CHEMISTRY-CY

Q.1 – Q.25 : Carry ONE mark each.

1. The maximum non-PV work that a system can perform at constant P is
(a) ΔH (b) ΔG (c) ΔS (d) ΔA

2. Consider the reaction :

$$A + B \rightleftharpoons C$$

The unit of the thermodynamic equilibrium constant for the reaction is
(a) mol L^{-1} (b) L mol^{-1} (c) mol^2 L^{-2} (d) dimensionless

3. The number of IR active vibrational normal modes of CO_2 is _____

4. The number of C_2 axes in CCl_4 is _____

5. The value of the magnetic quantum number of a p_x orbital is
(a) –1 (b) 0 (c) +1 (d) undefined.

6. The molecular partition function for a system in which the energy levels are equispaced by ε, is
(a) $\frac{1}{1+e^{\beta\varepsilon}}$ (b) $\frac{1}{1-e^{\beta\varepsilon}}$ (c) $\frac{1}{1+e^{-\beta\varepsilon}}$ (d) $\frac{1}{1-e^{-\beta\varepsilon}}$

7. A monoatomic gas, X, adsobred on a surface, Langmuir adsorption isotherm. A plot of the fraction of surface coverage, θ against the concentration of the gas [X], for very low concentration of the gas, is described by the equation
(a) $\theta = K[X]$ (b) $1-\theta = \frac{1}{K[X]}$ (c) $\theta = K^{1/2}[X]^{1/2}$ (d) $\theta = \frac{K[X]}{1-K[X]}$

8. At a given temperature and pressure, the ratio of the average speed of hydrogen gas to that of helium gas is approximately _____

9. An example of nido-borane from the following is
(a) B_4H_{10} (b) B_6H_{10} (c) B_6H_{12} (d) B_8H_{14}

10. The geometries of $Ni(CO)_4$ and $[NiCl_4]^{2-}$, respectively, are
(a) tetrahedral and square planar (b) square planar and tetrahedral
(c) tetrahedral and tetrahedral (d) square planar and square planar

11. The number of S–S bonds in $H_2S_5O_6$ is _____

12. In atomic absorption spectroscopy, the atomization process utilizes
(a) flame (b) electric field (c) magnetic field (d) electron beam

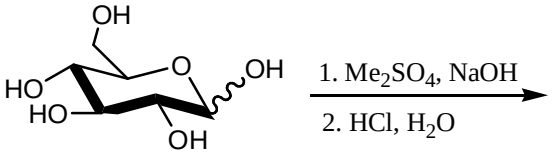
13. At room temperature, the number of singlet resonances observed in the ^1H NMR spectrum of $Me_3CC(O)NMe_2$ (N N–dimethyl pivalamide) is _____

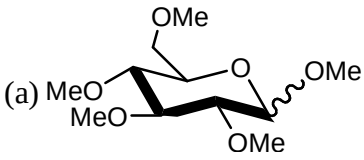
14. Amongst the following, the metal that does NOT form homoleptic polynuclear carbonyl is
(a) Mn (b) Fe (c) Cr (d) Co

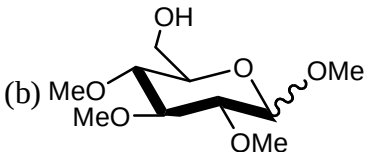
15. The reaction of $[Cp_2TaMe_2]I$ ($Cp = C_5H_5^-$) with NaOMe yields.
(a) $[Cp_2Ta(OMe)_2]I$ (b) $[Cp_2Ta(Me)OMe]I$
(c) $Cp_2Ta(Me) = CH_2$ (d) $Cp_2Ta(OMe) = CH_2$

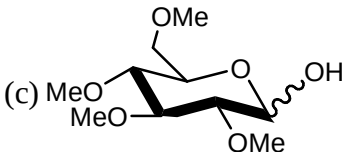
16. The complexes $[Co(H_2O)_4Cl_2]NO_2$ and $[Co(H_2O)_4Cl(NO_2)]Cl$ are
(a) linkage isomers (b) positional isomers (c) ionization isomers (d) optical isomers

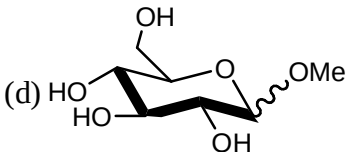
17. The major product of the following reaction is



