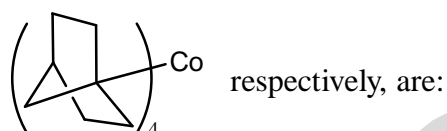


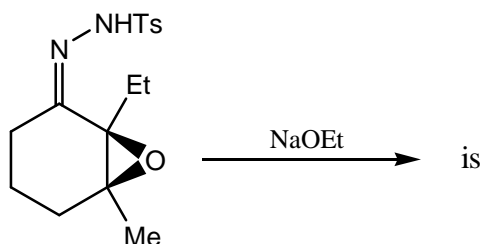
CHEMISTRY-CY

Q.1 – Q.25 : Carry ONE mark each.

1. A 5V battery delivers a steady current of 1.5 A for a period of 2 h. The total charge that has passed through the circuit is _____ Coulombs.
2. A reversible heat engine absorbs 20 kJ of heat from a source at 500 K and dissipates it to the reservoir at 400 K. The efficiency of the heat engine is _____%.
3. The characters of E , C_2 , σ_v , and σ'_v symmetry operations, in this order, for valid irreducible representation(s) of the C_{2v} point group is/are:
 - (a) 1, -1, -1, -1
 - (b) 1, -1, 1, -1
 - (c) 1, 1, 1, 1
 - (d) -1, 1, 1, -1
4. The number of photons emitted per nanosecond by a deuterium lamp (400 nm) having a power of 1 microwatt (rounded off to the nearest integer) is _____
 $[h = 6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}; c = 3.0 \times 10^8 \text{ ms}^{-1}]$
5. The geometry and the number of unpaired electrons in tetrakis(1-norbornyl)Co

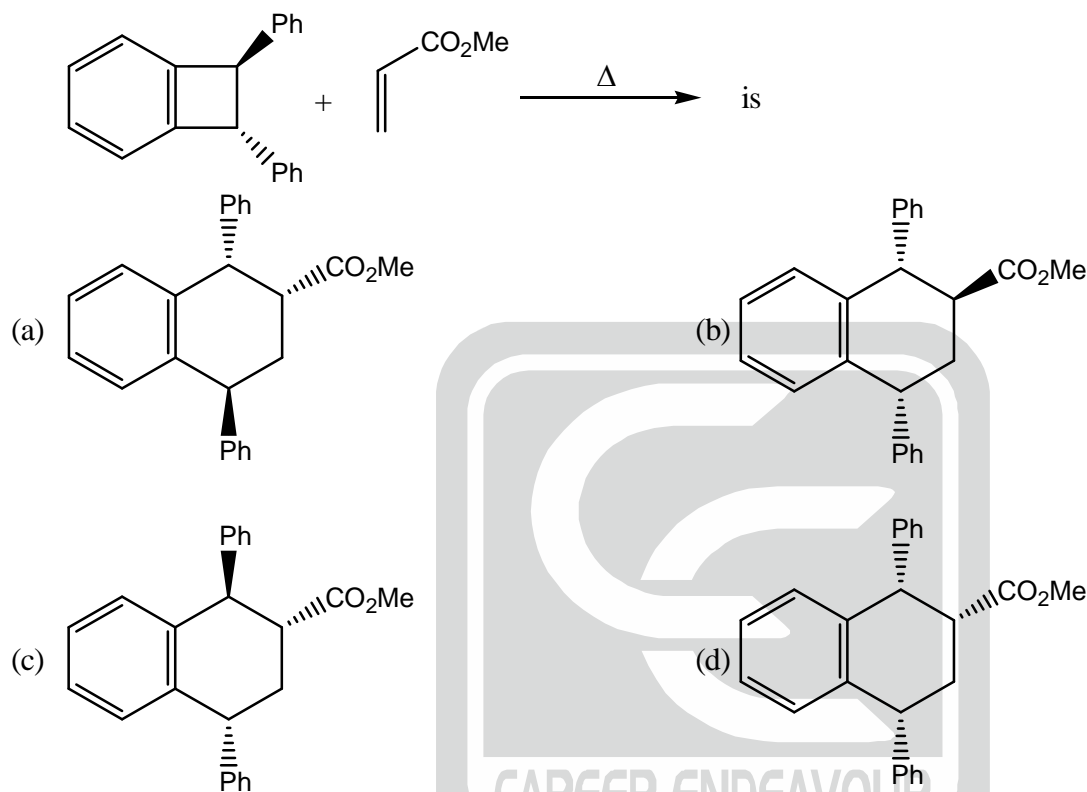


- (a) square planar and one
 - (b) tetrahedral and five
 - (c) square planar and three
 - (d) tetrahedral and one
6. The rate of the substitution reaction of $[\text{Co}(\text{CN})_5\text{Cl}]^{3-}$ with OH^- to give $[\text{Co}(\text{CN})_5(\text{OH})]^{3-}$
 - (a) is directly proportional to the concentration of OH^- only
 - (b) depends on the concentrations of both $[\text{Co}(\text{CN})_5\text{Cl}]^{3-}$ and OH^-
 - (c) depends on the concentration of $[\text{Co}(\text{CN})_5\text{Cl}]^{3-}$ only
 - (d) is inversely proportional to the concentration of OH^-
 7. The correct statement(s) about the concentration of Na^+ and K^+ ions in animal cells is/are:
 - (a) $[\text{Na}^+]$ inside the cell $>$ $[\text{Na}^+]$ outside the cell
 - (b) $[\text{Na}^+]$ inside the cell $<$ $[\text{Na}^+]$ outside the cell
 - (c) $[\text{K}^+]$ inside the cell $>$ $[\text{K}^+]$ outside the cell
 - (d) $[\text{K}^+]$ inside the cell $<$ $[\text{K}^+]$ outside the cell
 8. The rate constants for the decomposition of a molecule in the presence of oxygen are $0.237 \times 10^{-4} \text{ L mol}^{-1} \text{ s}^{-1}$ at 0°C and $2.64 \times 10^{-4} \text{ L mol}^{-1} \text{ s}^{-1}$ at 25°C ($R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$). The activation energy for this reaction (rounded off to one decimal place) is _____ kJ mol^{-1} .
 9. The major product formed in the following reaction

