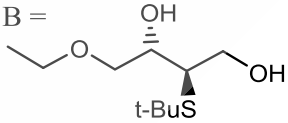


1. **A** = cat. OsO_4, NMO; **B** = i. I_2 $PhCO_2Ag$, ii. aq. NaOH
2. **A** = alkaline $KMnO_4$; **B** = i. I_2, $PhCO_2Ag$, H_2O, ii. aq. NaOH
3. **A** = I_2, $PhCO_2Ag$, ii. aq. NaOH; **B** = cat. OsO_4, TMEDA, NMO
4. **A** = i. m-CPBA, ii. aq. NaOH; **B** =alkaline $KMnO_4$

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



1.
A =


B =


2.
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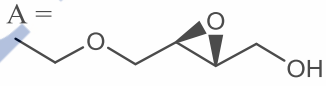

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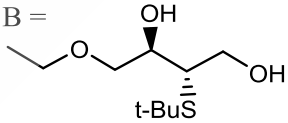

3.
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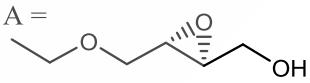

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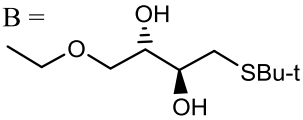

4.
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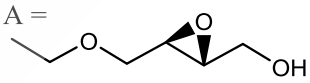

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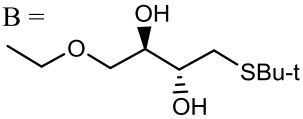
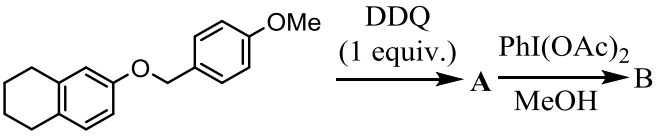


100. The major products **A** and **B** formed in the following reaction sequence are



1.
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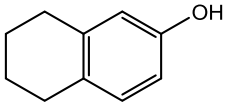

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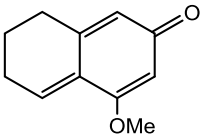
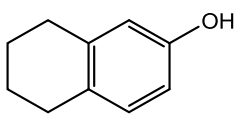
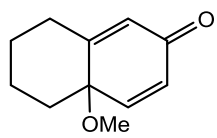
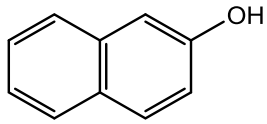


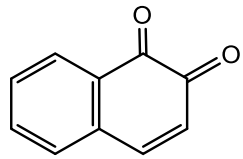
2.

A = 

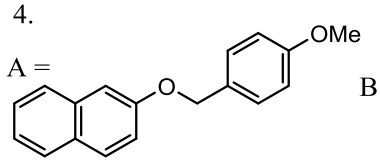
B = 

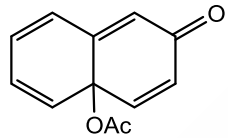
3.

A = 

B = 

4.

A = 

B = 

101. For the reaction $H_2O(g) \rightleftharpoons H_2(g) + \frac{1}{2} O_2(g)$, the equilibrium constant K_p depends on the degree of dissociation α (α ≪ 1) and total pressure P as

1. $K_p \propto \alpha^2 P$
2. $K_p \propto \alpha^{3/2} P^{1/2}$
3. $K_p \propto \alpha^{1/2} P^{3/2}$
4. $K_p \propto \alpha P^2$

102. The minimum work required by an engine to transfer 5 J of heat from a reservoir at 100 K to one at 300 K is

1. 5 J
2. 10 J
3. 15 J
4. 20 J

103. The correct relation involving symmetry operations

1. $S_4^2 = S_2$
2. $\sigma(xz)\sigma(yz) = C_2(x)$
3. $S_4^3 = C_4^3$
4. $S_6^3 = S_2$