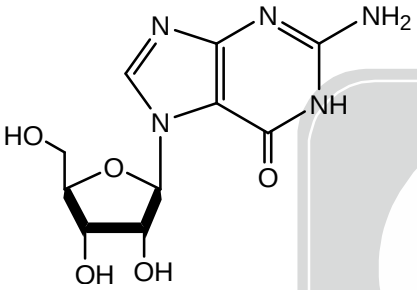
(a) 

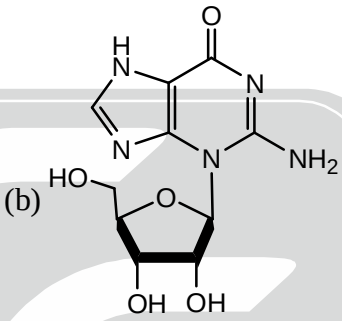
(b) 

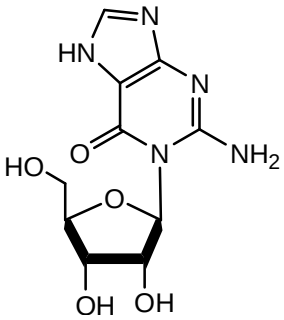
(c) 

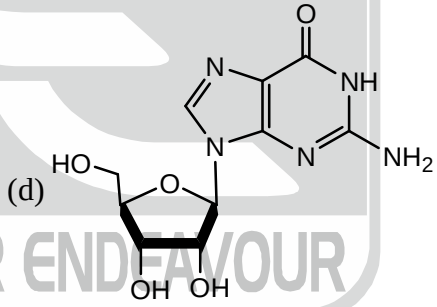
(d) 

18. Amongst the following, the structure of guanosine is

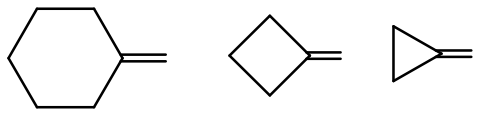
(a) 

(b) 

(c) 

(d) 

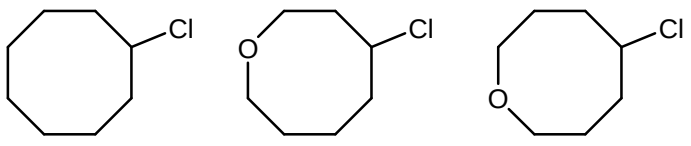
19. The correct order of IR stretching frequency of the C═C in the following olefins is



(I) **(II)** **(III)**

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

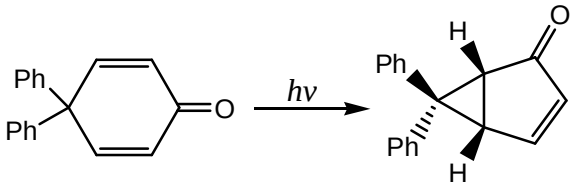
20. The correct order of the solvolysis for the following chlorides in acetic acid is



(I) **(II)** **(III)**

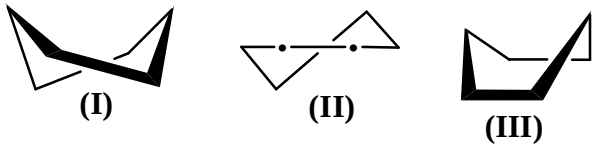
(a) II > I > III (b) III > II > I (c) III > I > II (d) I > III > II

21. Formation of the product in the following photochemical reaction involves



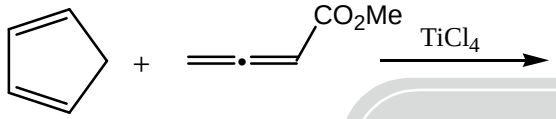
(a) di-π-methane rearrangement (b) Paterno-Buchi reaction
(c) [2, 3]-sigmatropic rearrangement (d) Norrish type I reaction

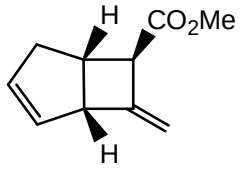
22. The correct order of stability for the following conformations of cyclohexane is