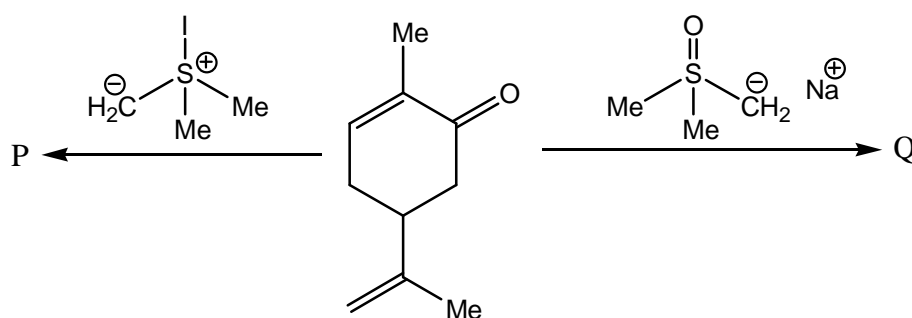


- (a) non-6-yn-2-one
- (b) non-2-yn-6-one
- (c) non-3-yn-8-one
- (d) non-3-en-8-one

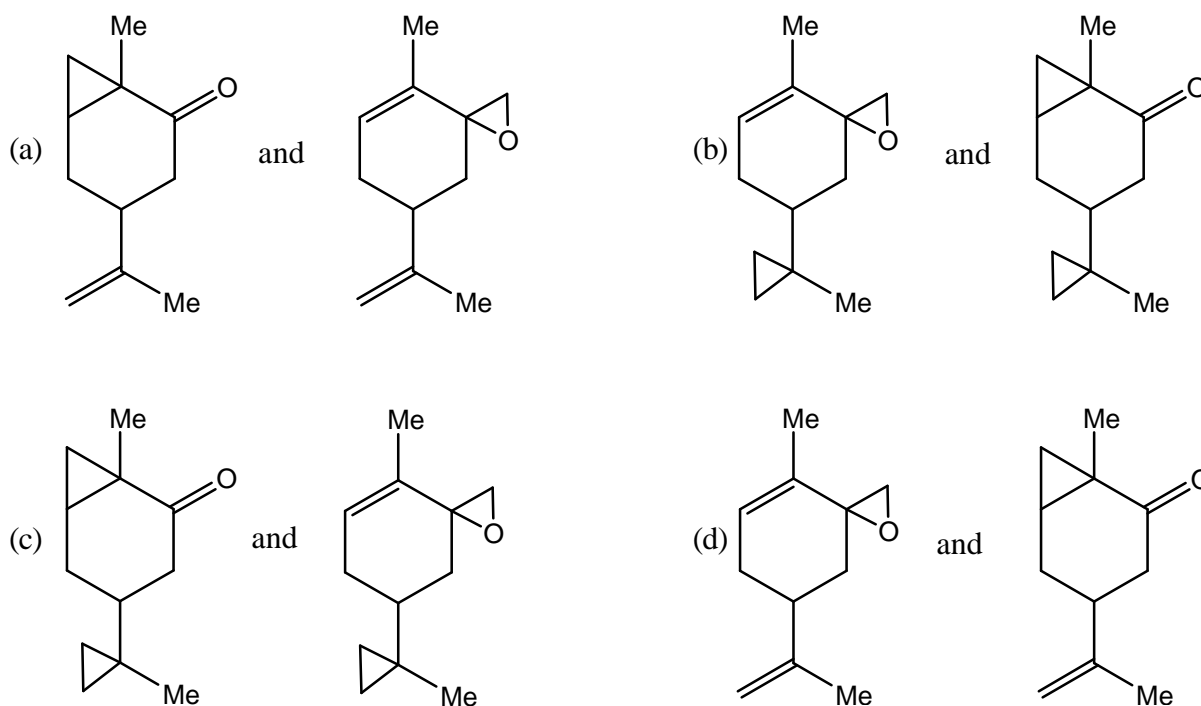
10. The Δ_0 of $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$, $[\text{CrF}_6]^{3-}$ and $[\text{Cr}(\text{CN})_6]^{3-}$ follows the order:
- (a) $[\text{CrF}_6]^{3-} > [\text{Cr}(\text{H}_2\text{O})_6]^{3+} > [\text{Cr}(\text{CN})_6]^{3-}$ (b) $[\text{Cr}(\text{CN})_6]^{3-} > [\text{Cr}(\text{H}_2\text{O})_6]^{3+} > [\text{CrF}_6]^{3-}$
 (c) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} > [\text{CrF}_6]^{3-} > [\text{Cr}(\text{CN})_6]^{3-}$ (d) $[\text{CrF}_6]^{3-} > [\text{Cr}(\text{CN})_6]^{3-} > [\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
11. The vapor pressure of toluene (Mol. Wt. = 92) is 0.13 atm at 25°C. If 6g of a hydrocarbon is dissolved in 92 g of toluene, the vapor pressure drops to 0.12 atm. The molar mass of the hydrocarbon (rounded off to the nearest integer) is _____
12. The metal borides that contain isolated boron atoms are:
- (a) TiB and HfB (b) Tc_7B_3 and Re_7B_3
 (c) Ti_4B_4 and V_3B_4 (d) Cr_5B_3 and V_3B_2
13. The major product formed in the following reaction



