1.A milkman adds 10 litres of water to 90 litres of milk. After selling 1/5th of the total quantity, he adds water equal to the quantity he has sold. The proportion of water to milk he sells now would be

A. 72 : 28

B. 28 : 72

C. 20 : 80

D. 30 : 70

2.A train running at 36km/h crosses a mark on the platform in 8 sec and takes 20 sec to cross the platform. What is the length of the platform?

A. 120 m

B. 280 m

C. 40 m

D. 160 m

3.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 has tray the maximum volume?
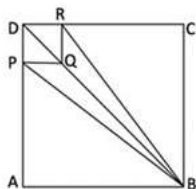
A. 1cm   B. 2cm

C. 3cm   D. 4cm

4.What is angle x in the schematic diagram given below?
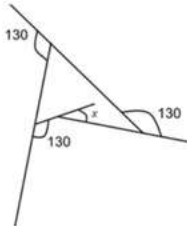
A. 60   B. 50

C. 40   D. 30

5.DRQP is a small square of side s in the corner of a big square ABCD of side S.

What is the ratio of the area of the quadrilateral PBRQ to that of the square ABCD given S/s=3?

A. 2/9   B. 1/6

C. 1/3   D. 2/7

6.Consider a series of letters placed in the following way

U_G_C_C_S_I_R

Each letter moves one step to its right and the extreme right letter takes the first position, completing one operation. After which of the following number of operations do both the Cs not sit side by side?

A. 3

B. 10

C. 19

D. 25

7.A buy n copies of a book at 20% discount. B gets the same book at 30% discount. What is the minimum value of n for which B can buy one extra copy of the book, spending the same amount as A?

A. 7

B. 8

C. 6

D. This problem cannot be solved unless the marked price of the book is known.

8.A tells only lies on Monday, Tuesday and Wednesday and speaks only the truth for the rest of the week. B tells only lies on Thursday, Friday and Saturday and speaks only the truth for the rest of the week. If today both of them state that they have lied yesterday, what is it today?

A. Monday

B. Thursday

C. Sunday

D. Tuesday

9.The different between the squares of the ages (in complete years) of a father and his son is 899. The age of the father when his son was born

A. cannot be ascertained due to inadequate data.

B. is 27 years

C. is 29 years

D. is 31 years

10.$81^{1/3} \times 81^{1/9} \times 81^{1/27} \times 81^{1/81} \times$ ...... up to infinite term will be equal to
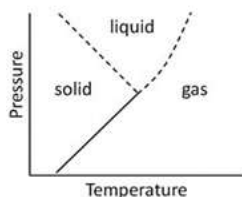
A. 3

B. 9

C. 27

D. 81

11. A vessel is partially filled with water. More water is added to it at a rate directly proportional to time $\left[i.e., \dfrac{dV}{dt} \propto t\right]$. Which of the following graphs depicts correctly the variation of total volume V and time t?

A.

B.

C.

D.
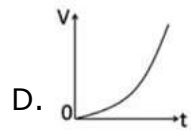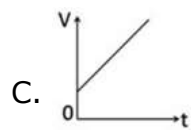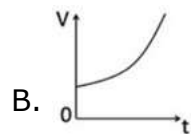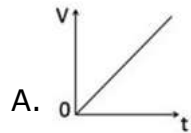
12. By reading the accompanying graph, determine the INCORRECT statement out of the following

(Pressure, Temperature, Solid, liquid, gas)

A. melting point increases with pressure

B. Melting point decreases with pressure

C. Boiling point increases with pressure

D. Solid, liquid and gas can co-exist at the same pressure and temperature

13. The distance between X and Y is 1000 km. A person flies from X at 8 AM local time and reaches Y at 10 AM local time. He flies back after a halt of 4 hours at Y and reaches X at 4 PM local time on the same day. What is his average speed for the duration he is in the air?

A. 500 km/hour

B. 250 km/hour

C. 750 km/hour

D. cannot be calculated with the given information

14. 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?

A. ½
B. 1/8
C. 1/12
D. 1/24

15. Let m and n be two positive integers such that m + n + mn = 118. Then the value of m + n is

A. not uniquely determined
B. 18
C. 20
D. 22

16. In how many ways can you place N coins on a board with N rows and N columns such that every row and every column contains exactly one coin?

A. N

B. N (N − 1) (N − 2) …. 2 × 1

C. N^2

D. N^N

17. The triangle formed by the lines y = x, y = 1 − x and x = 0 in a two dimensional plane is (x and y axes have the same scale)

A. isosceles and right-angled
B. isosceles but not right-angled
C. right-angled but not isosceles
D. neither isosceles not right-angled

18.

The graph shows the percentage change (over the previous year) in the number of candidates passing the three subjects. Which of the following inferences can be drawn from the above graph?

A. The total number of students qualifying in Physics in 2015 and 2014 is the same

B. The number of students qualifying in Biology in 2015 is less than that in 2013

C. The number of Chemistry students qualifying in 2015 must be more than the number of students who qualified in biology in 2014

D. The number of students qualifying in physics in 2015 is equal to number 2014

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 40000km. The height of human beings is between 1 & 2m)

A. Yes

B. No

C. Cannot be determined

D. Only those with height less than 1.7m

20. Suppose three meetings of a group of professors were arranged in Mumbai, Delhi and Chennai. Each professor of the group attended exactly two meeting. How many of them attended both the Chennai and Delhi meetings?

A. 18

B. 24

C. 26

D. Cannot be found from the above information

21. The number of micro states corresponding to the atomic term symbol ^4F is

A. 7   B. 12

C. 28   D. 42

22. The molecular orbital involved in the interaction of the oxime shown below, with a base is

A. σ^* of O−H   B. σ^* of C−H
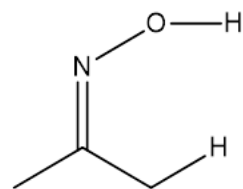
C. σ of O−H   D. σ of C−H

23. Identify the correct statement for the two reactions given below

$$Xe + PtF_6 \xrightarrow{SF_6} [Xe]^+ [PtF_6]^-$$

$$XeF_4 + Me_4NF \longrightarrow [Me_4N]^+ [XeF_5]^-$$
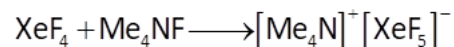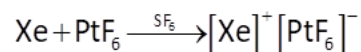
A. Xe and XeF$_4$ both act as acids

B. Xe and XeF$_4$ both act as bases

C. Xe acts as an acid and XeF$_4$ acts as a base

D. Xe acts as a base and XeF$_4$ acts as an acid

24. Consider the following statement(s) in the context of NO and CO ligands

1). In the bent mode, NO donates three electrons to the metal centre.

2). In IR spectrum, the v_{NO} for the bent nitrosyl ligand typically lies between 1525 and 1690 cm^{-1}

3). The HOMO of NO and CO are π^* and σ orbitals, respectively.

A. 1 only

B. 2 and 3

C. 1 and 3

D. 1 and 2

25. When three planes of a two-component system are simultaneously in equilibrium, the number of degrees of freedom is

A. 0

B. 1

C. 2

D. 3

26. Consider an octahedral complex Ma$_2$b$_2$cd, where a, b, c and d are monodentate ligands. The number of enantiomeric pairs for the complex is

A. One

B. Two

C. Three

D. Four

27. The rate of decomposition of a gas is 10 mMs^{-1} when 10% is reacted and it is 5 mMs^{-1} when 40% is reacted. The order of the reaction is:

A. 2

B. 1.71

C. 0

D. 2.15

28. The amount of Ba(NO$_3$)$_2$ (molecular weight 261.32 amu) required to be added to 500 g of a 0.11 mol kg^{-1} solution of KNO$_3$ in order to raise its ionic strength to 1.00 is approximately:

A. 38.8 g

B. 19.4 g

C. 76.2 g

D. 126.5 g

29. The pK$_a$ values for the following compounds are in the order
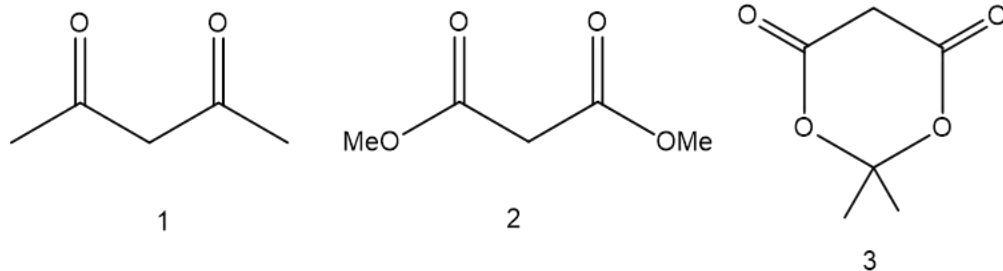
A. 2 > 3 > 1

B. 1 > 2 > 3

C. 3 > 2 > 1

D. 2 > 1 > 3

30. When yellow phosphorous is converted to red phosphorous, the entropy and volume of the system do not change. The order of this phase transition is most likely to be

A. 3

B. 2

C. 1

D. 0

31. The major product formed in the following reaction

conc. HNO$_3$

conc. H$_2$SO$_4$
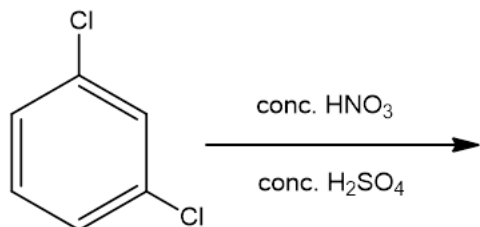
A.

