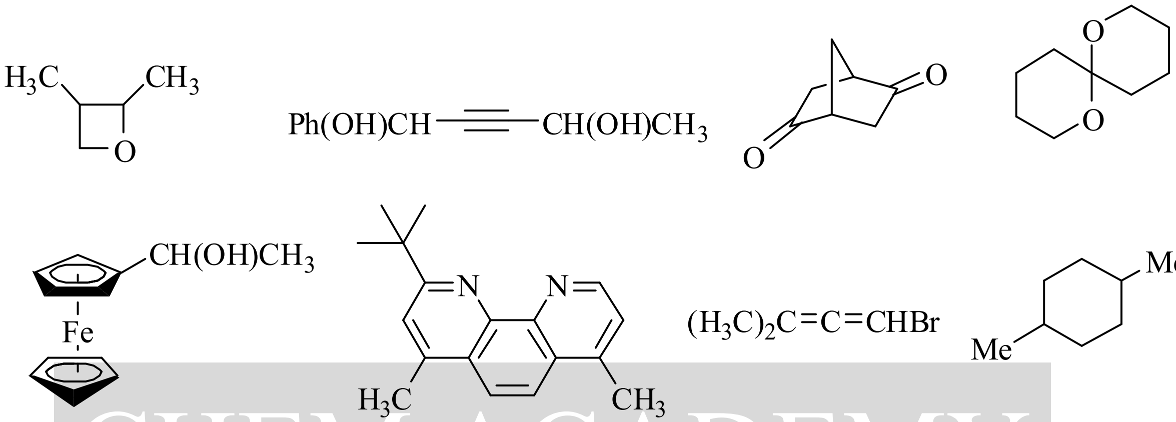
GATE (2021)

1. Among the following eight compounds,



The number of compound(s) which can exhibit stereoisomerism is______.

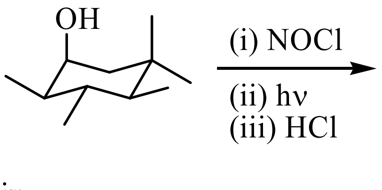
2. The characters of E, C_2, σ_v and σ'_v symmetry operations, in this order, for valid irreducible representation(s) of the C_{2v} point group is /are:

(a) 1, 1, 1, 1 (b) 1, –1, 1, –1 (c) 1, –1, –1, –1 (d) –1, 1, 1, –1

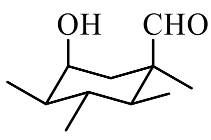
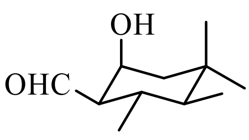
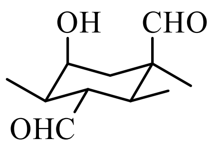
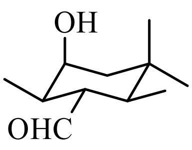
3. The de Broglie wavelength of an argon atom (mass = 40 amu) traveling at a speed of 250 m s^{-1} (rounded off to one decmial place) is _______ picometers.

[N = 6.022×10^{23}; h = 6.626×10^{-34} kg m^2 s^{-1}]

4. The majro product formed in the following reaction



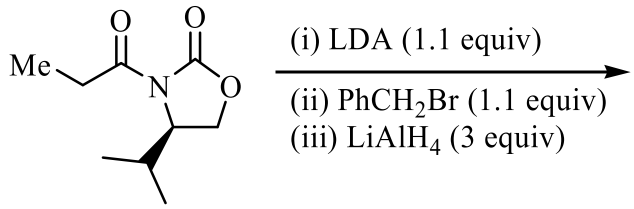
is:

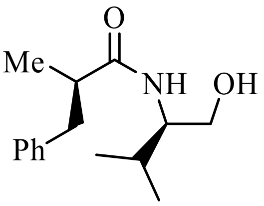
(a)  (b)  (c)  (d) 

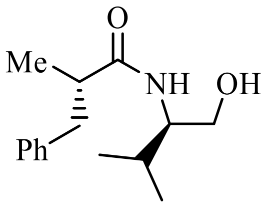
5. The quantity of the cobalt ore [$Co_3(AsO_4)_2 \cdot H_2O$] required to obtain 1 kg of cobalt (rounded off to two decimal places) is_____ kg.

