



Punjab Technical University, Jalandhar

Maximum Marks: 90

Time: 90Mins.

Entrance Test for Enrollment in Ph.D Programme

Important Instructions

- Fill all the information in various columns, in Capital letters, with blue/black point pen for attempting the questions
- Use of calculators is not allowed
- Make attempt by writing the answer in capital letters in the box against each question number.
- All questions are compulsory. Each Question has only one right answer. No Negative marking for wrong answers.
- Questions attempted with two or more options/answers will not be evaluated

Stream: ...Applied Sciences.....
Discipline ...Chemistry
Name
Fathers Name
Roll Number Date: 13-07-2014
Signature of Candidate:
Signature of Invigilator

- The O-O bond length varies in the following species as
(A) $O_2^{2-} < O_2^- < O_2 < O_2^+$ (B) $O_2^{2-} > O_2^- > O_2 > O_2^+$
(C) $O_2^{2-} < O_2^- < O_2^+ < O_2$ (D) $O_2^{2-} > O_2^- > O_2^+ > O_2^-$
- The hybridization of the xenon atom in XeF_4 is:
(A) sp^2 (B) sp^3
(C) sp^3d (D) sp^3d^2
- Which of the following molecule will have a permanent dipole moment?
(A) SiF_4 (B) XeF_4
(C) SF_4 (D) BF_3
- According to MO theory, for the atomic species C_2
(A) Bond order is zero and it is paramagnetic
(B) Bond order is zero and it is diamagnetic

- (C) Bond order is two and it is paramagnetic
(D) Bond order is two and it is diamagnetic
5. The number of antibonding electrons in NO and CO according to MO theory are respectively
(A) 1,0 (B) 2,2
(C) 3,2 (D) 2,3
6. Iron-sulphur clusters in biological systems are involved in
(A) proton transfer (B) atom transfer
(C) group transfer (D) electron transfer
7. Which one of the following statements for hemoglobin is not correct?
(A) The binding with O_2 is weaker in comparison with myoglobin.
(B) Iron is 5-coordinated
(C) Iron is co-planar with the porphyrin ring in the absence of oxygen
(D) The oxidation state of iron is +2.
8. The metal present at the active site of the protein carboxypeptidase A is
(A) Zinc (B) molybdenum
(C) magnesium (D) cobalt
9. Which of the following statement for borazene is not correct?
(A) It has six B-H bonds (B) it has three B=N bonds
(C) it has three N-H bonds (D) It has cyclic structure
10. Which of the following mixture of gases is used for breathing in deep of sea by divers?
(A) O_2+N_2 (B) O_2+He
(C) O_2+Ne (D) O_2+CO_2
11. The type of force that holds the layers of carbon atoms in graphite together is:
(A) Ionic (B) Hydrogen bonding
(C) Vander waal forces (D) Covalent
12. Which one of the following species is isoelectronic with CO_2 ?
(A) N_3^- (B) CN_2^{2-}
(C) SCN^- (D) CNO^-

13. The increasing order of ease of liquefaction of noble gases is:
- (A) He<Ne<Ar<Kr<Xe (B) Xe<Kr<Ar<Ne<He
 (C) Ne<He<Ar<Kr<Xe (D) Ne<Ar<He<Kr<Xe
14. Which one of the following noble gases does not form the clathrates?
- (A) He (B) Ar
 (C) Kr (D) Xe
15. Among N_2 , N_3^- , azobenzene and hydrazine, the shortest and longest N-N distance are found, respectively in
- (A) N_3^- and hydrazine (B) N_2 and azobenzene
 (C) N_3^- and azobenzene (D) N_2 and hydrazine
16. The hybrid orbitals used by bromine atom in BrF_3 are
- (A) sp^2 (B) sp^3
 (C) sp^3d (D) sp^3d^2
17. Wilkinson's catalyst is:
- (A) $[Rh(CO)_2I_2]^-$ (B) $(Ph_3P)_3RhCl$
 (C) $Co_2(CO)_8$ (D) $(Ph_3P)_2Rh(CO)Cl$
18. Which one of the following does not obey 18 electron rule?
- (A) $Cr(CO)_6$ (B) $Fe(CO)_5$
 (C) $V(CO)_6$ (D) $Mn_2(CO)_{10}$
19. The compound which has four metal-metal bonds is
- (A) $Fe_2(CO)_9$ (B) $Co_2(CO)_8$
 (C) $[Re_2Cl_8]^{2-}$ (D) $[Ru_3(CO)]_{12}$
20. The catalyst used in the conversion of ethylene to acetaldehyde using Wacker process is
- (A) $HCo(CO)_4$ (B) $[PdCl_4]^{2-}$
 (C) V_2O_5 (D) $TiCl_4$ in the presence of $Al(C_2H_5)_3$
21. Hemocyanin contains
- (A) A dinuclear copper core that binds dioxygen in the cuprous state
 (B) A dinuclear copper core that binds dioxygen in the cupric state
 (C) A mononuclear copper core that binds dioxygen in the cuprous state