14. Reaction of LiAlH_4 with one equivalent of $\text{Me}_3\text{N.HCl}$ gives a tetrahedral compound, which reacts with another equivalent of $\text{Me}_3\text{N.HCl}$ to give compound N. The compound N and its geometry, respectively, are:
- (a) $\text{AlH}_3(\text{NMe}_3)_2$ and pentagonal (b) $\text{AlH}_3(\text{NMe}_3)_2$ and trigonal bipyramidal
 (c) $\text{Li}_2\text{AlH}_4\text{Cl}$ and square pyramidal (d) $\text{LiAlH}_4\text{NMe}_3$ and trigonal bipyramidal
15. The major products P and Q formed in the following reactions



respectively, are:



16. The yellow color of an aqueous solution of K_2CrO_4 changes to red-orange upon the addition of a few drops of HCl. The red-orange complex, the oxidation state of its central element(s), and the origin of its color, respectively, are:

- (a) dichromate ion, +6 and +6, charge transfer (b) chromium chloride, +3, d-d transition
 (c) perchlorate ion, +7, charge transfer (d) chromic acid, +6, charge transfer

17. The normal mode(s) of vibration of H_2O is/are:



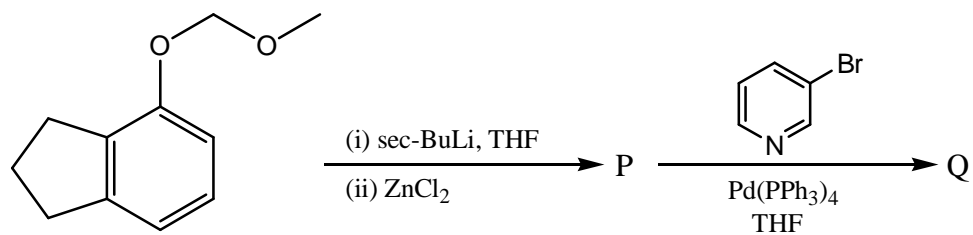
18. Given the initial weight of 1 mg of radioactive ${}^{60}_{27}Co$ (half-life = 5.27 years), the amount disintegrated in 1 year (rounded off to two decimal places) is _____ mg.

19. 2 L of a gas at 1 atm pressure is reversibly heated to reach a final volume of 3.5 L. The absolute value of the work done on the gas (rounded off to the nearest integer) is _____ Joules.

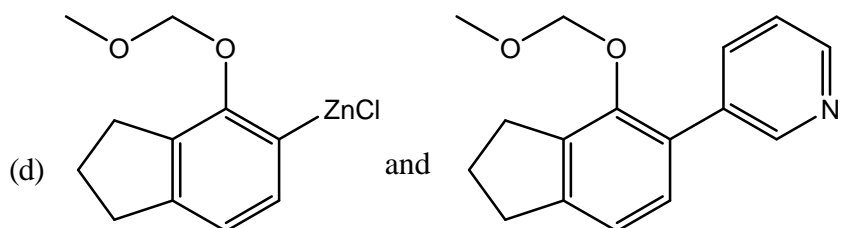
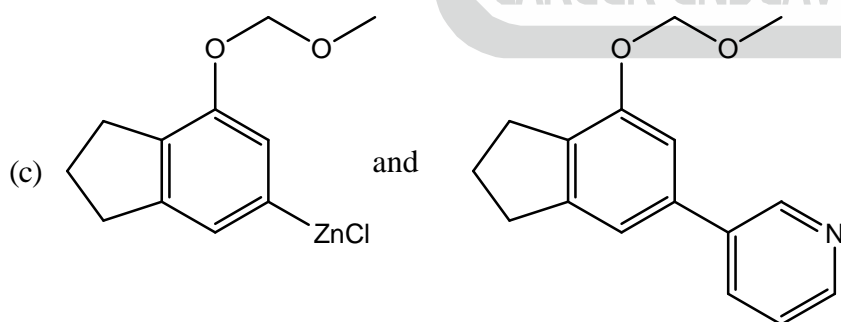
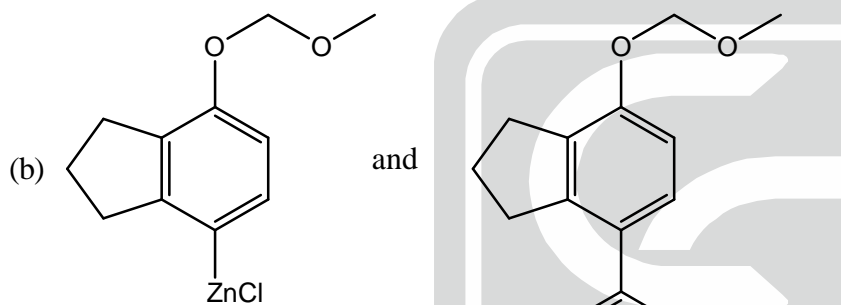
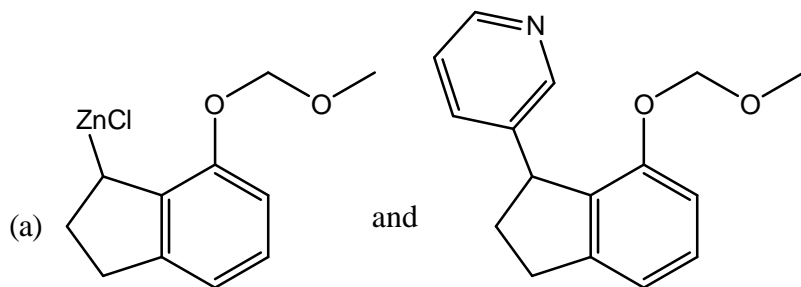
20. The quantity of the cobalt ore $[Co_3(AsO_4)_2 \cdot H_2O]$ required to obtain 1 kg of cobalt (rounded off to two decimal places) is _____ kg.