B.

C.

D.

32. Match the items of Column I with the applications given in Column II

	Column I		Column II
a.	Zeolite	i.	Solar Cell
b.	Indium tin oxide	ii.	CO_2 capture
c.	$LiCoO_2$	iii.	Fuel cell
d.	Pt alloy	iv.	Battery

A. a-iii, b-iv, c-i, d-ii

B. a-i, b-iii, c-ii, d-iv

C. a-ii, b-i, c-iv, d-iii

D. a-iv, b-ii, c-iii, d-i

33. The major product formed in the following reaction:

A.

B.

C.

D.
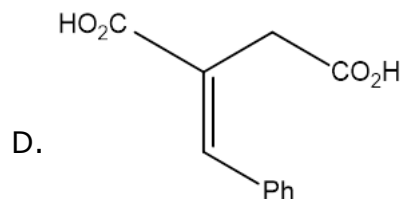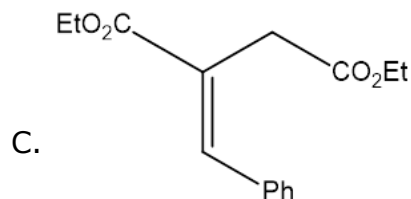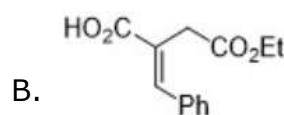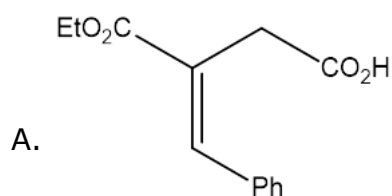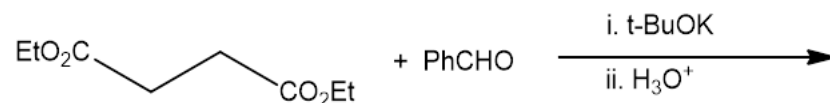
34. The commutator, $\left[\hat{x}, \hat{p}_x^2 \right]$ is equivalent to

A. $-2i\hbar\hat{p}_x$

B. $2i\hbar\hat{p}_x$

C. $-i\hbar\hat{p}_x$

D. $i\hbar\hat{p}_x$

35. The structure that corresponds to the most stable conformation of the following compound is

A.

B.

C.

D.
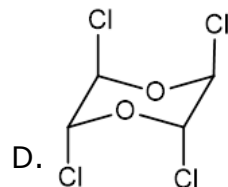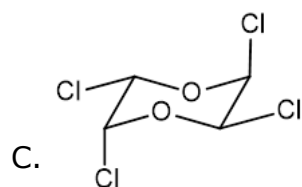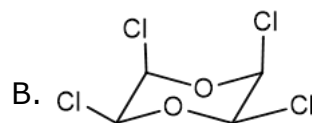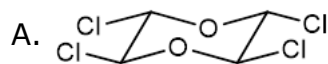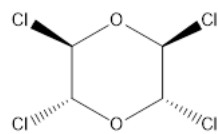
36. Of the following statements regarding dissociative substitution in an octahedral transition metal complex,

A). High steric hindrance between ligands in the metal complex favors fast dissociation of ligand.

B). Increased charge on the metal atom/ion of the complex favors the acceptance of electron pair of the entering ligands.

C). A pentacoordinated intermediate is observed.

D). Nature of the entering ligand significantly influences the reaction.

Which are correct?

A. a and d

B. a and c

C. a, c and d

D. a, b, c and (d)

37. The effective magnetic moment (in BM) for a lanthanide f^{10} ion is approximately

A. 10.6

B. 9.92

C. 9.59

D. 7.94

38. The correct match for the Bond Dissociation Energies (BDE) of the C-H bonds of compounds in Column I, with the values in Column II is (As an example, the BDE for Me-H is 105.0 kcal/mol)

	Column I		Column II BDE (kcal/mol)
a.	▷—H	i.	110.9
b.	⬡—H	ii.	71.1
c.	⬠—H	iii.	132.0
d.	HC≡C-H	iv.	90.6

A. a-iii; b-iv; c-i; d-ii

B. a-i; b-iii; c-ii; d-iv

C. a-iii; b-i; C-iv; d-ii

D. a-iv; b-i; c-ii; d-iii

39. The correct order of the electron affinity for one-electron gain of the elements is

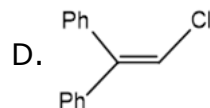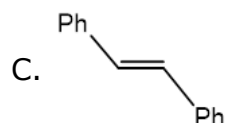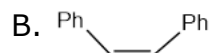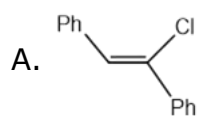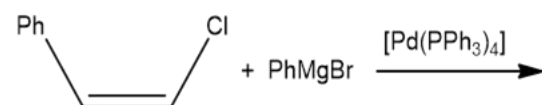A. F > Cl > Br

B. P > N > As

C. S > Se > O

D. K > Li > Na

40. The ozonolysis of a hydrocarbon in the presence of water produced pentanoic acid and carbonic acid. The hydrocarbon is

A. 1-hexene

B. 1-hexyne

C. 5-decene

D. 5-decyne

41. Which of the following compound has the ^{1}H NMR Spectrum ^{1}H NMR : δ 2.4 (s, H), 3.9(s, 3H), 7.25 (d, J = 7 Hz, 2H), 7.95 (d, = 7 Hz, 2H)ppm

A.

B.

C.

D.
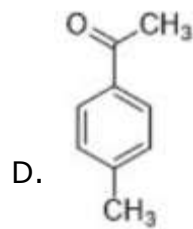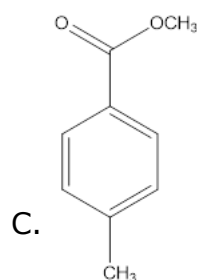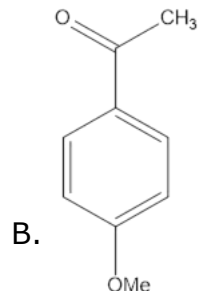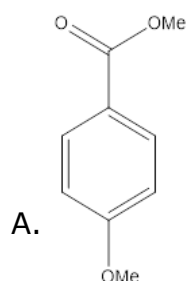
42. The major product formed in the following reaction:

A.

B.

C.

D.