104.A polydisperse polymer sample has ten molecules of molar mass 20,000 g mol^{-1} and fifteen molecules of molar mass 10,000 g mol^{-1}. The number-average molar mass (g mol^{-1}) ($\bar{M}_n$) of the sample is

1. 13,000
2. 14,000
3. 15,000
4. 16,000

105. Consider a system of three particles which can occupy energy levels with energy 0, ε and 2 ε, such that the total energy E = 4ε. Cases A, B andC correspond to spin $\frac{1}{2}$ fermions, spin 0 bosons, and classically distinguishable particles, respectively. The correct ordering of entropy is

1. $S_A > S_B > S_C$
2. $S_B > S_A > S_C$
3. $S_C > S_B > S_A$
4. $S_C > S_A > S_B$

106. The two limiting wavefunction of the ground state of H_2^+ molecular ion, as the internuclear separation R goes to (i) ∞ (infinity) and (ii) 0 (zero) are ($1s_a$, $1s_b$, are 1s-orbital wave functions of hydrogen atoms a and b in H_2^+, and $1s_{He}$ is the wave function of the 1s orbital of He^+)

1. (i) $1s_a(r)$; (ii) $1s_b(r)$
2. (i) $1s_b(r)$; (ii) $1s_a(r)$
3. (i) $1s_a(r_1)\, 1s_b(r_2)$; (ii) $1s_{He}(r_1) 1s_{He}(r_2)$
4. (i) $1s_a(r) + 1s_b(r)$; (ii) $1s_{He}(r)$

107. For a certain magnetic field strength, a free proton spin transition occurs at 700 MHz. Keeping the magnetic field strength constant the ^{14}N nucleus will resonate at
(g(p) ≃ 5.6 and g(^{14}N) ≃ 0.4)

1. 700 MHz
2. 400 MHz
3. 200 MHz.
4. 50 MHz

108. The first electronic absorption band maximum of a polar and relatively rigid aromatic molecule appears at 310 nm but its fluorescence maximum in acetonitrile solution appears with a large Stokes shift at 450 nm. The most likely treason for the Stokes shift is

1. large change in molecular geometry in the excited state
2. increase in dipole moment of the molecule in the excited state
3. decrease in polarizability of the molecule in the excited state
4. lowered interaction of the excited molecule with polar solvent

109. The un-normalized radial wave function of a certain hydrogen atom eigenstate is $(6r - r^2)\exp(-r/3)$. A possible angular part of the eigenstate is

1. $5\cos^3\theta - 3\cos\theta$
2. $3\cos^2\theta - 1$
3. $\cos\theta$
4. 1

110. Given a trial wave function $\psi_t = C_1\phi_1 + C_2\phi_2$, and the Hamiltonian matrix elements, $\int \phi_1^* H \phi_1 dv = 0$, $\int \phi_1^* H \phi_2 dv = 2.5$, $\int \phi_2^* H \phi_2 dv = 12.0$, the variationally determined ground state energy is

1. – 0.52
2. – 0.50
3. 12.50
4. 12.52

10. For a point group, an incomplete character table is given below with one irreducible representation missing

	E	$2C_3$	$3\sigma_v$
A_1	1	1	1

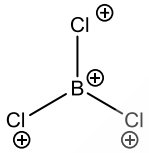
-	-	-	-
E	2	-1	0

The Mulliken symbol and characters of the missing representation are

1.	A'_1	1	-1	1
2.	B_1	1	-1	-1
3.	A_2	1	1	-1
4.	B_2	1	-1	1

112. Given below is a specific vibrational mode of BCl_3 with ⊕ and ⊖ denoting movements of the respective atoms above and below the plane of the molecule respectively. The irreducible representation of the vibrational mode and its IR/ Raman activity are

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
A_1	1	1	1	1	1	1		$x^2 + y^2$, z^2
A_2	1	1	-1	1	1	-1	R_z	
E'	2	-1	0	2	-1	0	(x,y)	($x^2 - y^2$, xy)
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	z	
E"	2	-1	0	-2	1	0	(R_x,R_y)	(xz, yz)