- (D) A mononuclear copper core that binds dioxygen in the cupric state
22. In oxy-hemoglobin, the iron centre is best described as
- (A) high-spin Fe(III) (B) high-spin Fe(II)
(C) low-spin Fe(III) (D) low-spin Fe(II)
23. The ligand system in vitamin B₁₂ is:
- (A) Porphyrin (B) Corrin
(C) Phthalocyanine (D) crown ether
24. According to crystal field theory, Ni²⁺ can have two unpaired electrons in
- (A) Octahedral geometry only (B) Square planar geometry only
(C) Tetrahedral geometry only (D) Both octahedral and tetrahedral geometry
25. Which of the following spectroscopic techniques will be useful to distinguish between M-SCN and M-NCS?
- (A) NMR (B) IR
(C) EPR (D) Mass
26. Which of the following compounds show a charge-transfer band?
- (A) Lanthanum nitrate (B) Ceric ammonium nitrate
(C) Manganese(II)acetate (D) Copper(II)sulphate pentahydrate
27. In the molecule H₂O, NH₃ and CH₄:
- (A) The bond angles are same (B) The bond distances are same
(C) The hybridizations are same (D) The shapes are same
28. Which one of the following exhibit rotational spectra?
- (A) H₂ (B) N₂
(C) CO (D) CO₂
29. The correct order of stability of difluorides is:
- (A) GeF₂>SiF₂>CF₂ (B) CF₂>SiF₂>GeF₂
(C) SiF₂>GeF₂>CF₂ (D) CF₂>GeF₂>SiF₂
30. Cis and trans complexes of the type [Pt A₂ X₂] are distinguished by
- (A) Chromyl chloride test (B) Carbylamine test
(C) Kurnakov test (D) Ring test

31. How much energy is created from the conversion of 1.0×10^{-4} kg of matter?

- (A) 3.0×10^4 J (B) 3.0×10^7 J
(C) 9.0×10^{12} J (D) 9.0×10^{15} J

32. In a certain reaction $\Delta H = -136$ kJ and E_a reverse = 236 kJ. Which of the following is true of its forward reaction?

- (A) The reaction is exothermic and $E_a = -100$ kJ.
(B) The reaction is exothermic and $E_a = 100$ kJ.
(C) The reaction is endothermic and $E_a = 372$ kJ.
(D) The reaction is endothermic and $E_a = 232$ kJ

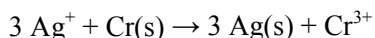
33. For the reaction $2\text{HI}(\text{g}) \rightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})$, $K_p = 0.0198$ at 721 K. In a particular experiment, the partial pressures of $[\text{H}_2]$ and $[\text{I}_2]$ at equilibrium are 0.710 and 0.888 atm, respectively. The partial pressure of HI is

- (A) 7.87 atm (B) 1.98 atm
(C) 5.64 atm (D) 0.125 atm

34. $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}(\text{s})$ $E^0 = +0.80$ V

$\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$ $E^0 = -0.74$ V

Based on the standard reduction potentials for chromium and silver shown above, what is the cell potential for the reaction below?



- (A) 0.06 V (B) 1.54 V
(C) 1.66 V (D) 3.14 V

35. Which one of the following will change the value of an equilibrium constant?

- (A) changing temperature
(B) adding other substances that do not react with any of the species involved in the equilibrium
(C) varying the initial concentrations of reactants
(D) changing the volume of the reaction vessel

36. Calculate the vibrational partition function for the sodium dimer, Na_2 , molecule at 298 K. The harmonic vibrational wavenumber is 159 cm^{-1} .