43. The hypothetical NMR spectrum of ^{1}H - C - ^{2}H would consist of (spin of the ^{2}H is 1) a

A. Singlet

B. Doublet of 1:1 ratio

C. Triplet of 1:1:1 ratio

D. Triplet of 1 : 2 : 1 ratio

44. Among the following which set of molecular / ionic species all have a planar structure?

A. $BrF_3, FClO_2$ and $[XeF_5]^-$

B. $XeO_3, [ClF_4]^-$ and $FClO_2$

C. $[ClF_4]^-, BrF_3$ and $[XeF_5]^-$

D. $FClO_2, [XeF_5]^-$ and XeO_3

45. For $[Hg_2]^{2+}$, the bond order and the orbitals involved in bonding are, respectively

A. one; s and s

B. two; s and p

C. one; p and p

D. three; s and d

46. The total number of lone pairs of electrons on all the atoms in cyanogen acids and thiocyanogen respectively, are

A. 4 and 6

B. 6 and 6

C. 3 and 4

D. 4 and 4

47. For a micro-canonical system, the correct probability distribution function for energy is given by

A. Exponential distribution function

B. Gaussian distribution function

C. Poisson distribution function

D. Uniform distribution function

48. The following transformation
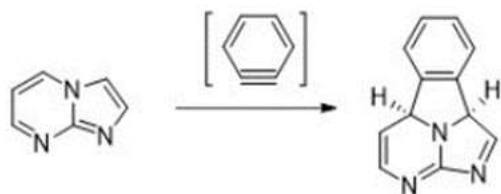
Is an example of

A. [3п + 2п] cycloaddition

B. [6п + 2п] cycloaddition

C. [8п + 2п] cycloaddition
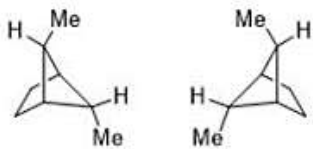
D. [8п + 4п] cycloaddition

49. The reaction that is expected to show a primary kinetic isotope effort for the indicated H-atom (C-H) is

A.

B.

C.

D.
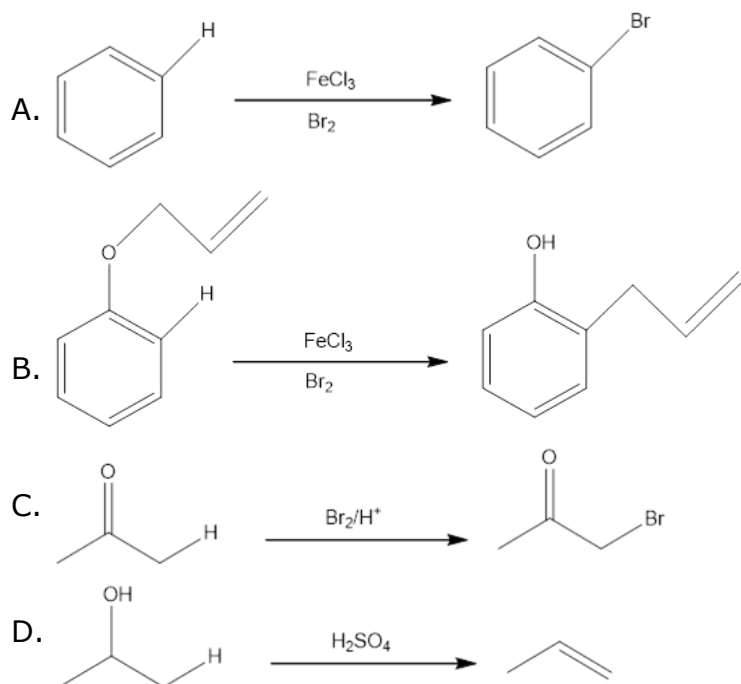
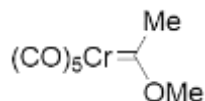50. The reactive cross section is expected to be the largest for the reaction

A. $Li + Cl_2 \rightarrow LiCl + Cl$

B. $Na + Cl_2$

C. $K + Cl_2$

D. $Rb + Cl_2$

51. The correct relationship between the following structures is that they are

A. Identical

B. Enantiomers

C. Diastereomers

D. Constitutional isomers

52. Consider the following statement(s) in the context of the organo metallic complex (X)

A) The carbene ligand donates two electrons to the metal and accepts d electrons to make a π bond

B) The C(carbene) is nucleophilic

C) Rotation around the Cr=C(OMe)Me double bond has low barrier (< 10 kCal/mol)

A. A and B

B. A only

C. A and C

D. B and C

53.The total π-electron density on the four carbon atoms of trans butadiene are in the ratio

A. 1:1:1:1

B. 1:2:2:1

C. $1: \sqrt{2}: \sqrt{2}: 1$

D. 1:3:3:1

54.The correct order of C=O stretching frequency in IR spectrum for the following compounds is:
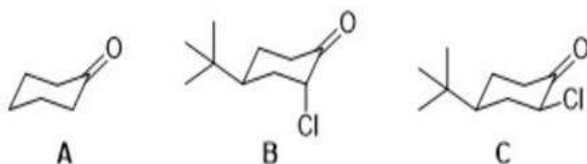
A. A > C > B

B. B > C > A

C. C > B > A

D. B > A > C

55.For a person weighing 70 kg the minimal volume (in ml) of a fatal dose of a compound with LD_{50} = 80 mg.kg^{-1} and density =1.45 gml^{-1}

A. 5.6

B. 3.9

C. 0.8

D. 0.4

56.The volume of nitrogen gas absorbed at STP to form a monolayer on a porous solid surface is 22.4 cm^{3}g^{-1}. If the area occupied by one nitrogen gas molecule is 16.2 Å^2, then the surface area (in cm^{2}g^{-1}) of the solid is close to:

A. 1.2x 10^7

B. 9.8x10^5

C. 1.2x10^5

D. 9.8x10^8

57.The penetrating power (R) and ionizing power (I) of α, β, γ rays follows the order

A. $R_\beta > R_\alpha > R_\gamma$ and $I_\beta > I_\gamma > I_\alpha$

B. $R_\gamma > R_\beta > R_\alpha$ and $I_\beta > I_\gamma > I_\alpha$

C. $R_\beta > R_\alpha > R_\gamma$ and $I_\alpha > I_\beta > I_\gamma$

D. $R_\gamma > R_\beta > R_\alpha$ and $I_\alpha > I_\beta > I_\gamma$

58. For the ligand-to-metal charge transfer (LMCT) transitions in the oxo-anions given below, the wavelength of the transitions are in the order

A. $VO_4^{3-}<CrO_4^{2-}<MnO_4^-$ and $WO_4^{2-}<MoO_4^{2-}<CrO_4^{2-}$

B. $VO_4^{3-}<CrO_4^{2-}<MnO_4^-$ and $WO_4^{2-}>MoO_4^{2-}>CrO_4^{2-}$

C. $VO_4^{3-}>CrO_4^{2-}>MnO_4^-$ and $WO_4^{2-}<MoO_4^{2-}<CrO_4^{2-}$

D. $VO_4^{3-}>CrO_4^{2-}>MnO_4^-$ and $WO_4^{2-}>MoO_4^{2-}>CrO_4^{2-}$

59. The combination of two reflection $\sigma_v{'}$, $\sigma_v{''}$ about an intersecting mirror plane is equivalent to

A. S_n

B. C_n

C. σ_h

D. i

60. The miller indices of the planes parallel to the b axis and intersecting the a and c axis as shown in the figure are
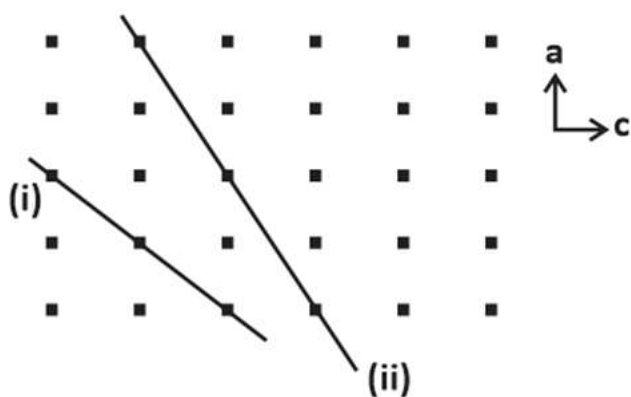
A. (i) 101, (ii) 102

B. (i) 102, (ii) 101

C. (i) 100, (ii) 101

D. (i) 100, (ii) 102

61. In 3-iron ferredoxins, the number of sulfide bridges and cysteinyl ligands, respectively, are:

A. 3,3

B. 4,3

C. 3,4

D. 4,4

62. Consider the following statements for the self-exchange electron transfer reaction in $[Cr(H_2O)_6]^{2+/3+}$

A) σ^* orbitals are only involved in electron transfer

B) It involves large inner-sphere reorganization energy

C) It involves no change in M–L bond lengths

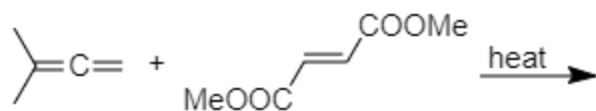D) Rate of self-exchange electron transfer is fast

The correct statements are

A. A, B and D

B. A and B

C. A and C

D. B and D

63. For the cell $Cd|CdCl_2||AgCl|Ag$; $E^0_{cell} = 0.675V$ and $\dfrac{dE^0_{cell}}{dT} = -6.5 \times 10^{-4} VK^{-1}$ at 27°C.