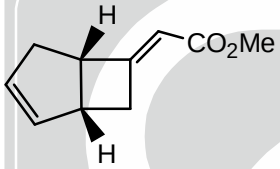


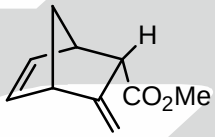
(a) I > II > III (b) I > III > II (c) II > I > III (d) III > I > II

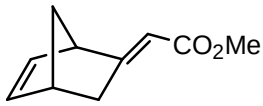
23. The major product formed in the following reaction is



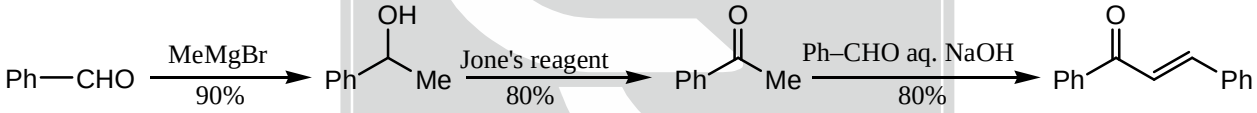
(a) 

(b) 

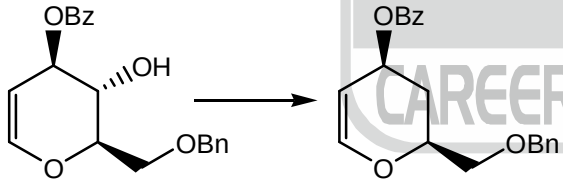
(c) 

(d) 

24. The overall yield (in %) for the following reaction sequence is _____



25. The most suitable reagent combination to effect the following conversion is



(a) (i) NaH, CS_2, then MeI; (ii) Bu_3SnH, AlBN, C_6H_6, Reflux.
(b) (i) I_2, PPh_3, imidazole; (ii) H_2, 10% Pd-C, AcOH, high pressure
(c) (i) Me_3SiCl, pyridine, DMAP; (ii) Bu_3SnH, AlBN, C_6H_6, reflux
(d) (i) MsCl, pyridine, DMAP; (ii) $LiAlH_4$, THF, reflux,

Q.26 – Q.55 : Carry TWO marks each.

26. $\psi = N\, r\left(6 - Z\, r\right)e^{-Zr/3}\cos\theta$, is a proposed hydrogenic wavefunction, where Z = atomic number, r = radial distance from the nucleus, θ = azimuthal angle, N is a constant. The **INCORRECT** statement about ψ is

(a) $\psi = 0$ in the xy-plane
(b) two radial nodes are presenet in ψ
(c) one angular node is present in ψ
(d) the size of the orbital decreases with increase in atomic number

27. The van der waals constant a and b of CO_2 are 3.64 L^2 bar mol^{-2} and 0.04 L mol^{-1}, respectively. The value of R is 0.083 bar dm^3 $mol^{-1}K^{-1}$. If one mole of CO_2 is confined to a volume of 0.15L at 300K, then the pressure (in bar) exerted by the gas, is _____

28. A plot of osmotic pressure against concentration (gL^{-1}) of a polymer is constructed. The slope of the plot
(a) increases with increase in temperature
(b) increases with increase in molar mass of the polymer
(c) decreases with decrease in concentration of the polymer
(d) decreases with increase in temperature.

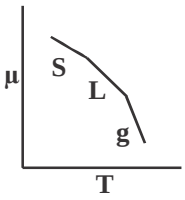
29. A platinum electrode is immersed in a solution containing 0.1 M Fe^{2+} and 0.1 M Fe^{3+}. Its potential is found to be 0.77V against SHE. Under standard conditions and considering activity coefficients to be equal to unity, the potential of the electrode, when the concentration of Fe^{3+} is increased to 1 M, is _____

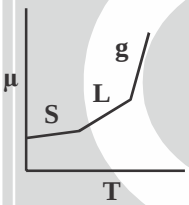
30. Molybdenum crystallizes in a bcc structure with unit cell dimensions of 0.314 nm. Considering the atomic mass of molybdenum to be 96, its density (in kg m^{-3}) is _____

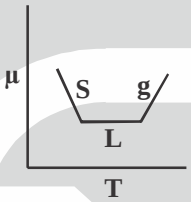
31. The ratio of molecules distributed between two states is 9.22×10^6 at 300K. The difference in energy (in kJ mol^{-1}) of the two states is _____