[Atomic Wt. of Co = 59, As = 75, O = 16, H = 1]

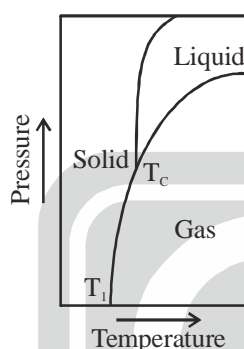
21. In the following reaction sequence



the major products P and Q, respectively, are:

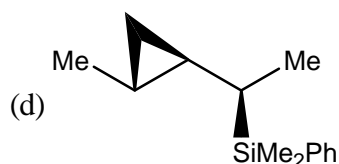
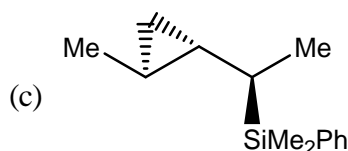
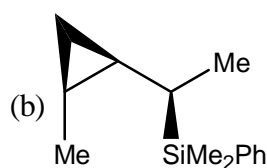
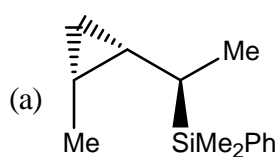
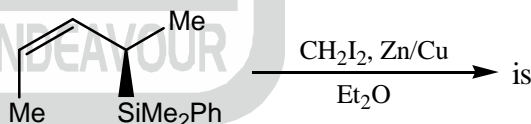


22. The shapes of the compounds ClF_3 , XeOF_2 , N_3^- and XeO_3F_2 respectively, are:
- trigonal planar, T-shape, V-shape and square pyramidal
 - T-shape, T-shape, linear and trigonal bipyramidal
 - T-shape, trigonal planar, linear and square pyramidal
 - trigonal planar, trigonal planar, V-shape and trigonal bipyramidal
23. The reaction of NiBr_2 with two equivalents of PPh_3 in CS_2 at -78°C gives a red-colored diamagnetic complex, $[\text{NiBr}_2(\text{PPh}_3)_2]$. This transforms to a green-colored paramagnetic complex with the same molecular formula at 25°C . The geometry and the number of unpaired electrons in the green-colored complex, respectively, are:
- tetrahedral and 2
 - square planar and 2
 - square planar and 4
 - tetrahedral and 1
24. The phase diagram of CO_2 is shown below:



The correct statement(s) about CO_2 is/are:

- Above T_c , it does not exist in liquid state.
 - Below T_c , it does not exist in liquid state.
 - At T_c , it can exist in all three phases.
 - Above T_l , it does not exist in solid state.
25. The major product formed in the following reaction

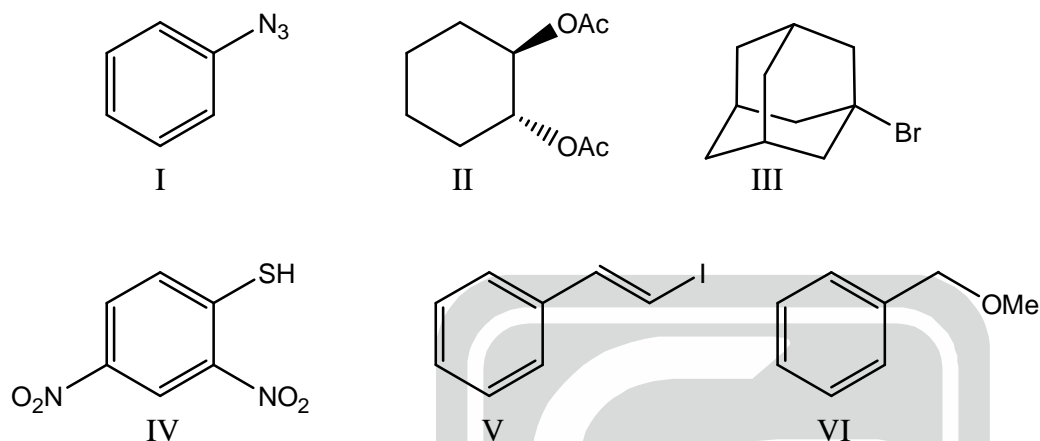


Q.26 – Q.55 : Carry TWO marks each.

26. A laser Raman spectrometer operating at 532 nm is used to record the vibrational spectrum of Cl_2 having its fundamental vibration at 560 cm^{-1} . The Stokes line corresponding to this vibration will be observed at _____ cm^{-1} . (Rounded off to the nearest integer).