The $\Delta H(KJmol^{-1})$ value for the reaction $Cd + 2AgCl \rightarrow 2Ag + CdCl_2$ is closest to:

A. -168

B. -123

C. -95

D. -234

64. The major product formed in the following reaction is

A.

B.

C.

D.

65.The reaction that will show a large increase in rate when the reaction medium is changed from a non-polar to polar organic solvent is:

A. $NMe_3 + Me_3\overset{\oplus}{S}\overset{\ominus}{Br} \longrightarrow Me_4\overset{\oplus}{N}\overset{\ominus}{Br} + Me_2S$

B. $Et_3\overset{\oplus}{S}\overset{\ominus}{Br} \longrightarrow EtBr + Et_2S$

C. $NMe_3 + MeI \longrightarrow Me_4\overset{\oplus}{N}\overset{\ominus}{I}$

D.
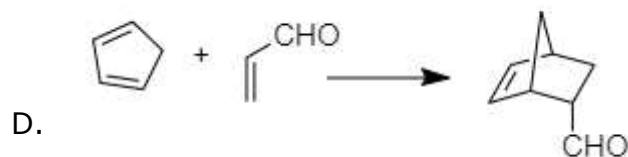
66.Consider the following statements regarding EPR spectra:

a) For allowed transitions, $\Delta M_s = \pm 1$ and $\Delta M_l = 0$.

b) For allowed transitions, $\Delta M_s = 0$ and $\Delta M_l = \pm 1$.

c) Tetragonally elongated Cu(II) complexes have $g_\parallel > g_\perp$.

d) The orbital considered as ground state for tetragonally compressed Cu(II) complexes is $d_{x^2-y^2}$.

The correct statements are

A. A, C and D

B. B, C and D

C. A and C

D. B and D

67. For every atom that is not shifted under C_4 and σ symmetry operations, the characters are, respectively,

A. -1,-1

B. 0,0

C. 1,1

D. -1,1

68.A compound shows [M]+ at m/z 84 and has a base peak at 56. It exhibits only one signal in ^1H NMR at δ 1.4 ppm and one signal in ^{13}C NMR at δ 35 ppm. The compound is:
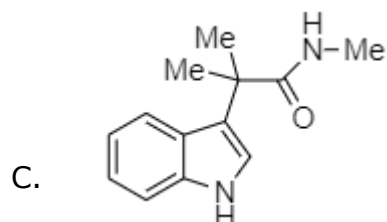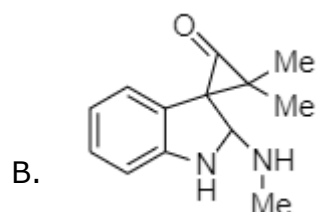
A. cyclobutane-1,3-dione

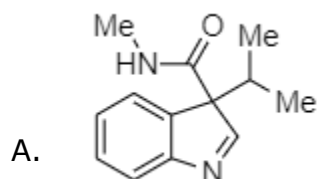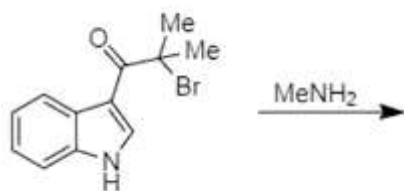B. dichloromethane

C. cyclohexane

D. 1,2,3-trimethylcyclopropane

69.The major product formed in the following reaction is:

A.

B.

C.

D.
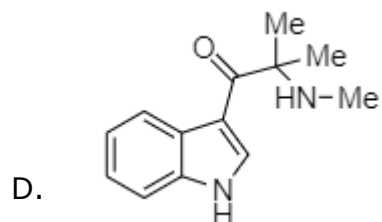
70.Which of the following statements for rubredoxin,
A) Fe^{2+} center has a tetrahedral geometry.
B) Reduced form of iron is diamagnetic.
C) Fe^{2+} center undergoes Jahn-Teller distortion.
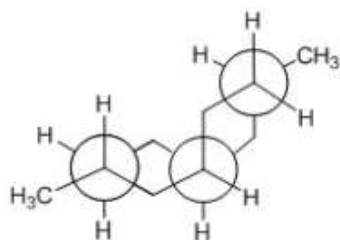D) It is a [2Fe−2S] cluster.

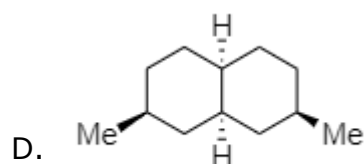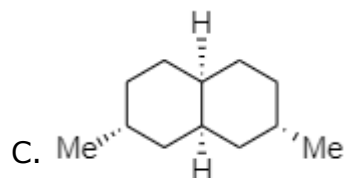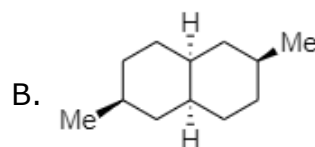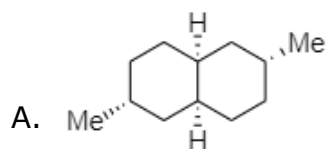A. A, B and C   B. A, C and D
C. C and D only   D. A and C only
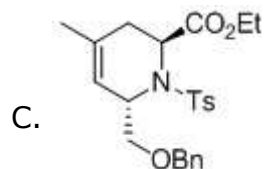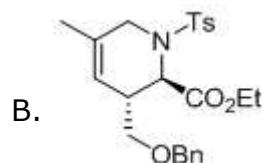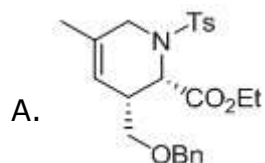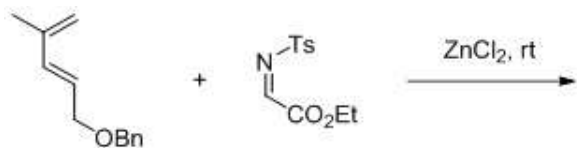
71. The Newmann projection given below:

Corresponds to the compound

A.

B.

C.

D.

72. The major product formed in the following reaction is

A.

B.

C.

D.
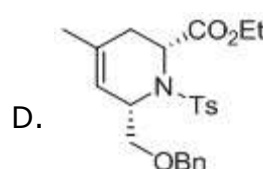
73. The surface tension of a dilute soap solution is lower than that of pure water because

A. soap molecules accumulate more at the surface than in the bulk solution

B. soap molecules accumulate more in the bulk of the solution than on the surface

C. the soap molecules aggregate uniformly in the bulk and the surface.

D. soap molecules form micellar structures at low concentration.

74. Match the iron and copper proteins with biological function in the table below:

	Iron protein		Copper protein		Biological function
A	Hemerythrin	i	Azurin	X	Oxygenase
B	Cytochrome P450	ii	Hemocyanin	Y	Electron transfer
C	Rieske protein	iii	Tyrosinase	Z	O_2 transport

A. A-ii-Z, B-iii-X,C-i-Y

B. A-ii-Z, B-i-X, C-iii-Y

C. A-iii-Y, B-i-Z,C-ii-X

D. A-i-Y, B-iii-Z, C-ii-X

75. Consider following terms. Identify those which are relevant to d.c. polarography

A) Thermal current

B) Supporting electrolyte

C) Depolarization

D) Gelatin

A. A, B and C

B. A, B and D

C. B, C and D

D. C and D only

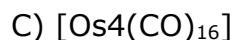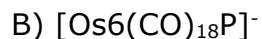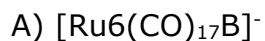76. The major product formed in the following reaction is

1. 9-BBN

2. PhBr, Pd(PPh$_3$)$_4$
   K$_3$PO$_4$
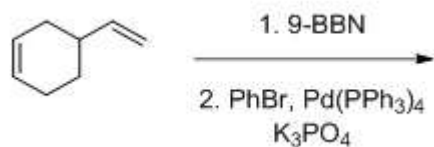
A.

B.

C.

D.