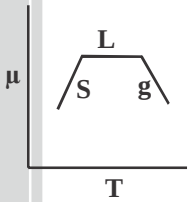
32. A Carnot engine operates at 55% efficiency. If the temperature of reject steam is 105°C, then the absolute temperature of input steam is _____

33. Of the following plots, the correct representation of chemical potential (μ) against absolute temperature (T) for a pure substance is (S, L and g denote solid, liquid and gas phases, respectively)

(a) 

(b) 

(c) 

(d) 

34. The enthalpy of fusion of ice at 273K is 6.01 kJ mol^{-1} and the enthalpy of vaporization of water at 273K is 44.83 kJ mol^{-1}. The enthalpy of sublimation (in kJ mol^{-1}) of ice at 273K, is _____

35. Suppose ψ_1 and ψ_2, are two hybrid orbitals:

$\psi_1 = 0.12\,\psi_{3s} + 0.63\psi_{3p_x} + 0.77\psi_{3p_y}$ and $\psi_2 = 0.12\,\psi_{3s} - 0.63\psi_{3p_x} - 0.77\psi_{3p_y}$

The angle (in degrees) between them is _____

36. BCl_3 and NH_4Cl were heated at 140°C to give compound X, which when treated with $NaBH_4$ gave another compound Y. Compounds X and Y are
(a) X = $B_3N_3H_3Cl_3$ and Y = $B_3N_3H_6$ (b) X = $B_3N_3H_9Cl_3$ and Y = $B_3N_3H_6$
(c) X = $B_3N_3H_3Cl_3$ and Y = $B_3N_3H_{12}$ (d) X = $B_3N_3Cl_6$ and Y = $B_3N_3H_6$

37. The number of microstates in term ^1G is _____

38. The set of protons (underlined) in $CH_3CH_2CH_2OCH_3$ that would exhibit different splitting patterns in high (500 MHz) and low (60 MHz) field ^1H NMR, is
(a) $C\underline{H}_3CH_2CH_2OCH_3$ (b) $CH_3C\underline{H}_2CH_2OCH_3$
(c) $CH_3CH_2C\underline{H}_2OCH_3$ (d) $CH_3CH_2CH_2OC\underline{H}_3$

39. Amongst the following, the complex ion that would show strong Jahn-Teller distortion is
(a) $[Cr(H_2O)_6]^+$ (b) $[Ti(H_2O)_6]^{3+}$ (c) $[Co(H_2O)_6]^{2+}$ (d) $[Fe(H_2O)_6]^{2+}$

40. Amonst the following, the metal carbonyl species having the highest ν_{CO} stretching freqency is
(a) $[Mn(CO)_6]^+$ (b) $Cr(CO)_6$ (c) $[V(CO)_6]^-$ (d) $[Fe(CO)_4]^{2-}$

41. The correct order of thermal stability for the given compounds is
(a) $TiMe_4 > Ti(CH_2CMe_3)_4 > TiEt_4$ (b) $TiEt_4 > Ti(CH_2CMe_3)_4 > TiMe_4$
(c) $TiMe_4 > TiEt_4 > Ti(CH_2CMe_3)_4$ (d) $Ti(CH_2CMe_3)_4 > TiMe_4 > TiEt_4$

42. Amongst the following, the complex ion that is expected to the highest magnetic moment at room temperature is
(a) $[Ni(CN)_4]^{2-}$ (b) $[Fe(CN)_6]^{3-}$ (c) $[Cu(H_2O)_6]^{2+}$ (d) $[Co(CN)_6]^{3-}$

43. $MnCr_2O_4$ is
(a) normal spinel with total CFSE of –15.5 Dq
(b) inverse spinel with total CFSE of –15.5 Dq
(c) normal spinel with total CFSE of –24 Dq
(d) inverse spinel with total CFSE of –24 Dq

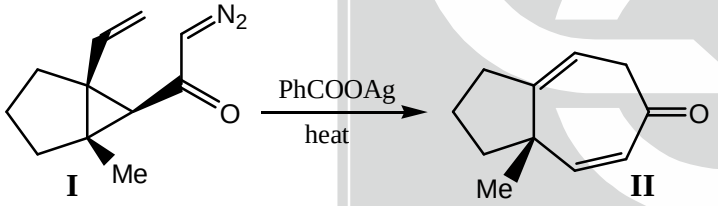
44. Mg^{2+} is preferred in photosynthesis by chlorphyll because
(a) it has strong spin-orbit coupling (b) it has weak spin-orbit coupling
(c) it is a heavy metal (d) it binds strongly with chlorophyll