- (A) 1.107 (B) 1.542
(C) 2.341 (C) 1.866

37. What is the degeneracy of the energy level with $n=6$ in a hydrogenic atom or ion?

- (A) 25 (B) 16
(C) 36 (D) 9

38. How many nodes does a 4d orbital possess?

- (A) 3, of which 1 is an angular node and 2 are radial nodes
- (B) 3, of which 2 are angular nodes and 1 a radial node
- (C) 3, of which all are radial nodes
- (D) 3, of which all are angular nodes

39. What is the symmetry of the antibonding molecular orbital formed by a linear combination of the p_x or p_y atomic orbitals in a homonuclear diatomic molecule?

- (A) σ_g
- (B) σ_u
- (C) π_u
- (D) π_g

40. Use molecular orbital theory to determine the bond order for the O_2^+ ion.

- (A) 3
- (B) $1\frac{1}{2}$
- (C) $2\frac{1}{2}$
- (D) 2

41. Calculate the quantum-mechanical zero-point energy of an electron confined within a one-dimensional box of length 1.0 nm.

- (A) $2.4 \times 10^{-19} \text{ J}$
- (B) 0 J
- (C) $6.0 \times 10^{-20} \text{ J}$
- (D) $5.4 \times 10^{-19} \text{ J}$

42. What terms can arise from the configuration $2p^1 3p^1$?

- (A) $^3D, ^1D, ^3P, ^1P, ^3S, ^1S$
- (B) $^3D, ^3P, ^3S$
- (C) $^1D, ^1P, ^1S$
- (D) $^1D, ^3P, ^3S$

43. The root-mean-square distance between the ends of a polymer chain was found to be 6.2 nm. Estimate the number of monomers in the chain, given that the length of each monomer unit is 2.1 Å.

- (A) 870
- (B) 30
- (C) 6
- (D) 17

44. A large activation energy implies which of the following about a reaction?

- (A) It is spontaneous.
- (B) It is highly endothermic.
- (C) It is at equilibrium.
- (D) It has a highly temperature-dependent rate constant.

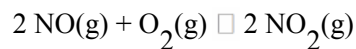
45. What is the degeneracy of the rotational energy level with $J = 4$ for a heteronuclear diatomic molecule?

- (A) 2 (B) 9
(C) 6 (D) 5

46. Which of the following statements are false?

- (A) the greater the energy transition, the greater the frequency
(B) the greater the energy transition, the shorter the wavelength
(C) the higher the frequency, the longer the wavelength
(D) the smaller the energy transition, the longer the wavelength

47. Calculate the equilibrium constant at 25°C for the reaction



given that $\Delta_r G^\circ = -69.8 \text{ kJ mol}^{-1}$.

- (A) 1.7×10^{12} (B) 28.2
(C) 1.03 (D) 5.91×10^{-13}

48. The function $F(x) = c \sin(ax)$ is an eigen function of d^2/dx^2 . What is the eigen value

- (A) ca (B) ca^2
(C) $-a^2$ (D) 1

49. Which of the following conditions is necessary for a reaction to be spontaneous?

- (A) $\Delta S_{\text{sur}} > 0$ (B) $\Delta S_{\text{sys}} > 0$
(C) $\Delta S_{\text{sur}} + \Delta S_{\text{sys}} > 0$ (D) $\Delta S_{\text{sur}} + \Delta S_{\text{sys}} < 0$

50. Schottky-defect in ceramic material is

- (A) Interstitial impurity
(B) Vacancy- interstitial pair of cations
(C) Pair of nearby cation and anion vacancies
(D) Substitutional impurity

51. Which one of the following is not a strong bond?

- (A) van der Waals bond
(B) Covalent bond
(C) Metallic bond
(D) Ionic bond

52. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$. This reaction is thermodynamically spontaneous at 298K but becomes non-spontaneous at higher temperatures, which of the following is true at 298K?

- (A) ΔG , ΔH and ΔS are all positive.
- (B) ΔG , ΔH and ΔS are all negative.
- (C) ΔG , ΔH are negative but ΔS is positive.
- (D) ΔG , ΔH are positive but ΔS is negative.