77. The equivalent symmetry operations for S_6^3 and S_3^6 are respectively,

A. C$_3$ and C$_2$

B. σ_h and i

C. σ_h and E

D. i and E

78. The correct geometries for the metal carbonyl clusters, A-C

A) $[Ru6(CO)_{17}B]^-$

B) $[Os6(CO)_{18}P]^-$

C) $[Os4(CO)_{16}]$

A. A: pentagonal bipyramidal, B: trigonal prismatic, and C: tetrahedral

B. A: pentagonal bipyramidal, B: octahedral, and C: square

C. A: octahedral, B: trigonal prismatic, and C: tetrahedral

D. A: octahedral, B: trigonal prismatic, and C: square

79. Sample of polystyrene is composed of three weight fractions: 0.20, 0.50 and 0.30. The molecular weight of these fractions is 10,000, 40,000 and 60,000, respectively. The weight average molecular weight of this sample is:

A. 40000

B. 55000

C. 50000

D. 60000

80. When a hydrogen atom is exposed to a perturbation $V = E.z$, the first order correction to the wave function comes only from the orbital
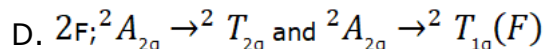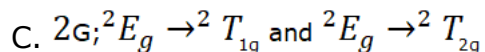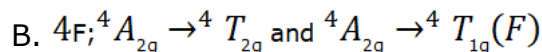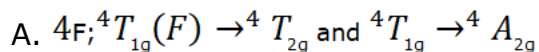
A. 2s

B. $2p_z$

C. $3p_y$

D. $3d_z^2$

81. The absorption spectrum of $[Cr(NH_3)_6]^{3+}$ in water shows two bands around 475 and 365 nm. The ground term and the spin-allowed transitions, respectively, are

A. $4F; {}^4T_{1g}(F) \rightarrow^4 T_{2g}$ and ${}^4T_{1g} \rightarrow^4 A_{2g}$

B. $4F; {}^4A_{2g} \rightarrow^4 T_{2g}$ and ${}^4A_{2g} \rightarrow^4 T_{1g}(F)$

C. $2G; {}^2E_g \rightarrow^2 T_{1g}$ and ${}^2E_g \rightarrow^2 T_{2g}$

D. $2F; {}^2A_{2g} \rightarrow^2 T_{2g}$ and ${}^2A_{2g} \rightarrow^2 T_{1g}(F)$

82. The number of CO bands for isomers from sets (i) and (ii) in their IR spectra

Set (i): Trigonal bipyramidal isomers, axial-Fe(CO)₄L (A) and equatorial-Fe(CO)₄L (B)

Set (ii): Octahedral isomers, fac-Mo(CO)₃L₃ (C) and mer-Mo(CO)₃L₃ (D)

are

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

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

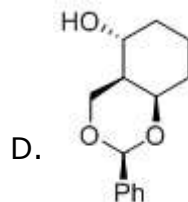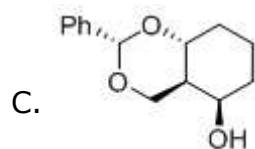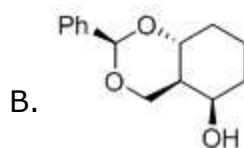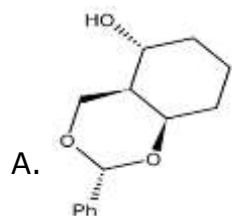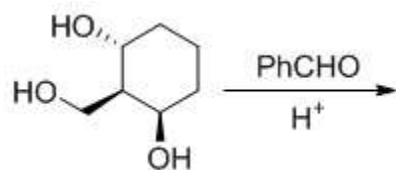C. A, 3 and B, 4; C, 3 and D, 2

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

83. The rate constant for the reaction, $A_2B_4O \rightarrow AB_4 + AO$, is described as,

$$\log k = 1.41 - \frac{10000k}{T}$$

The activation energy for this reaction (in kJ mol^{-1}) is closest to

A. 191.4

B. 83.14

C. 382.8

D. 166.28

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

A.

B.

C.

D.

85. The correct statements from the following set (i) to (iv) is

(i) If q is the displacement from equilibrium for harmonic motion, the potential energy is proportional to q.

(ii) If the vibrational frequency ($\bar{v}$) of HCl is 2990 cm^{-1}, its zero-point energy will be 1495 cm^{-1}

(iii) The correct order of vibrational frequency of O-^{1}H (X$_1$), O-^{2}H (X$_2$), and O-^{3}H (X$_3$), is $X_1 > X_2 > X_3$

(iv) The fundamental vibrational transition of a diatomic molecule appears at 1880cm^{-1}. Its first overtone will be at 940 cm^{-1}.

A. i, ii, iii only
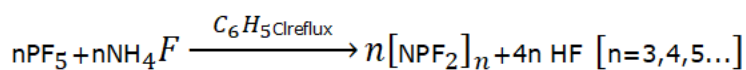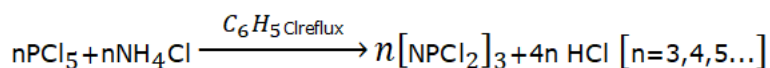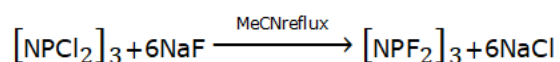
B. i, ii, iii, iv

C. ii, iii only

D. i, ii, iv only

86.Liquid A has half the surface tension and twice the density of liquid B at 30 °C. The contact angles of A and B are the same. If A rises 10 cm in a capillary, then the rise (in cm) of liquid B in the same capillary at the same temperature will be equal to

A. 60

B. 10

C. 40

D. 20

87.Consider an electron (m_e=9.1 x 10^{-31} Kg) having energy 13.6 eV, confined in an infinite potential well. If the potential energy inside the well is zero, the expectation value for the square of the electron speed, $\langle v^2 \rangle$, is
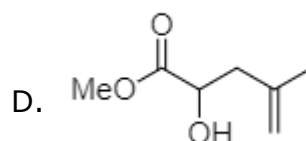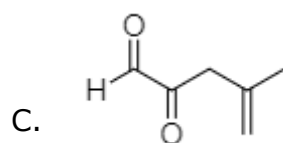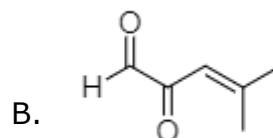
A. 3 x 10^{12}m^{2}s^{-2}

B. 4.3 x 10^{-18}m^{2}s^{-2}

C. 4.7 x 10^{12}m^{2}s^{-2}

D. 4.7 x 10^{31}m^{2}s^{-2}

88.Which of the following reaction (s) do(es) NOT occur

$[NPCl_2]_3 + 6NaF \xrightarrow{MeCNreflux} [NPF_2]_3 + 6NaCl$

$nPCl_5 + nNH_4Cl \xrightarrow{C_6H_5Clreflux} n[NPCl_2]_3 + 4n\ HCl\ [n=3,4,5...]$

$nPF_5 + nNH_4F \xrightarrow{C_6H_5Clreflux} n[NPF_2]_n + 4n\ HF\ [n=3,4,5...]$

A. (i) and (iii)   B. (i) and (ii)

C. (i) only   D. (iii) only

89.The major product formed in the following reaction is

A.

B.

C.

D.
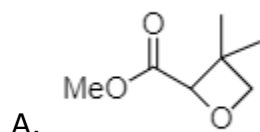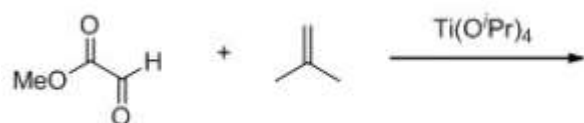
90. Which of the statements (A-D) given below are correct for B_2H_6 molecule is:

A) Addition of $Et_2O.BF_3$ to $NaBH_4$ in a polyether solvent produces B_2H_6

B) It has D_{2d} symmetry.

C) Reaction of B_2H_6 with NMe_3 gives $Me_3N\text{-}BH_3$.

D) It is diamagnetic

A. A, B, and C

B. A, C, and D

C. A and B only

D. B and D only

91. Plutonium (atomic mass=244 $gmol^{-1}$) crystallizes in monoclinic lattice (a=620pm; b=480 pm; c=1100 pm; β= 102^0) with 16 atoms per unit cell. The density in $g\ cm^{-3}$ will be close to (Use sin β= 0.98; sin β/2 =0.78)

A. 25.38

B. 16.12

C. 12.69

D. 20.26

92. Choose the correct statement(s) from the following:

(i) The trend in Lewis acidity among silicon halides is $SiI_4 < SiBr_4 < SiCl_4 < SiF_4$

(ii) Tin(II) chloride can act as a Lewis acid and not as a Lewis base.