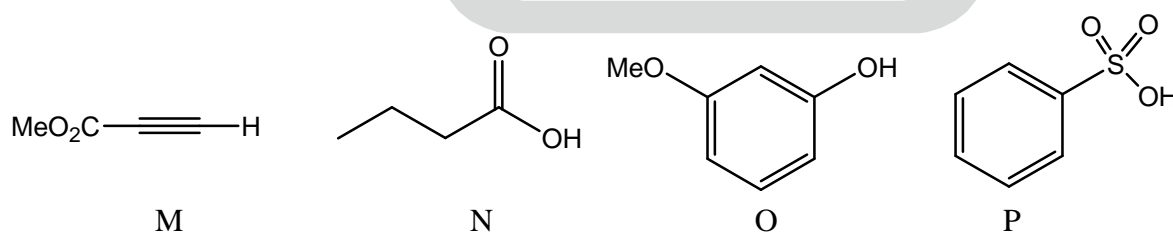
27. The major product formed in the reaction of (2*R*, 3*R*)-2-bromo-3-methylpentane with NaOMe is:
 (a) (E)-3-methylpent-2-ene (b) (Z)-3-methylpent-2-ene
 (c) (2*R*, 3*R*)-2-methoxy-3-methylpentane (d) (2*S*, 3*R*)-2-methoxy-3-methylpentane
28. The correct order of increasing intensity (molar absorptivity) of the UV-visible absorption bands for the ions [Ti(H₂O)₆]³⁺, [Mn(H₂O)₆]²⁺, [CrO₄]²⁻, and [NiCl₄]²⁻ is:
 (a) [Ti(H₂O)₆]³⁺ < [NiCl₄]²⁻ < [CrO₄]²⁻ < [Mn(H₂O)₆]²⁺
 (b) [Ti(H₂O)₆]³⁺ < [Mn(H₂O)₆]²⁺ < [CrO₄]²⁻ < [NiCl₄]²⁻
 (c) [NiCl₄]²⁻ < [Ti(H₂O)₆]³⁺ < [Mn(H₂O)₆]²⁺ < [CrO₄]²⁻
 (d) [Mn(H₂O)₆]²⁺ < [Ti(H₂O)₆]³⁺ < [NiCl₄]²⁻ < [CrO₄]²⁻

29. Among the following



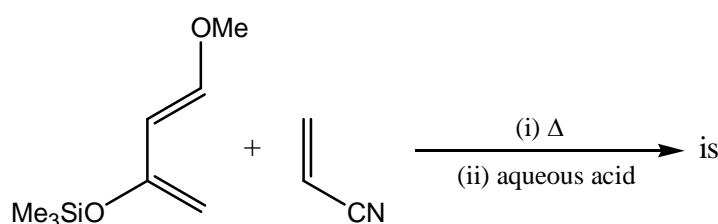
the compounds which can be prepared by nucleophilic substitution reaction are

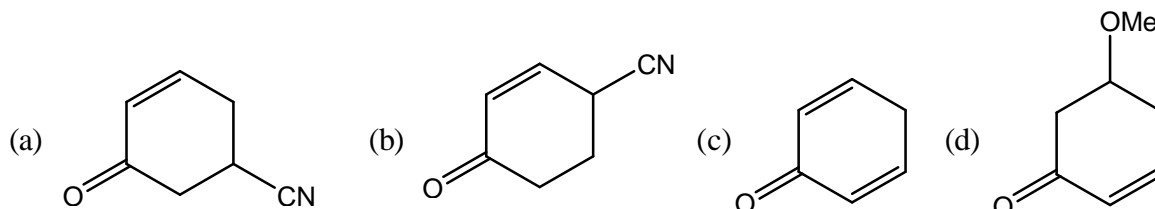
- (a) III, IV, and V (b) II, IV, and VI (c) I, III, and V (d) I, II, and VI
30. The de Broglie wavelength of an argon atom (mass = 40 amu) travelling at a speed of 250 ms⁻¹ (rounded off to one decimal place) is _____ picometers.
 [N = 6.022 × 10²³; h = 6.626 × 10⁻³⁴ kg m² s⁻¹]
31. The **least** acidic among the following compounds



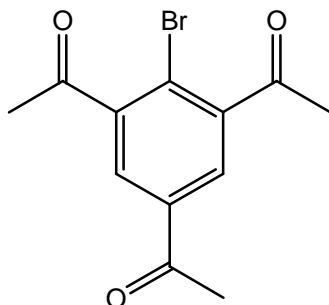
is

- (a) N (b) M (c) O (d) P
32. The major product formed in the following reaction





33. The number of signal(s) in the ^1H NMR spectrum of the following compound



recorded at 25°C in CDCl_3 is _____

34. The spin-only magnetic moment of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ (rounded off to one decimal place) is _____ BM.