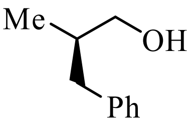
[Atomic Wt. of Co = 59, As = 75, O = 16, H = 1]

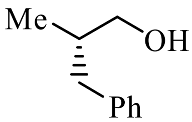
6. The major product formed in the following reaction



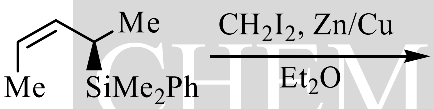
(a) 

(b) 

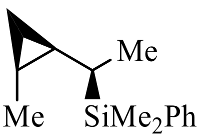
(c) 

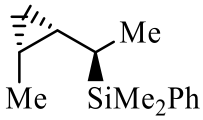
(d) 

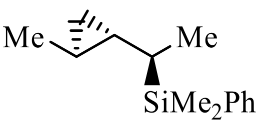
7. The major product formed in the following reaction

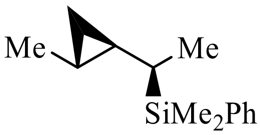


is:

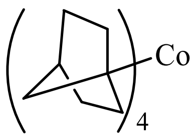
(a) 

(b) 

(c) 

(d) 

8. The geometry and the number of unpaired electrons in tetrakis (1 – norbornyl)Co



respectively, are:

(a) tetrahedral and five
(b) square planar and three
(c) tetrahedral and one
(d) square planar and one

9. Acceptable wavefunction for a quantum particle must be;

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

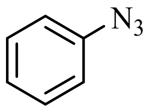
10. The vapour pressure of toluene (Mol. Wt. = 92) is 0.13 atm at 25 ºC. If 6 g of a hydrocarbon is dissolved in 92 g of toluene, the vapor pressure drops to 0.12 atm. The molar mass of the hydrocarbon (rounded off to the nearest integer) is_______.

11. The correct order of Lewis acid strengths of BF_2Cl, BFClFBr, BF_2Br and $BFBr_2$ is:

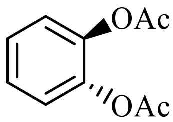
(a) $BFBr_2$ > BFClBr > BF_2Br > BF_2Cl (b) BFClBr > $BFBr_2$ > BF_2Cl > BF_2Br

(c) BF_2Cl > BFClBr > BF_2Br > $BFBr_2$ (d) BF_2Cl > BF_2Br > BFClBr > $BFBr_2$

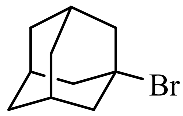
12. Among the following



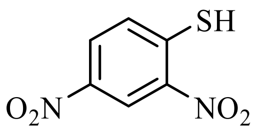
I



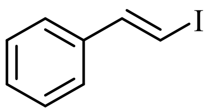
II



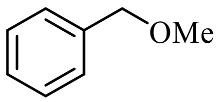
III



IV



V



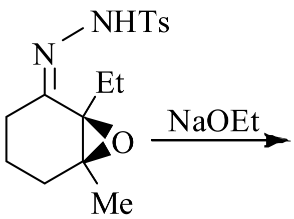
VI

The compounds which can be prepared by nucleophilic substitution reaction are:

(a) II, IV and VI (b) III, IV and V (c) I, II and VI (d) I, III and V

13. 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______%.