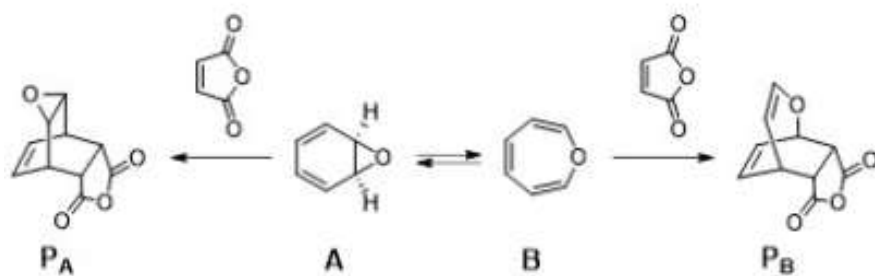(iii) Aluminosilicates can display Bronsted acidity.
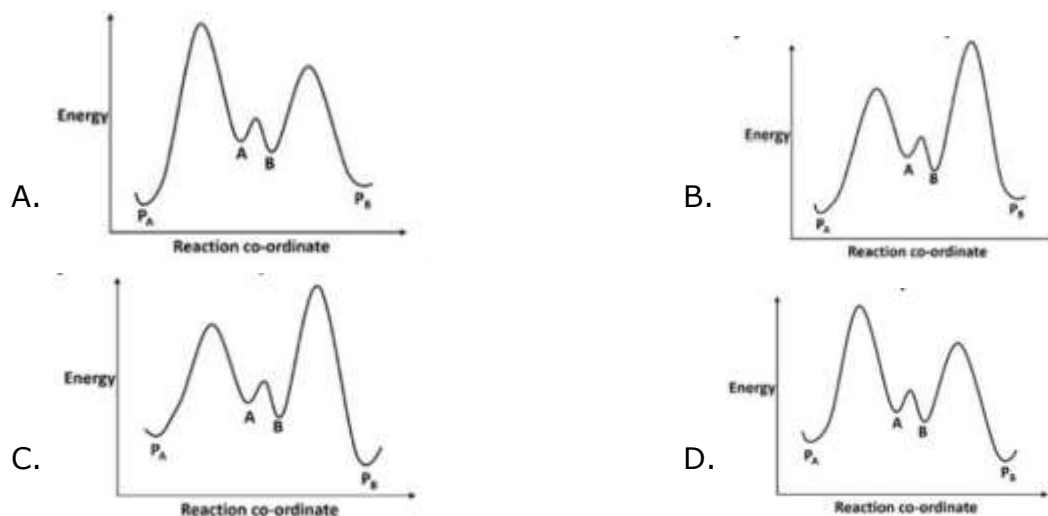
A. (i) and (ii)
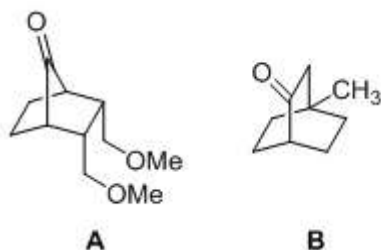
B. (i) and (iii)

C. (ii) and (iii)

D. (ii) only

93.

P_A A   B P_B

The correct energy profile diagram for the above reactions is

A.

Energy
Reaction co-ordinate

B.

Energy
Reaction co-ordinate

C.

Energy
Reaction co-ordinate

D.

Energy
Reaction co-ordinate

94.The correct relationship between the two faces of the C=O group in compounds A and B is

A   B

A. A =diastereotopic;

B =enantiotopic

B. A = B =enantiotopic

C. A = enantiotopic;

B =diastereotopic

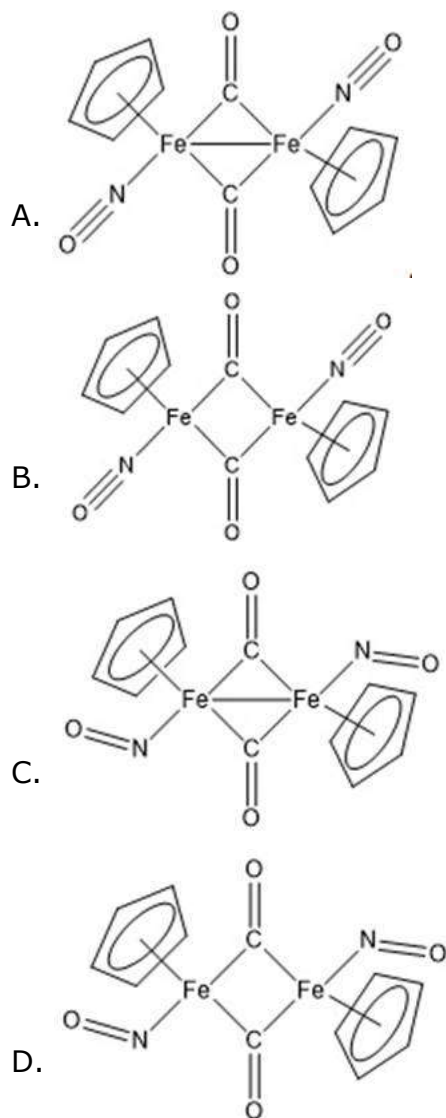D. A = B =diastereotopic

95.The reagent that will affect the following selective conversion is

A. NaOMe, MeOH

B. TBAF, THF

C. DDQ, CH$_2$Cl$_2$

D. Et$_3$N, MeOH

96. Identify the thermodynamically stable structure of $[(\eta^5\text{-}C_5H_5)(\mu_2\text{-}CO)(NO)]_2$

A.

B.

C.

D.

97. Match the following:

Measurement		Spectroscopic Technique	
A	Binding energy	i	NMR spectroscopy
B	Quadrupole splitting	ii	Energy-dispersive X-ray spectroscopy (EDS)
C	Contact shift	iii	X-ray photoelectron spectroscopy (XPS)
D	Elemental analysis	iv	Mossbauer spectroscopy

A. (A) – (ii), (B) – (i), (C) – (iv), (D) – (iii)

B. (A) – (iii), (B) – (iv), (C) – (i), (D) – (ii)

C. (A) – (iv), (B) – (iii), (C) – (i), (D) – (ii)

D. (A) – (i), (B) – (iv), (C) – (ii), (D) – (iii)

98. Which of the patterns (A, B, C or D) fits best with the ^{13}C NMR spectrum of TiCl$_3$(CDH$_2$) [Given: $^1J(C-H) > {}^1J(C-D)$]
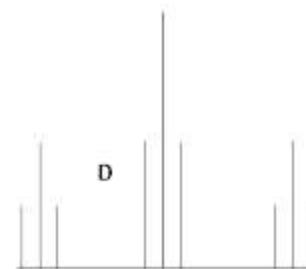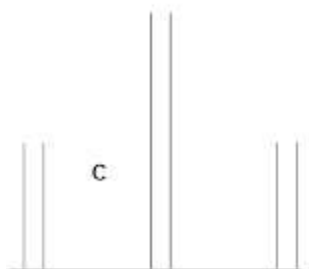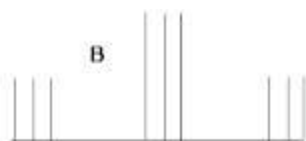
A. A   B. B
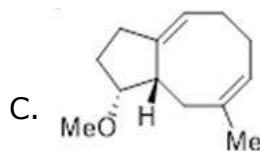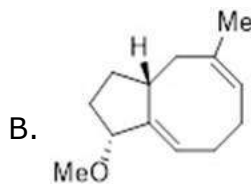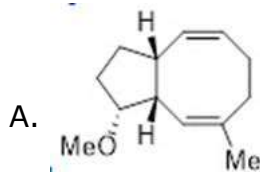
C. C   D. D

99. The structure of the reactive intermediate generated by reaction of CHCl$_3$ and KOH is

A.

B.

C.

D.
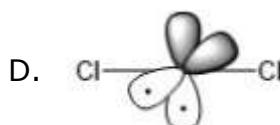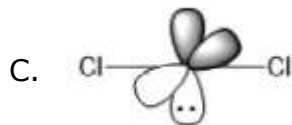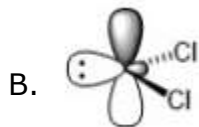
100. The major product formed in the following reaction is

A.