35. A correct example of a nucleotide is:

- (a) RNA (b) uridine
(c) adenosine monophosphate (AMP) (d) DNA

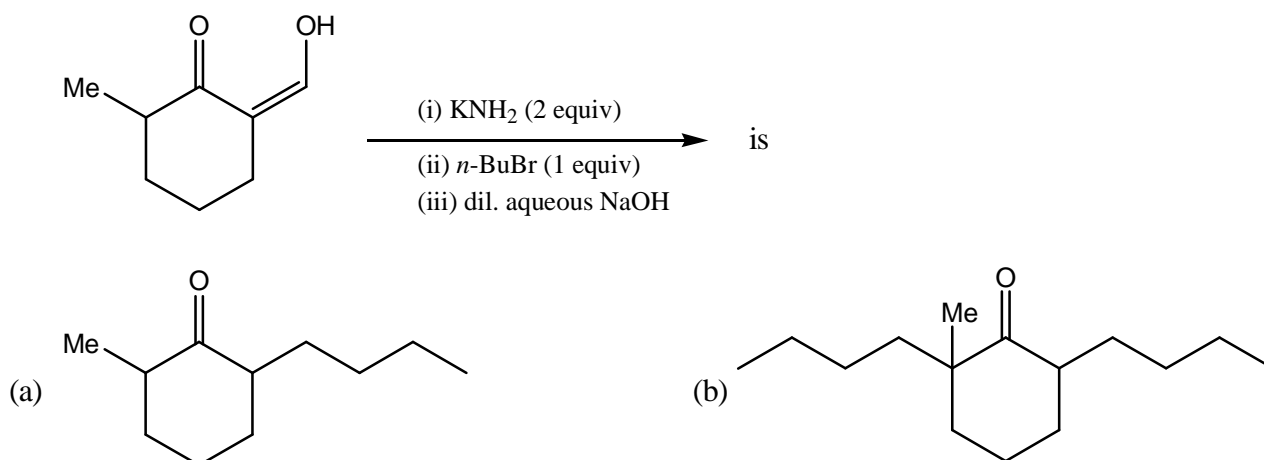
36. The correct statement(s) about actinides is/are:

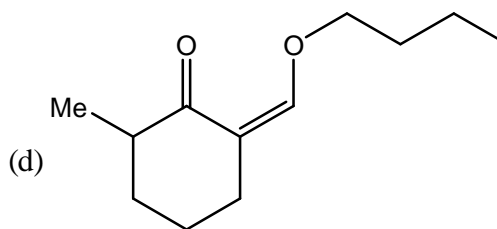
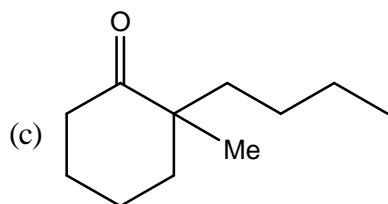
- (a) The 5f electrons of actinides are bound less tightly than the 4f electrons.
(b) All the actinides are radioactive.
(c) The trans uranium elements are prepared artificially.
(d) Actinides do not exhibit actinide contraction.

37. An organic compound exhibits the $[\text{M}]^+$, $[\text{M}+2]^+$ and $[\text{M}+4]^+$ peaks in the intensity ratio 1 : 2 : 1 in the mass spectrum, and shows a singlet at δ 7.49 in the ^1H NMR spectrum in CDCl_3 . The compound is:

- (a) 1, 4-dibromobenzene (b) 1, 2-dibromobenzene
(c) 1, 4-dichlorobenzene (d) 1, 2-dichlorobenzene

38. The major product formed in the following reaction





39. The equilibrium constant for the reaction

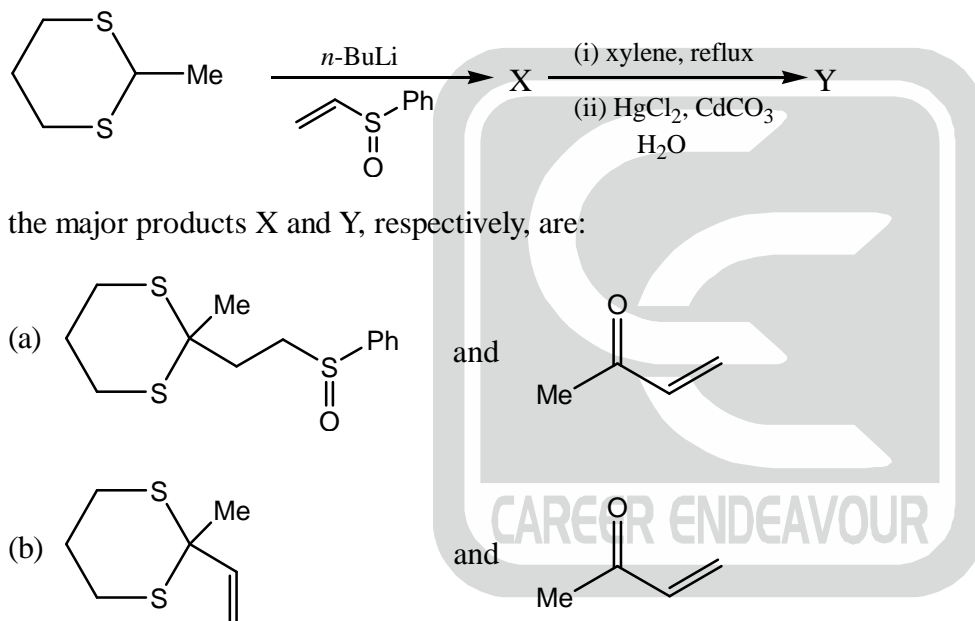


$$[\Delta G^\circ = -104.18 \text{ kJ}; R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}]$$

- (a) 1.043 (b) 1.651 (c) 5.7×10^{-19} (d) 1.8×10^{18}

40. The molar absorption coefficient of a substance dissolved in cyclohexane is $1710 \text{ L mol}^{-1} \text{ cm}^{-1}$ at 500 nm. The reduction in intensity of light of the same wavelength that passes through a cell of 1 mm path length containing a 2 mmol L^{-1} solution (rounded off to one decimal place) is _____%.