45. In Monsanto acetic acid process shown below, the role of HI is

$$CH_3OH + CO \xrightarrow[180°C,\ 30\ bar]{Rh(\ell)\ catalyst/HI} CH_3CO_2H$$

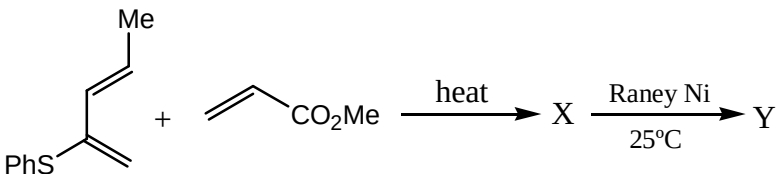
(a) to convert CH_3OH to a stronger nucleophile (CH_3O^-)
(b) to reduce the Rh(I) catalyst to a Rh(0) species
(c) to reduce a Rh(III) active species to a Rh(I) species in the catalytic cycle
(d) to convert CH_3OH to CH_3I

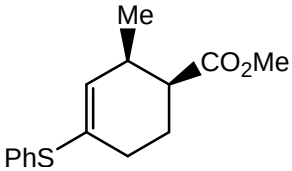
46. Formation of the ketone H from the diazoketone I involves

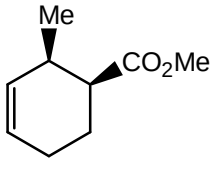


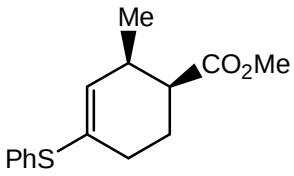
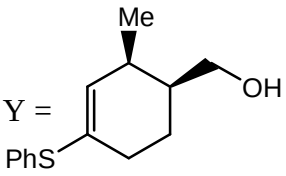
(a) generation of carbene and a [2, 3]-sigmatropic rearrangement
(b) generation of carbene and an electrocyclic ring closing reaction
(c) generation of ketene and a [2+2] cycloaddition
(d) generation of ketene and a [3, 3]sigmatropic rearrangement

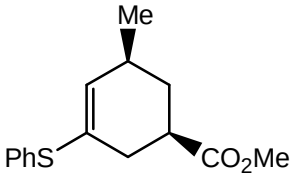
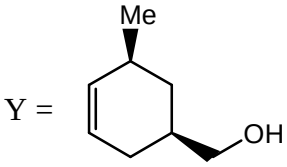
47. The major products X and Y formed in the following reaction sequence are

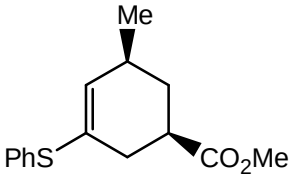
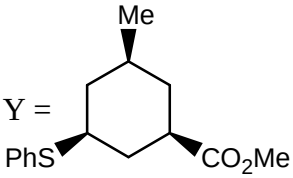


(a) X = 

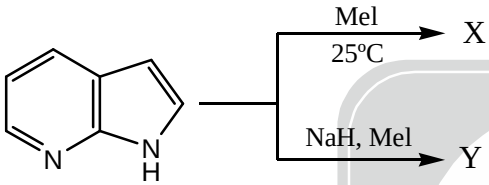
Y = 

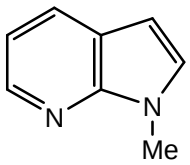
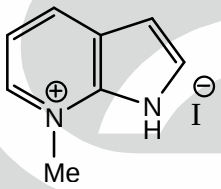
(b) X =  Y = 

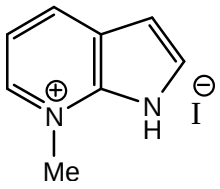
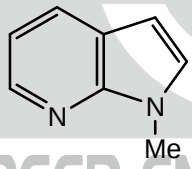
(c) X =  Y = 

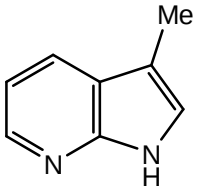
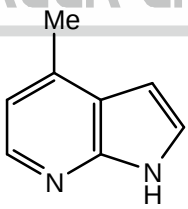
(d) X =  Y = 