B.

C.

D.
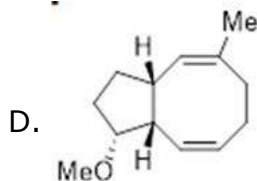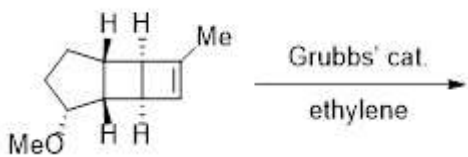
101. For a weak electrolyte such as acetic acid, the relation among conductance (λ), equilibrium constant (k) and concentration (C) an be expressed as: (λ^0 is the conductance at infinite dilution).

A. $\dfrac{1}{\lambda} = \dfrac{1}{\lambda^0} - \dfrac{c\lambda}{\kappa\lambda^0}$

B. $\dfrac{1}{\lambda} = \dfrac{1}{\lambda^0} - \dfrac{c\lambda}{\kappa\lambda^{0^2}}$

C. $\dfrac{1}{\lambda^0} = \dfrac{1}{\lambda} - \dfrac{c\lambda}{\kappa\lambda^{0^2}}$

D. $\dfrac{1}{\lambda} = \dfrac{c\lambda}{\kappa\lambda^{0^2}}$

102. For trigonal bipyramidal coordination complex (ML$_5$) the correct point group symmetry and the relative order of the energies of the 3d orbitals in that crystal field, respectively are

A. $D_{3h}; d_{x^2-y^2} > d_{z^2}, d_{xy} > d_{xz}, d_{yz}$

B. $D_{3d}; d_{z^2} > d_{x^2-y^2}, d_{xz} > d_{xy}, d_{yz}$

C. $D_{3d}; d_{x^2-y^2} > d_{z^2} > d_{xy} > d_{xz}, d_{yz}$

D. $D_{3h}; d_{z^2} > d_{x^2-y^2}, d_{xy} > d_{xz}, d_{yz}$

103. The major products A and B in the following reaction sequence are:

A.

B.

C.

D.
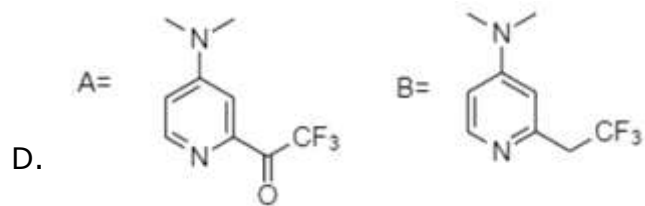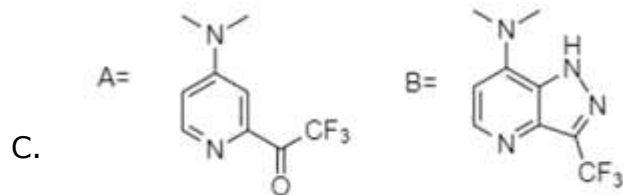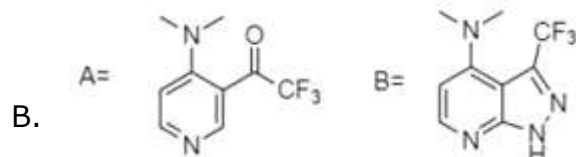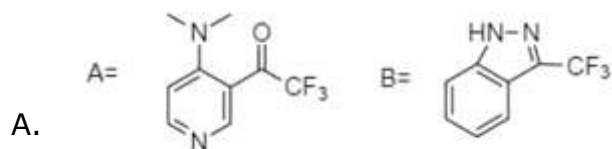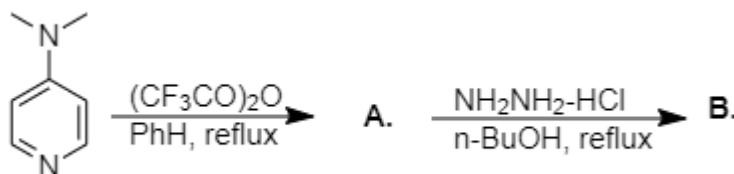
104.The correct sequence of reagents that will lead to the formation of the given product in the following transformation is
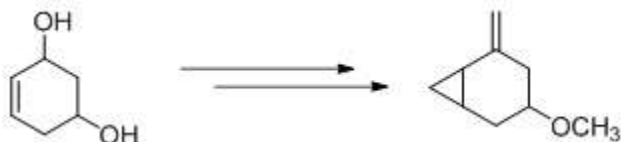
A. I. active MnO_2; II. MeI, NaH; III. $Me_3S(O)I$, NaH; IV. $MePPh_3Br$, NaH

B. I. MeI, NaH; II. active MnO_2; III. Me_3SI, NaH; IV. $MePPh_3Br$, NaH

C. I. CH_2I_2, Zn-Cu; II. $MePPh_3Br$, NaH; III. active MnO_2; IV. MeI, NaH

D. I. $MePPh_3Br$, NaH; II. active MnO_2; III. CH_2I_2, Zn-Cu; IV. MeI, NaH

105.For the reaction,

$$[cis\text{-}M(en)_2(OH)_2]^+ \underset{k_2}{\overset{k_1}{\rightleftharpoons}} [trans\text{-}M(en)_2(OH)_2]^+$$

the equilibrium constant is 0.16 and K_1 is $3.3 \times 10^{-4} s^{-1}$. The experiment is started with pure cis form. The time taken for half the equilibrium amount of trans isomer to be informed is about

A. 290 s

B. 580 s

C. 190 s

D. 480 s

106.The major product formed in the following reaction is:
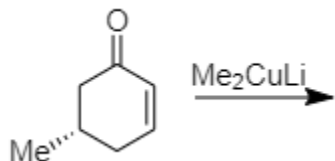
A. cis-3,5-dimethylcyclohexanone, which is chiral

B. trans-3,5-dimethylcyclohexanone, which is chiral

C. cis-3,5-dimethylcyclohexanone, which is achiral

D. trans-3,5-dimethylcyclohexanone, which is achiral

107.The maximum number of phases that can be simultaneously in equilibrium for a one component system is

A. 1

B. 2

C. 3

D. 4

108. The molecule that will not absorb in the microwave region, but will absorb in the infrared is

A. N_2

B. C_2H_2

C. HCl

D. H_2O

109. Given the specific rotation $[\alpha]_D^{20}$ of (S)-4-methyl-3-heptanone in hexane as +22°, the specific rotation $[\alpha]_D^{20}$, in hexane, of the product A (ee = 98%) obtained from the following enantioselective alkylation reaction is

1.
MeO   NH₂
2. LDA then n-C₃H₇I, -110°C
3. O₃, CH₂Cl₂, 0°C

A
ee=98%
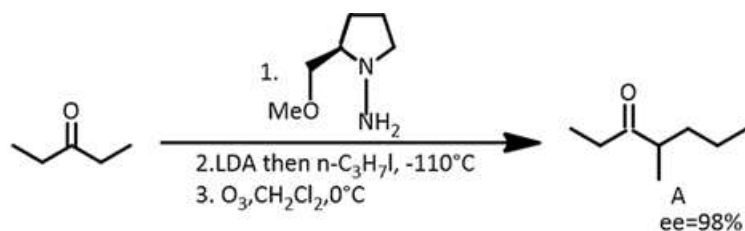
A. +21.56

B. +21.12

C. -21.56

D. -21.12

110. The following data is obtained For a light diatomic (AB) molecule from its rotational Raman spectrum.

$B = 2cm^{-1}$, $x_e = 0.01$, $v_e = 1600cm^{-1}$

If the molecule is irradiated by laser of 20,000 cm^{-1}, the expected stokes lines (cm^{-1}) for this molecule are

A. 18348, 18356, 18368, 18380, 18388

B. 18412, 18420, 18432, 18444, 18452

C. 18380, 18388, 18400, 18412, 18420

D. 18416, 18424, 18430, 18440, 18452

111. The correct sequence of mechanistic steps involved in the formation of product in the following reaction is

Me
Me
-CH₂OBz
Me
SnCl₄
Me   Me
Me   O   CH₂OBz
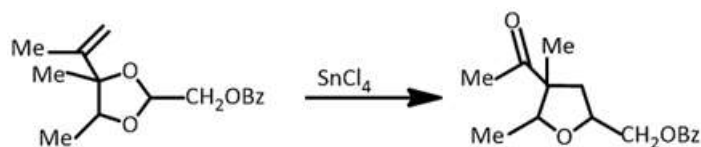
A. Prins cyclization, formation of oxonium ion, pinacol rearrangement