14. The major product formed in the following reaction



is

(a) non – 2 – yn – 6 – one (b) non – 3 – en – 8 – one

(c) non – 2 – yn – 8 – one (d) non – 6 – yn – 2 – one

15. The major product formed in the reaction of (2R, 3R) – 2 – bromo – 3 – methylpentane with NaOMe is:

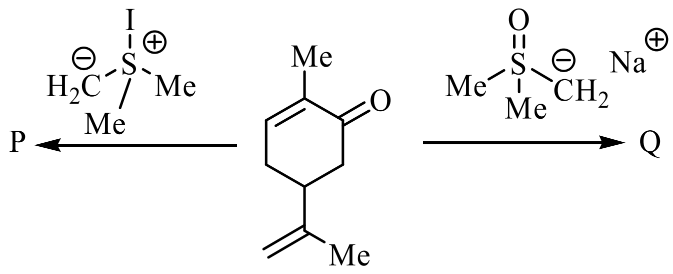
(a) (2S, 3R) – 2 – methoxy – 3 – methylpentane

(b) (Z) – 3 – methylpent – 2 – ene

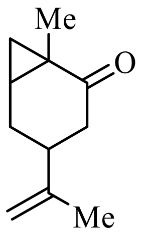
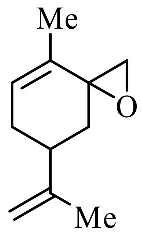
(c) (2R, 3R) – 2 – methoxy – 3 – methylpentane

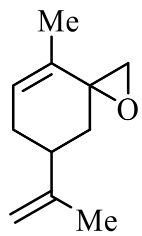
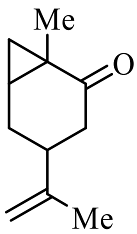
(d) (E) – 3 – methyplent – 2 – ene

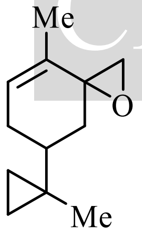
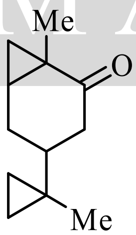
16. The major product P and Q formed in the following reactions

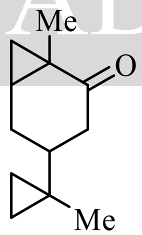
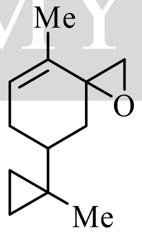


respectively, are:

(a)  and 

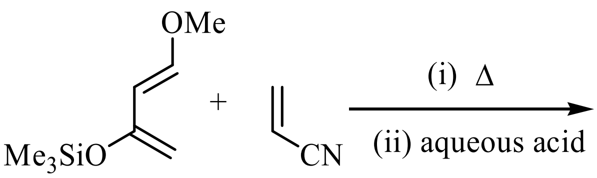
(b)  and 

(c)  and 

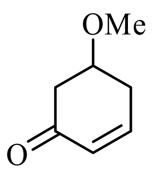
(d)  and 

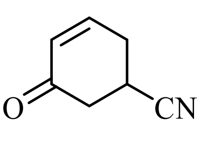
17. 2L of gas at 1 atm pressure is reversibly heated to reach a final volume of 3.5 L. The absolute value of the work done on the gas (rounded off to the nearest integer) is _____ Joules.

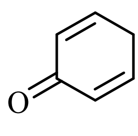
18. The major product formed in the following reaction

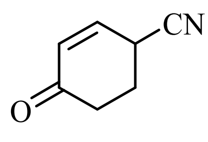


is:

(a) 

(b) 

(c) 

(d) 

19. The metal borides that contain isolated boron atoms are:

(a) Ti_4B_4 and V_3B_4 (b) TiB and HfB (c) Tc_7B_3 and Re_7B_3 (d) Cr_5B_3 and V_3B_2

20. The fundamental vibrational frequency of $^1H^{127}I$ is 2309 cm^{-1}. The force constant for this molecule (rounded off to the nearest integer) is ______ N m^{-1}.

[$N = 6.022 \times 10^{22}$, $c = 3.0 \times 10^8$ m s^{-1}]

21. A correct example of a nucleotide is:

(a) DNA (b) adenosine monophosphate (AMP)

(c) RNA (d) uridine

22. The equilibrium constant for the reaction

(a) $NO(g) \rightleftharpoons N_2O(g) + NO_2(g)$

at 25ºC is closest to:

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

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

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

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

24. The Mo–Mo bond order in $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ which obeys the 18-electron rule is _______.