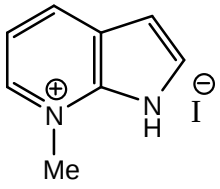
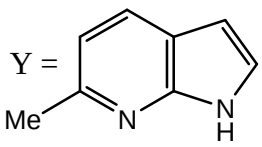
48. The major products X and Y formed in the following reactions are



(a) X =  Y = 

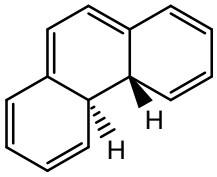
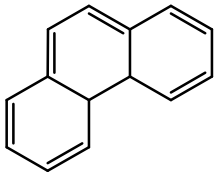
(b) X =  Y = 

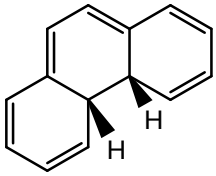
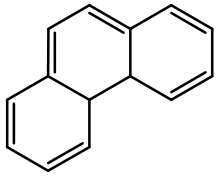
(c) X =  Y = 

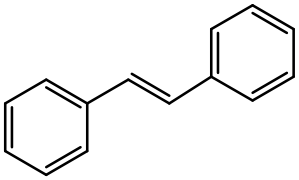
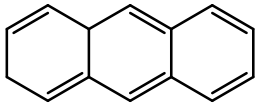
(d) X =  Y = 

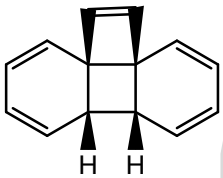
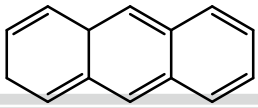
49. The major product X and Y formed in the following reaction sequence are

$$\text{cis} - \text{stilbene} \xrightarrow[C_6H_{12}]{h\nu} X \xrightarrow[\text{air}]{I_2} Y$$

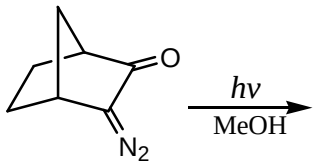
(a) X =  Y = 

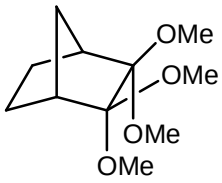
(b) X =  Y = 

(c) X =  Y = 

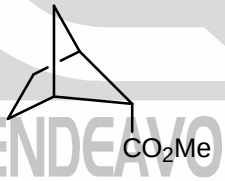
(d) X =  Y = 

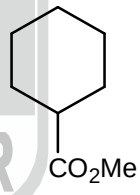
50. The product of the following reaction gave 6 line ^{13}C NMR spectrum with peaks at δ 175, 52, 50, 46, 37, 33 ppm. The structure of the product is



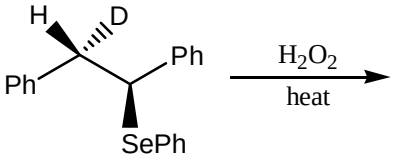
(a) 

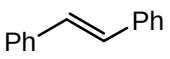
(b) 

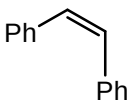
(c) 

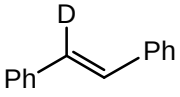
(d) 

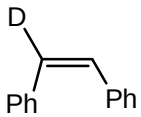
51. The major product formed in the following reaction is



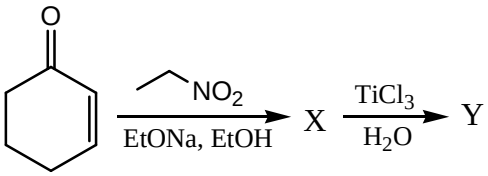
(a) 

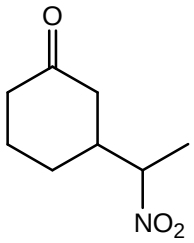
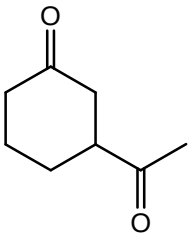
(b) 

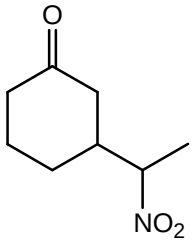
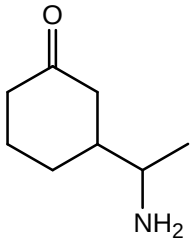
(c) 