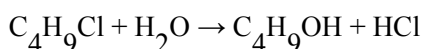
53. Which of the following is *not* a state function?

- (A) Temperature
- (B) Pressure
- (C) Volume
- (D) Mole

54. For hydrogen like atom with nuclear charge Z , the energy of orbital with principal quantum number n follows the relation:

- (A) $E_n \propto n^2 Z^2$
- (B) $E_n \propto -Z^2/n$
- (C) $E_n \propto -Z/n$
- (D) $E_n \propto -Z^2/n^2$

55. The rate constant for the substitution reaction



increases by a factor of 10.6 when the temperature is increased from 298 K to 308 K. Calculate the activation energy of the reaction.

- (A) 180 kJ/mol
- (B) 78.2 kJ/mol
- (C) 809 kJ/mol
- (D) 2.14 kJ/mol

56. Calculate the change in the chemical potential of a perfect gas when it expands isothermally at a temperature of 20.0°C so that its volume doubles.

- (A) -1.69 kJ/mol
- (B) -115 kJ/mol
- (C) 1.69 kJ/mol
- (D) 115 kJ/mol

57. Which of the following statements is always true for a liquid mixture of two components A and B in equilibrium with a mixture of their vapours?

- (A) $\mu_A(\text{l}) = \mu_B(\text{g})$ and $\mu_A(\text{g}) = \mu_B(\text{g})$
- (B) $\mu_A(\text{l}) = \mu_A(\text{g}) = \mu_B(\text{l}) = \mu_B(\text{g})$
- (C) $\mu_A(\text{l}) = \mu_A(\text{g})$ and $\mu_B(\text{l}) = \mu_B(\text{g})$
- (D) $\mu_A(\text{l}) \neq \mu_A(\text{g}) \neq \mu_B(\text{l}) \neq \mu_B(\text{g})$

58. A perfect gas expands reversibly at a constant temperature of 298 K so that its volume doubles. What is the change in the molar internal energy of the gas?

- (A) +2.27kJ/mol (B) 0kJ/mol
 (C) +1.72kJ/mol (D) -2.27kJ/mol

59. The main difference between a suspension and a colloid is that:

- (A) In suspensions the particles eventually settle to the bottom.
 (B) In colloids the particles eventually settle to the bottom.
 (C) In colloids, the solute is permanently dissolved in the solvent.
 (D) In suspensions, the solute is permanently dissolved in the solvent.

60. Consider the following: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$

Colourless Brown

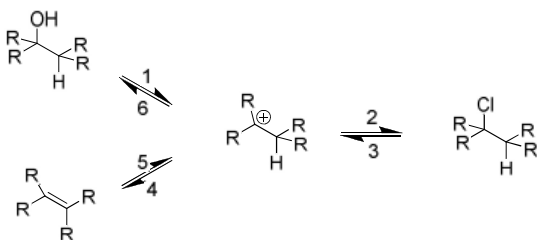
N_2O_4 is placed in a flask at a constant temperature. Which of the following is true as the system approaches equilibrium?

- (A) The colour gets darker as $[\text{NO}_2]$ increases.
 (B) The colour gets lighter as $[\text{NO}_2]$ decreases.
 (C) The colour gets darker as $[\text{N}_2\text{O}_4]$ increases.
 (D) The colour gets lighter as $[\text{N}_2\text{O}_4]$ decreases.

61. Which of the following structure is antiaromatic?

- (A) Pyridinium cation
 (B) Anthracene
 (C) Cyclooctatetraene
 (D) Cyclopentadiene in presence of base

62. The following flow chart connects few reactions



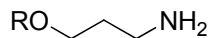
To which arrow(s) does Markovnikov and Zaitsev rule closely relate, respectively