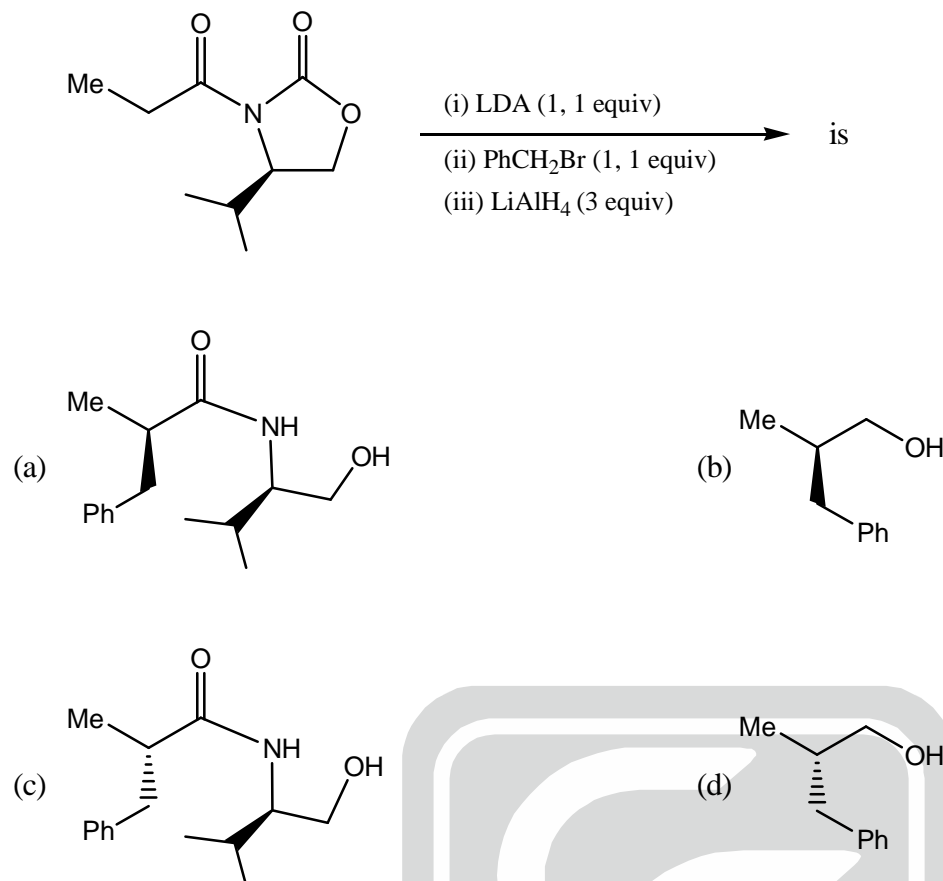
41. In the following reaction



42. Which one of the following is a non-heme protein?

- (a) hemocyanin (b) cytochrome P-450
(c) myoglobin (d) hemoglobin

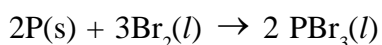
43. The major product formed in the following reaction



44. Hexane and heptane are completely miscible. At 25°C, the vapor pressures of hexane and heptane are 0.198 atm and 0.06 atm, respectively. The mole fractions of hexane and heptane in the vapor phase for a solution containing 4 M hexane and 6 M heptane, respectively, are:

- (a) 0.312 and 0.688
(b) 0.688 and 0.312
(c) 0.600 and 0.400
(d) 0.400 and 0.600

45. The change in enthalpy (ΔH) for the reaction



is -243 kJ. In this reaction, if the amount of phosphorus consumed is 3.1 g, the change in enthalpy (rounded off to two decimal places) is _____ kJ. [Atomic Wt. of P = 31]

46. In an electrochemical cell, Ag⁺ ions in AgNO₃ are reduced to Ag metal at the cathode and Cu is oxidized to Cu²⁺ at the anode. A current of 0.7 A is passed through the cell for 10 min. The mass (in grams) of silver deposited and copper dissolved, respectively, are:

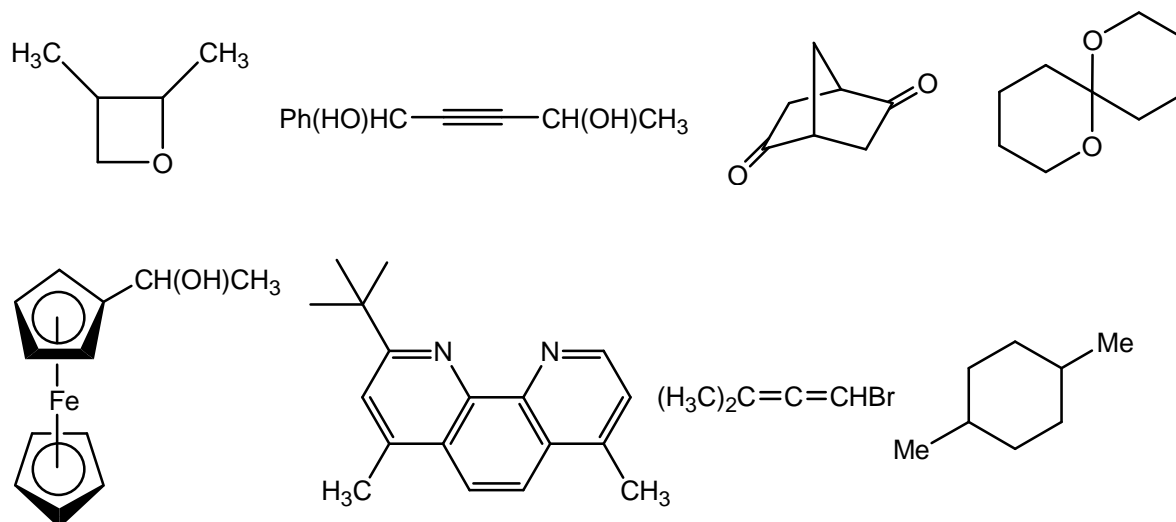
[Faraday Constant = 96,485 C mol⁻¹, Atomic Weight of Ag = 107.9, Atomic Weight of Cu = 63.55]