B. pinacol rearrangement, Prins cyclization and formation of oxonium ion

C. formation of oxonium ion, Prins cyclization and pinacol rearrangement

D. pinacol rearrangement, formation of oxonium ion and Prins cyclization

112.A system consists of N identical distinguishable non-interacting particles each having only two energy levels, 0 and ϵ. The expression of heat capacity at constant volume (C_v) is given by ($\beta = \dfrac{1}{k_B T}$)

A. NK_B

B. $NK_B(\dfrac{\epsilon\beta}{1+e^{\epsilon\beta}})^2$

C. $NK_B(\dfrac{\epsilon\beta e^{\frac{\epsilon\beta}{2}}}{1+e^{\epsilon\beta}})^2$

D. $NK_B(\dfrac{\epsilon\beta e^{-2\epsilon\beta}}{1+e^{-\epsilon\beta}})^2$

113.The type of molecular orbitals in the allyl ligand ($CH_2=CH-CH_2^-$) that are used for σ-donation and π-back donation with metal d-orbitals, respectively are

A. 2π and 3π

B. 1π and 3π

C. 3π and 2π

D. 1π and 2π

114.The stopping potential for photoelectrons emitted from a surface illuminated by light of frequency 6x 10^8 MHz is 0.72 V. when the incident frequency is changed, the stopping potential is found to be 1.44 V. The new frequency is approximately (e/h =2.4 x x10^{14} C J^{-1} s^{-1})

A. 7×10^{8}

B. 4×10^{8}

C. 2×10^{9}

D. 7×10^{14}

115.The major product formed in the following reaction is
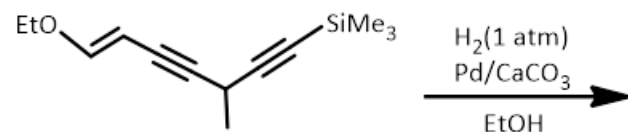
116. In a Langmuir-type adsorption, a solid adsorbs 0.25 mg of a gas when the pressure of the gas is 50 bar and 0.2 mg of the gas at 20 bar pressure. The percentage of surface coverage at 50 bar is close to:

A. 75   B. 38

C. 57   D. 83

117. The ore (X) gives a d-block metal (M) in the elemental form, following a chemical process. Which of the sets X/ M/Chemical process below is correct?

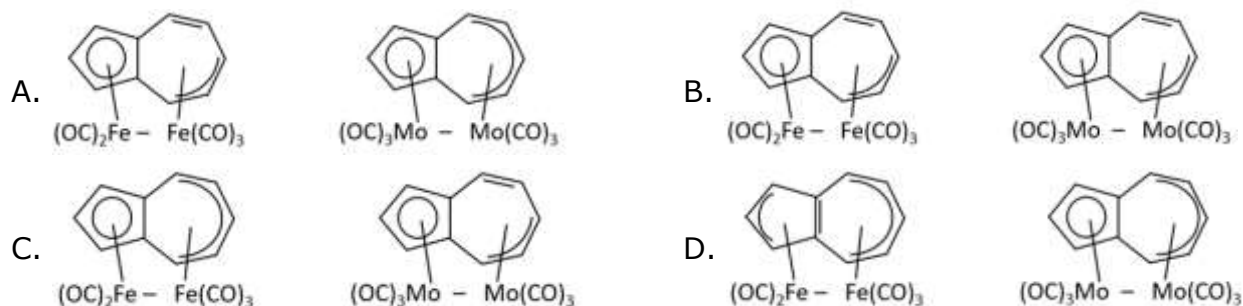A. Ilmenite/ Titanium/ $2FeTiO_3 + Mg + O_2 \rightarrow 2TiO_2 + MgO + Fe_2O_3$ followed by reduction of TiO_2 with Mg.

B. Rutile/ Titanium/ $TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$ followed by reduction of $TiCl_4$ with Na or Mg.

C. Rutile/ Titanium/ $TiO_2 + 4HCl$ (conc.) $\rightarrow TiCl_4 + 2H_2O$ followed by electrolytic reduction of $TiCl_4$

D. Molybdenite/ Molybdenum/ $2MoS_2 + 7O_2 \rightarrow 2MoO_3 + 4SO_2$ followed by reduction of MoO_3 with carbon.

118. The quantum number corresponding to the z-component of the total electronic orbital angular momentum in the nitric oxide molecule is

A. 0   B. 1

C. 2   D. 3

119. The set of structures showing the correct hapticity of azulene on the basis of the 18 e⁻ rule, is

A. $(OC)_2Fe - Fe(CO)_3$ $(OC)_3Mo - Mo(CO)_3$ B. $(OC)_2Fe - Fe(CO)_3$ $(OC)_3Mo - Mo(CO)_3$

C. $(OC)_2Fe - Fe(CO)_3$ $(OC)_3Mo - Mo(CO)_3$ D. $(OC)_2Fe - Fe(CO)_3$ $(OC)_3Mo - Mo(CO)_3$

120. Consider following statements

A) $PbCl_2$ has low solubility in water.

B) Sulfides of As(III) and Sb(III) are soluble in ammonium sulfide.

C) SnS is soluble in yellow ammonium sulfide.

D) MnS is precipitated by passing H_2S through acidic $MnCl_2$.

Correct statements are

A. A , B and C   B. B, C and D

C. A, C and D   D. A and C only

ANSWERS

1. Ans. B.	31. Ans. A.	61. Ans. B.	91. Ans. D.
2. Ans. A.	32. Ans. C.	62. Ans. B.	92. Ans. A.
3. Ans. A.	33. Ans. A.	63. Ans. A.	93. Ans. C.
4. Ans. B.	34. Ans. B.	64. Ans. B.	94. Ans. A.
5. Ans. A.	35. Ans. D.	65. Ans. C.	95. Ans. C.
6. Ans. D.	36. Ans. B.	66. Ans. C.	96. Ans. B.
7. Ans. C.	37. Ans. A.	67. Ans. C.	97. Ans. B.
8. Ans. B.	38. Ans. D.	68. Ans. C.	98. Ans. B.
9. Ans. C.	39. Ans. C.	69. Ans. C.	99. Ans. B.
10. Ans. B.	40. Ans. B.	70. Ans. D.	100. Ans. D.
11. Ans. B.	41. Ans. C.	71. Ans. A.	101. Ans. C.
12. Ans. C.	42. Ans. B.	72. Ans. D.	102. Ans. D.
13. Ans. A.	43. Ans. C.	73. Ans. A.	103. Ans. A.
14. Ans. D.	44. Ans. C.	74. Ans. A.	104. Ans. A.
15. Ans. D.	45. Ans. A.	75. Ans. C.	105. Ans. A.
16. Ans. B.	46. Ans. A.	76. Ans. A.	106. Ans. B.
17. Ans. A.	47. Ans. D.	77. Ans. D.	107. Ans. C.
18. Ans. B.	48. Ans. C.	78. Ans. C.	108. Ans. B.
19. Ans. A.	49. Ans. C.	79. Ans. A.	109. Ans. C.
20. Ans. A.	50. Ans. D.	80. Ans. B.	110. Ans. B.
21. Ans. C.	51. Ans. A.	81. Ans. B.	111. Ans. C.
22. Ans. A.	52. Ans. C.	82. Ans. D.	112. Ans. B.
23. Ans. D.	53. Ans. A.	83. Ans. A.	113. Ans. B.
24. Ans. B.	54. Ans. C.	84. Ans. C.	114. Ans. A.
25. Ans. B.	55. Ans. B.	85. Ans. C.	115. Ans. A.
26. Ans. B.	56. Ans. B.	86. Ans. C.	116. Ans. D.
27. Ans. B.	57. Ans. D.	87. Ans. C.	117. Ans. B.
28. Ans. A.	58. Ans. A.	88. Ans. D.	118. Ans. B.
29. Ans. D.	59. Ans. B.	89. Ans. D.	119. Ans. A.
30. Ans. B.	60. Ans. A.	90. Ans. B.	120. Ans. A.