- (A) 6,4
 (B) 6,3

(C) 5,3

(D) 5,4

63. The retrosynthetic analysis of following compound requires FGI and disconnection. Identify the disconnection



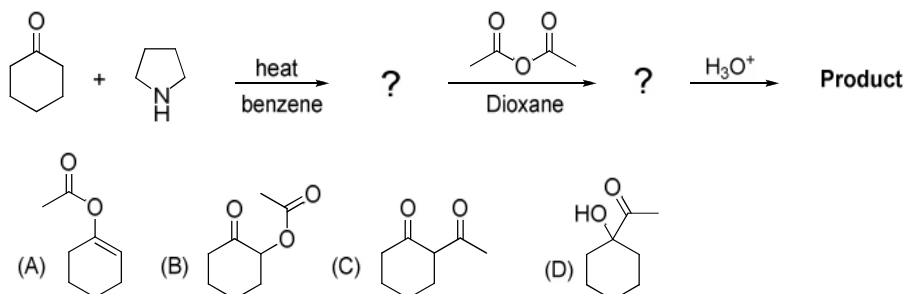
(A) 1,3-diX

(B) 1,2-diX

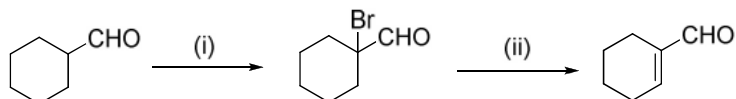
(C) 1,1-diX

(D) 1,1-diX and 1,3-diX

64. What is the product of following reaction?



65. Identify the reaction/mechanism appropriate for each step in the following syntheses



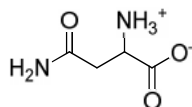
(A) (i) = Hell Vohlard Zelinski reaction; (ii) = E1 mechanism

(B) (i) = Haloform reaction; (ii) = E2 mechanism

(C) (i) = Hell Vohlard Zelinski reaction; (ii) = E2 mechanism

(D) (i) = Haloform reaction; (ii) = E1 mechanism

66. The following amino acid is



(A) Asparagine

(B) Glutamine

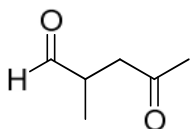
(C) Lysine

(D) Arginine

67. Supramolecular chemistry

- (A) Involves non-covalent interactions
- (B) Chemistry beyond the molecule
- (C) Both (A) and (B)
- (D) None of the above

68. Predict the IUPAC nomenclature of the following compound



- (A) 2-Methyl-1-formylpenta-4-one
- (B) 2-Methyl-4-oxopentanal
- (C) 4-Methyl-2-oxopentanal
- (D) 4-Methyl-5-formylpenta-2-one

69. A well-known sulfoxide – sulfenate rearrangement for the synthesis of E-allylic alcohol, is an example of

- (A) [3,3]-Sigmatropic rearrangement
- (B) [1,2]-Sigmatropic rearrangement
- (C) [3,2]-Sigmatropic rearrangement
- (D) [2,3]-Sigmatropic rearrangement

70. A catalyst with composition $\text{Pd-CaCO}_3\text{-Pb(OOCCH}_3)_2$ is known as

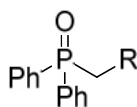
- (A) Jones Catalyst
- (B) Lindlar Catalyst
- (C) Wilkinson Catalyst
- (D) Fremy's Catalyst

71. Rank the compounds in the following group in order of decreasing acidity

$\text{NO}_2\text{CH}_2\text{COOH}$ (I), ClCH_2COOH (II), CNCH_2COOH (III) CH_3COOH (IV)

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

72. The following reagent is used in

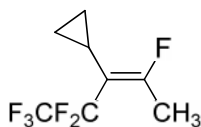


- (A) Horner-Wadsworth-Emmons reaction
- (B) Horner-Wittig reaction
- (C) Wittig reaction
- (D) Peterson reaction

73. Nucleophilic substitution at an aliphatic trigonal carbon involve

- (A) Tetrahedral Mechanism
- (B) S_N2 Mechanism
- (C) SET mechanism
- (D) Elimination-addition Mechanism

74. Determine the configuration of following alkene as appropriate



- (A) Z Configuration
- (B) S Configuration
- (C) R Configuration
- (D) E Configuration

75. Out of the following which statement is not correct?

- (A) Terpene is a diverse class of natural products.
- (B) Sesquiterpenes contain four isoprene units.
- (C) Isoprene is the most common volatile organic compound(D)
- (D) Steroids are metabolic derivatives of Terpenes.