25. The reaction

$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$

at 500ºC, 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 $COCl_2$ (g) at equilibrium is 0.15 bar. The equilibrium constant for this reaction at 500ºC (rounded off to two decimal places) is _____________.

26. In an electrochemical cell, Ag^+ ions in $AgNO_3$ are reduced to Ag metal at the cathode and Cu is oxidized to Cu^{2+} 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 0.138 (b) 0.469 and 0.069 (c) 0.469 and 0.138 (d) 0.235 and 0.069

27. 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) perchlorate ion, +7, charge transfer

(b) chromium chloride, +3, d-d transition

(c) dichromate ion, +6 and +6, charge transfer

(d) chromic acid, +6, charge transfer

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

(a) The trans uranium elements are prepared artificially.

(b) The 5f electrons of actinides are bound less tightly than the 4f electrons.

(c) All the actinides are radioactive.

(d) Actinides do not exhibit actinide contraction.

29. The Δ_0 of
$[Cr(H_2O)_6]^{3+}$, $[CrF_6]^{3-}$ and $[Cr(CN)_6]^{3-}$
follows the order:

(a) $[CrF_6]^{3-} > [Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+}$
(b) $[Cr(H_2O)_6]^{3+} > [CrF_6]^{3-} > [Cr(CN)_6]^{3-}$
(c) $[CrF_6]^{3-} > [Cr(H_2O)_6]^{3+} > [Cr(CN)_6]^{3-}$
(d) $[Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+} > [CrF_6]^{3-}$

30. The correct statement(s) about the concentration of Na^+ and K^+ ions in animal cells is/are:

(a) $[K^+]$ inside the cell < $[K^+]$ outside the cell
(b) $[Na^+]$ inside the cell < $[Na^+]$ outside the cell
(c) $[Na^+]$ inside the cell > $[Na^+]$ outside the cell
(d) $[K^+]$ inside the cell > $[K^+]$ outside the cell

31. 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 _______.
$[h = 6.626 \times 10^{-34}\ kg\ m^2\ s^{-1};\ c = 3.0 \times 10^8\ m\ s^{-1}]$

32. The spin-only magnetic moment of $[Co(H_2O)_6]^{2+}$ (rounded off to one decimal place) is ______BM.

33. Reaction of $LiAlH_4$ with one equivalent of $Me_3N \cdot HCl$ gives a tetrahedral compound, which reacts with another equivalent of $Me_3N \cdot HCl$ to give compound N. The compound N and its geometry, respectively, are:

(a) $LiAlH_4NMe_3$ and trigonal bipyramidal
(b) $AlH_3(NMe_3)_2$ and trigonal bipyramidal
(c) Li_2AlH_4Cl and square pyramidal
(d) $AlH_3(NMe_3)_2$ and pentagonal

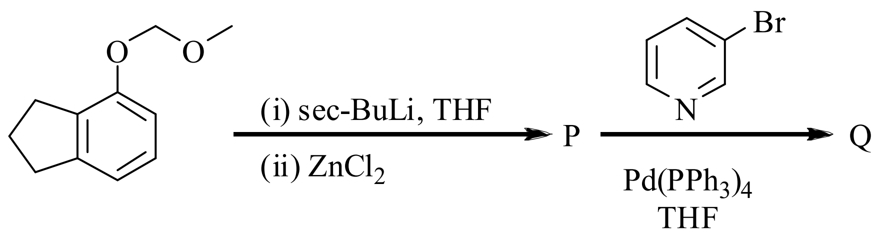
34. hexane and heptane are completely miscible. At 25ºC, the vapor pressures of hexane and heptane are 0.198 atm and 0.06 atm, respectively. The mole fractions of hexane and heptane in the vapor for a solution containing 4M hexane and 6M heptane, respectively, are:

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

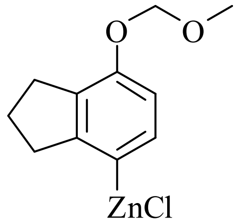
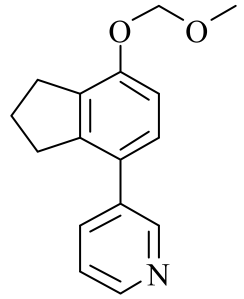
35. The correct order of increasing intensity (molar absorptivity) of the UV-visible absorption bands for the ions $[Ti(H_2O)_6]^{3+}$, $[Mn(H_2O)_6]^{2+}$, $[CrO_4]^{2-}$, and $[NiCl_4]^{2-}$ is

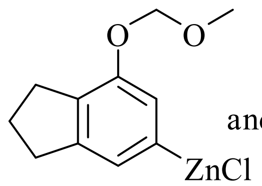
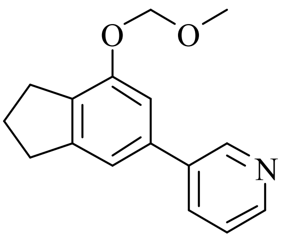
(a) $[Ti(H_2O)_6]^{3+} < [NiCl_4]^{2-} < [CrO_4]^{2-} < [Mn(H_2O)_6]^{2+}$
(b) $[Ti(H_2O)_6]^{3+} < [Mn(H_2O)_6]^{2+} < [CrO_4]^{2-} < [NiCl_4]^{2-}$
(c) $[Mn(H_2O)_6]^{2+} < [Ti(H_2O)_6]^{3+} < [NiCl_4]^{2-} < [CrO_4]^{2-}$
(d) $[NiCl_4]^{2-} < [Ti(H_2O)_6]^{3+} < [Mn(H_2O)_6]^{2+} < [CrO_4]^{2-}$

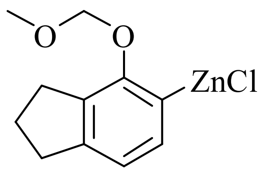
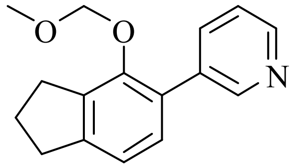
36. In the following reaction sequence

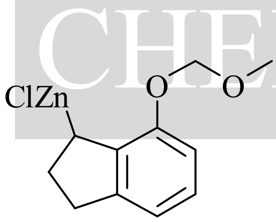
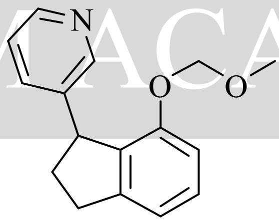


the major products P and Q, respectively, are:

(a)  and 

(b)  and 

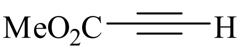
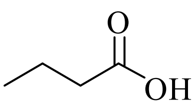
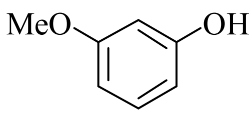
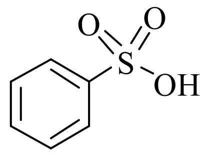
(c)  and 

(d)  and 

37. The rate constants for the decomposition of a molecule in the presence of oxygen are 0.237×10^{-4} L mol^{-1} s^{-1} at 0ºC and 2.64×10^{-4} L mol^{-1} s^{-1} at 25ºC (R = 8.314 J mol^{-1} K^{-1}).

The activation energy for this reaction (rounded off to one decimal place) is _______ kJ mol^{-1}.

38. The least acidic among the following compounds

M N O P

is

(a) N (b) O (c) P (d) M

39. The rate of the substitution reaction of $[Co(CN)_5Cl]^{3-}$ with OH^- to give $[Co(CN)_5(OH)]^{3-}$

(a) is inversely proportional to the concentration of OH^-

(b) depends on the concentrations of both $[Co(CN)_5Cl]^{3-}$ and OH^-

(c) depends on the concentration of $[Co(CN)_5Cl]^{3-}$ only

(d) is directly proportional to the concentration of OH^- only

40. 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.