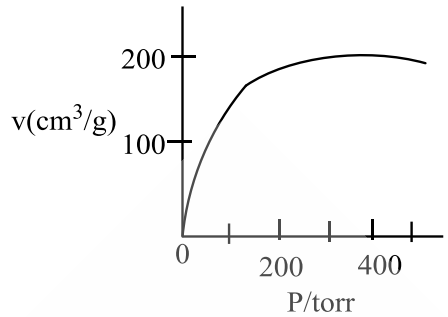


1. A_2'; neither IR nor Raman active
2. E'; both IR and Raman active
3. A_1'; Raman active
4. A_2''; IR active

113. The first excited state ($^2P_{1/2}$) of Fluorine lies at an energy of 400 cm^{-1} above the ground state ($^2P_{3/2}$). The fraction of Fluorine atoms in the first excited state at k_BT = 420 cm^{-1} is close to

1. $\frac{1}{1+e}$ 2. $\frac{1}{2+e}$ 3. $\frac{1}{1+4e}$ 4. $\frac{1}{1+2e}$

114. The figure below depicts an adsorption isotherm of O_2 on charcoal at 90 K.



At a pressure 25 torr, only 10% of charcoal sites are occupied by O_2. Therefore, the ratio of adsorption to desorption rate constants (in $torr^{-1}$) is close to

1. 0.003 2. 0.004 3. 0.006 4. 0.015

115. Polonium is the only metal known to exist in a simple cubic lattice form. The density of polonium at 0°C is measured to be 10.00 g/cm^3. The atomic radius of polonium would then be (assume the mass of a polonium atom = 2.7×10^{-22} g)

1. 1.1 Å 2. 1.9 Å 3. 1.5 Å 4. 2.3 Å

116. The specific conductance of a solution is $0.176\Omega^{-1}$ cm^{-1}. If the cell constant is 0.255 cm^{-1}, the conductance (Ω^{-1}) of that solution is

1. 1.449 2. 0.690 3. 0.045 4. 0.431

117. Photochemical decomposition of HI takes place with the following mechanism

$HI + h\nu\ (I_a) \rightarrow H + I$

$H + HI \xrightarrow{k_1} H_2 + I$

$I + I + M \xrightarrow{k_2} I_2 + M$

Considering hydrogen (H) and iodine (I) atoms as intermediates, the rate of removal of HI is

1. $I_a/2$ 2. I_a 3. $2I_a$ 4. I_a^2

118. In an enzyme-catalysed reaction

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

$k_2 = 3.42 \times 10^4 s^{-1}$. If $[E]_0 = 1 \times 10^{-2}$ mol dm^{-3}, the magnitude of maximum velocity and turn over number using Michaelis-Menten kinetics are

1. 3.42×10^2 mol $dm^{-3}s^{-1}$; 3.42×10^4 s^{-1}
2. 3.42×10^6 mol $dm^{-3}s^{-1}$; 3.42×10^4 s^{-1}
3. 3.42×10^4 mol $dm^{-3}s^{-1}$; 3.42×10^6 s^{-1}
3. 3.42×10^4 mol $dm^{-3}s^{-1}$; 3.42×10^2 s^{-1}

119. Arrhenius equations for two chemical reactions are; $k_1 = A_1 e^{-E_1/RT}$, $k_2 = A_2 e^{-E_2/RT}$. If $E_1 > E_2$, then at a given temperature T,

1. $\frac{k_1}{k_2} < \frac{A_1}{A_2}$ 2. $\frac{k_2}{k_1} < \frac{A_2}{A_1}$

3. $k_1 k_2 > A_1 A_2$ 4. $k_1 + k_2 > A_1 + A_2$

120. The fugacity of a real gas is less than the pressure (P) of an ideal gas at the same temperature (T) only when (T_b is the Boyle temperature of the real gas)

1. high P, $T < T_b$ 2. low P, $T < T_b$

3. high P, $T > T_b$ 4. low P, $T > T_b$