76. Kevlar fibers which are strong and stiff, belong to which class of condensation polymer

- (A) Polycarbonates
- (B) Polyesters
- (C) Polyamides
- (D) None of the above

77. Rank the compounds in the following group in order of decreasing basicity

Pyrrole, Imidazole, Pyridine and Pyrazole

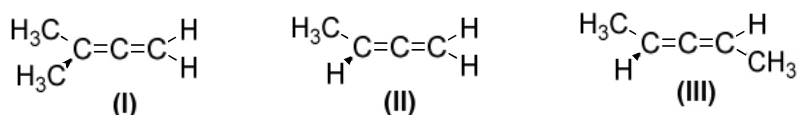
- (A) Imidazole > Pyrazole > Pyridine > Pyrrole

- (B) Pyrrole > Pyrazole > Pyridine > Imidazole
- (C) Pyridine > Pyrrole > Pyrazole > Imidazole
- (D) Imidazole > Pyrrole > Pyrazole > Pyridine

78. What is the orientation of the OH groups at C-2 and C-3 in the β -pyranose form of D-Ribose?

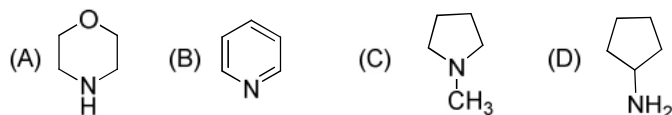
- (A) Both are axial
- (B) Both are equatorial
- (C) C-2 is axial; C-3 is equatorial
- (D) C-2 is equatorial; C-3 is axial

79. Out of the following group of compounds, which statement is true?



- (A) I & III are Achiral; II is Chiral
- (B) I & II are Achiral; III is Chiral
- (C) II & III are Achiral; I is Chiral
- (D) All are Chiral

80. One of the following is often used to prepare enamine from aldehyde and ketones. Identify the enamine-forming compound



81. Ozonolysis of 'X' alkene produces molecule of acetone and 2,2-Dimethylpropanal. What would be the structure of 'X'?

- (A) 2,4,4-Trimethyl-2-pentene
- (B) 2,3,4-Trimethyl-2-pentene
- (C) 3,4-Dimethyl-2-pentene
- (D) 2,4-Dimethyl-2-pentene

82. Most of the time the polarity of the organic compounds in the synthetic organic laboratory are talked in term of R_f value. What does R_f stands for

- (A) Ratio factor
- (B) Retention factor
- (C) Resonance factor
- (D) Reflectance factor

83. Norrish Type II reaction of aldehyde and ketone involve

- (A) Extrusion of CO group
- (B) Decomposition of ketone to give acyl radical
- (C) Abstraction of hydrogen at γ -position
- (D) Abstraction of hydrogen at β -position

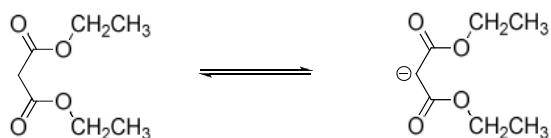
84. "If two states are similar in energy, they are similar in structure". This rationale is known as

- (A) Markov Theory
- (B) Woodward-Hoffmann rule
- (C) Hammonds Postulate
- (D) Gibbs energy relation

85. α -Amino ketones can be prepared by treatment of ketoxime tosylates and base via

- (A) Beckmann rearrangement
- (B) Schmidt Reaction
- (C) Lossen Rearrangement
- (D) Neber rearrangement

86. The following reaction equilibrium for formation of anion represent typical example of



- (A) d^1 Synthon
- (B) d^2 Synthon
- (C) a^1 Synthon
- (D) a^2 Synthon

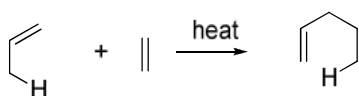
87. How many signals would you expect to find in the ^1H NMR spectrum of vinyl bromide

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

88. Bayer-villiger oxidation of ketone involve the use of

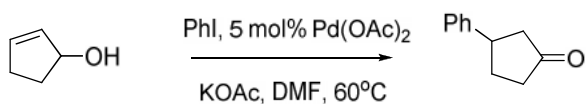
- (A) Caro's acid
- (B) Peracetic acid
- (C) m-CPBA
- (D) All of the above

89. Following reaction is an example of



- (A) Diels-Alder reaction
- (B) Cheletropic reaction
- (C) Ene reaction
- (D) None of the above

90. The following reaction is an example of?



- (A) Suzuki Reaction
- (B) Negishi reaction
- (C) Stille reaction
- (D) Heck Reaction