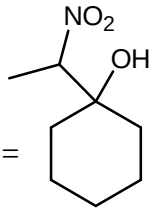
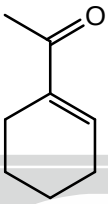
(d) 

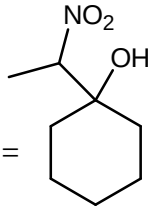
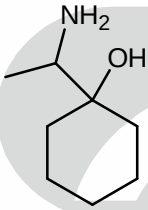
52. The major products X and Y formed in the following reaction sequence are



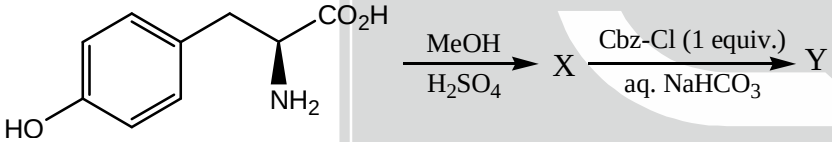
(a) X =  Y = 

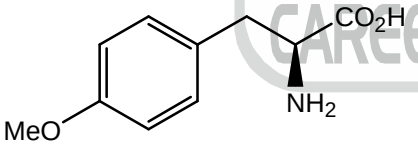
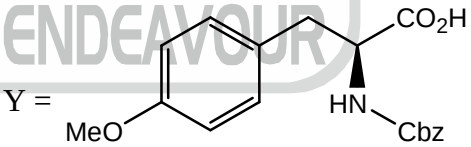
(b) X =  Y = 

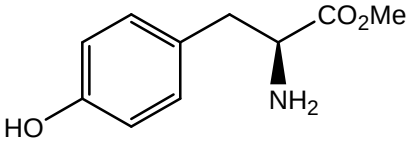
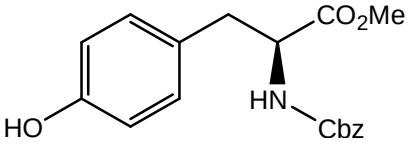
(c) X =  Y = 

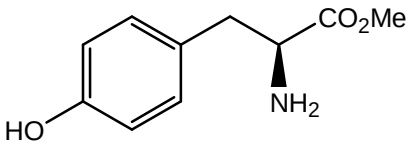
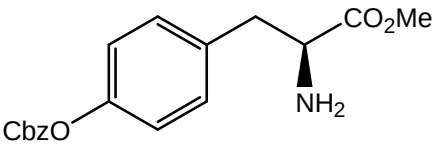
(d) X =  Y = 

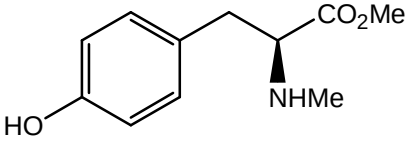
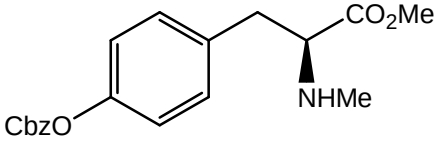
53. The major products X and Y formed in the following reaction sequence are



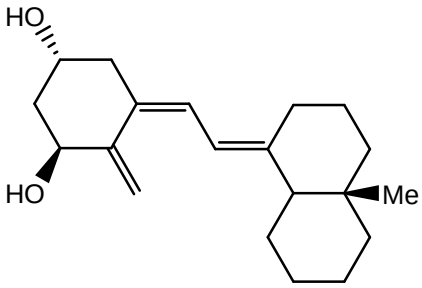
(a) X =  Y = 

(b) X =  Y = 

(c) X =  Y = 

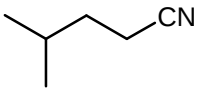
(d) X =  Y = 

54. Given the fact that 1, 3-butadiene has a UV absorption of 217nm, the absorption wavelength (in nm) for the conjugated system shown below is _____



(Use these absorption values for auxochromic groups:
alkyl : +5; exo-cyclic double bond : +5; every additional conjugated C = C : + 30)

55. The m/z value of the detectable fragment formed by McLafferty like rearrangement of the following compound in mass spectrometer is _____



***** END OF THE QUESTION PAPER *****