- (a) 0.235 and 0.069
(b) 0.235 and 0.138
(c) 0.469 and 0.069
(d) 0.469 and 0.138

47. The fundamental vibrational frequency of ¹H¹²⁷I is 2309 cm⁻¹. The force constant for this molecule (rounded off to the nearest integer) is _____ Nm⁻¹.

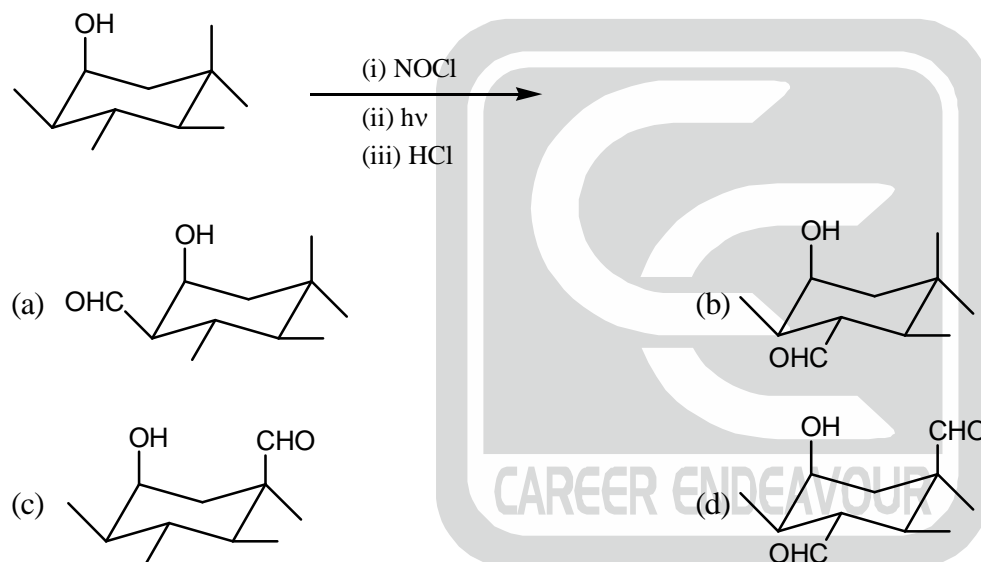
[$N = 6.022 \times 10^{23}$, $c = 3.0 \times 10^8$ ms⁻¹]

48. Among the following eight compounds,



the number of compound(s) which can exhibit stereoisomerism is _____

49. The major product formed in the following reaction



50. Acceptable wavefunctions for a quantum particle must be:

- (a) continuous (b) single-valued (c) even (d) odd

51. The correct order of Lewis acid strengths of BF_2Cl , BFCIBr , BF_2Br and BFBr_2 is:

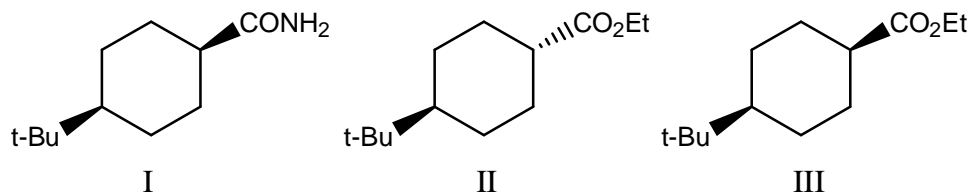
- (a) $\text{BF}_2\text{Cl} > \text{BF}_2\text{Br} > \text{BFCIBr} > \text{BFBr}_2$ (b) $\text{BF}_2\text{Cl} > \text{BFCIBr} > \text{BF}_2\text{Br} > \text{BFBr}_2$
 (c) $\text{BFCIBr} > \text{BFBr}_2 > \text{BF}_2\text{Cl} > \text{BF}_2\text{Br}$ (d) $\text{BFBr}_2 > \text{BFCIBr} > \text{BF}_2\text{Br} > \text{BF}_2\text{Cl}$

52. The reaction $\text{CO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{COCl}_2(\text{g})$ at 500°C , with initial pressures of 0.7 bar of CO and 1.0 bar of Cl_2 , is allowed to reach equilibrium. The partial pressure of $\text{COCl}_2(\text{g})$ at equilibrium is 0.15 bar. The equilibrium constant for this reaction at 500°C (rounded off to two decimal places) is _____

53. The reagent(s) required for the conversion of hex-3-yne to (*E*)-hex-3-ene is/are:

- (a) LiAlH_4 (b) Li/liquid NH_3 (c) Bu_3SnH (d) H_2 , Pd/ BaSO_4

54. The rates of alkaline hydrolysis of the compounds shown below



follow the order:

(a) III > I > II

(b) II > I > III

(c) I > II > III

(d) II > III > I

55. The Mo–Mo bond order in $[(\eta^5\text{-C}_5\text{H}_5)\text{Mo}(\text{CO})_2]_2$ which obeys the 18-electron rule is _____



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