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

$2P(s) + 3Br_2(I) \rightarrow 2PBr_3(l)$

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]

42. The shapes of the compounds

ClF_3, $XeOF_2$, N_3^- and XeO_3F_2

respectively, are:

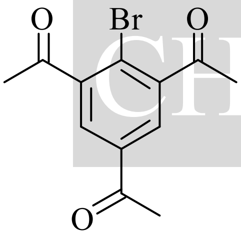
(a) trigonal planar, T-shape, V-shape and square pyramidal

(b) trigonal planar, trigonal planar, V-shape and trigonal bipyramidal

(c) T-shape, T-shape, linear and trigonal bipyramidal

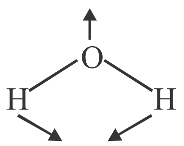
(d) T-shape, trigonal planar, linear and square pyramidal

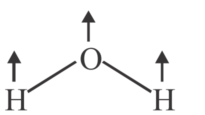
43. The number of signal(s) in the ^1H NMR spectrum of the following compound

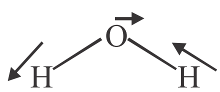


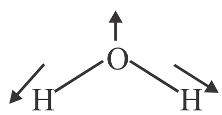
recorded at 25°C in $CDCl_3$ is __________.

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

(a) 

(b) 

(c) 

(d) 

45. The reaction of $NiBr_2$ with two equivalents of PPh_3 in CS_2 at –78°C gives a red-colored diamagnetic complex. $[NiBr_2(PPh_3)_2]$. 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:

(a) square planar and 2 (b) tetrahedral and 2

(c) square planar and 4 (d) tetrahedral and 1

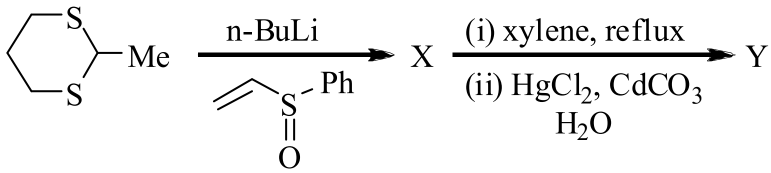
46. The reagent(s) required for the conversion of hex-3-yne to (E)-hex-3-ene is/are:

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

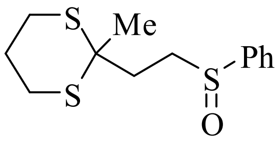
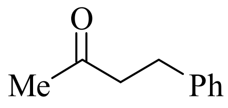
47. A 5 V battery delivers a steady current of 1.5 A for a period of 2 h. The total charge tht has passed through the circuit is ________ Coulombs.

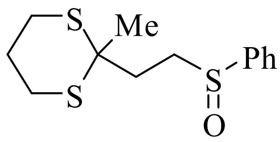
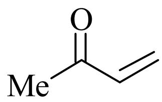
48. A laser Raman spectrometer operating at 532 nm is used to record the vibrational spectrum of Cl_2 having its fundamental vibration at 560 cm^{-1}. The Stokes line corresponding to this vibration will be observed at ________ cm^{-1}. (Rounded off to the nearest integer)

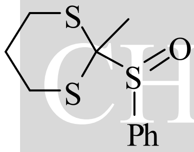
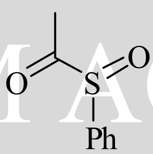
49. In the following reaction

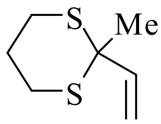
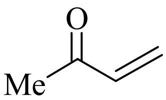


the major products X and Y, respectively, are:

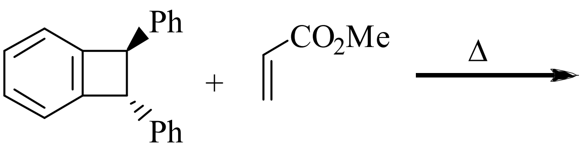
(a)  and 

(b)  and 

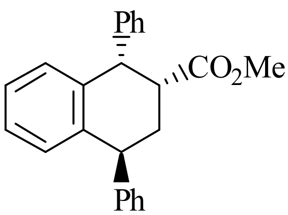
(c)  and 

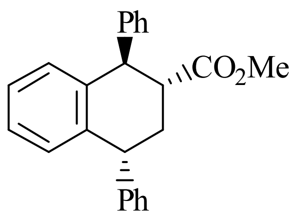
(d)  and 

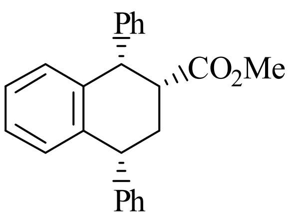
50. The major product formed in the following reaction

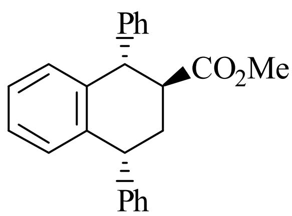


is

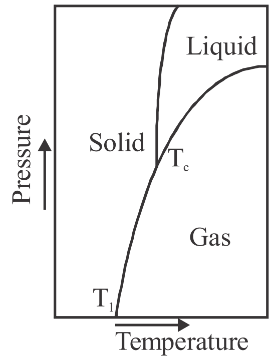
(a) 

(b) 

(c) 

(d) 

51. The phase diagram of CO_2 is shown below:



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

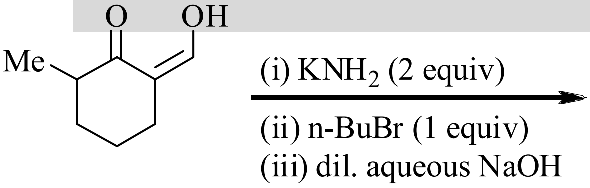
(a) At T_c, it can exist in all three phases.
(b) Below T_c, it does not exist in liquid state.
(c) Above T_c, it does not exist in liquid state.
(d) Above T_1, it does not exist in solid state.

52. The molar absorption coefficient of a substance dissolved in cyclohexane is 1710 L mol^{-1} 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 _________%.

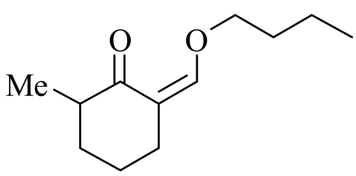
53. An organic compound exhibits the $[M]^+$, $[M+2]^+$ and $[M+4]^+$ peaks in the intensity ratio 1:2:1 in the mass spectrum, and shows a singlet at δ 7.49 in th ^{1}H NMR spectrum in $CDCl_3$. The compound is:

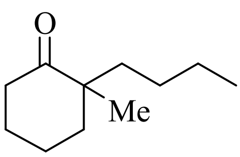
(a) 1,2-dibromobenzene
(b) 1,4-dibromobenzene
(c) 1,4-dichlorobenzene
(d) 1,2-dichlorobenzene

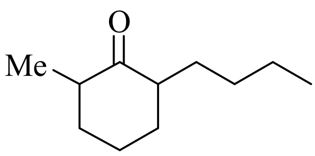
54. The major product formed in the following reaction

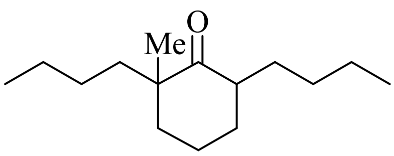


is:

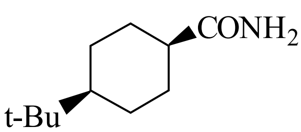
(a) 

(b) 

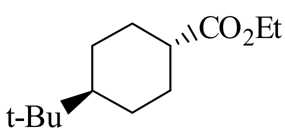
(c) 

(d) 

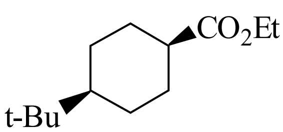
55. The rates of alkaline hydrolysis of the compounds shown below



I



II



III

follow the order:

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