P-64

ENTRANCE EXAMINATION – 2017

Ph. D. Chemistry

(Ph.D. Admission - January Session 2018)

TIME: 2 HOURS **MAXIMUM MARKS: 80**

HALL TICKET NUMBER: | |

INSTRUCTIONS

1. Write your **HALL TICKET NUMBER** in the space provided above and also on the **OMR** ANSWER SHEET given to you.
2. Make sure that pages numbered from **1 - 19** are present (excluding 5 pages assigned for rough work).
3. There are eighty (80) multiple choice questions in this paper (**20 in Part-A** and **60 in Part-B**). You are required to answer all **questions of Part-A** and a **maximum of 20 questions of Part-B**. If more than the required numbers of questions are answered, **only the first 20 questions of Part-B** will be evaluated.
4. Each question in Part-A and Part-B carries **two marks**.
5. **There is negative marking** for both Part-A and Part-B**. Each wrong answer carries – 0.66 mark.**
6. Answers are to be marked on the OMR answer sheet following the instructions provided on it.
7. Hand over the OMR answer sheet to the invigilator at the end of the examination.
8. In case of a tie, the marks obtained in the first 20 questions (**Part-A**) will be used to determine the order of merit.
8. No additional sheets will be provided. Rough work can be done in the space provided at the end of the booklet.
9. Calculators are allowed. Cell phones are not allowed.
10. Useful constants are provided at the beginning of Part-A in the question paper.
11. OMR without hall ticket number will not be evaluated and University shall not be held responsible.

Useful Constants:

Rydberg constant = 109737 cm^{-1}; Faraday constant = 96500 C; Planck constant = 6.625×10^{-34} J s; Speed of light = 2.998×10^{8} m s^{-1}; Boltzmann constant = 1.380×10^{-23} J K^{-1}; Gas constant = 8.314 J K^{-1} mol^{-1} = 0.082 L atm K^{-1} mol^{-1} = 1.987 cal K^{-1} mol^{-1}; Mass of electron = 9.109×10^{-31} kg; Mass of proton = 1.672×10^{-27} kg; Charge of electron = 1.6×10^{-19} C; 1 D = 3.336×10^{-30} Cm; 1 bar = 10^{5} N m^{-2}; RT/F (at 298.15 K) = 0.0257 V.

Part-A

1. The product formed in the reaction of SCl_2 with ammonia is:

   [A] S_4N_4 [B] S_2N_2

   [C] $(SN)_x$ [D] S_3N_3

2. A typical drying agent is:

   [A] H_3PO_4 [B] MoO_3

   [C] P_4S_{10} [D] P_4O_{10}

3. The correct order for the basic steps in mass spectrometry is:

   [A] acceleration, deflection, detection and ionization

   [B] ionization, acceleration, deflection and detection

   [C] acceleration, ionization, deflection and detection

   [D] acceleration, deflection, ionization and detection

4. Which of the following will show an Electron Spin Resonance signal?

   [A] Oxy-hemocyanin [B] Cytochrome

   [C] Chlorophyll [D] Carboxypeptidase

5. The coordination number of the anion in the structures of fluorite (CaF_2) and antifluorite (e.g., Na_2O) are respectively:

[A] 4 and 8 [B] 6 and 8

[C] 8 and 6 [D] 8 and 4

6. Predict the product of the reaction between sodium and ethylenediamine (en).

[A] $Na^+(en) + e^-(en)$ [B] $Na(en)$

[C] $Na^+(en) + Na^-(en)$ [D] $Na^+(en) + en$

7. The most appropriate ionization technique in mass-spectrometry to get the structural information of small molecules is:

[A] Fast atom bombardment [B] Chemical ionization

[C] Electron impact [D] Electrospray ionization

8. Name the chemists who are well known for their work in hydroboration and development of NMR spectroscopy, respectively:

[A] H.C. Brown; R.B. Woodward [B] H.C. Brown; R.R. Ernst

[C] R.R. Ernst; K. Wuthrich [D] R.B. Woodward; R.R. Ernst

9. A non-stereospecific reaction proceeds through:

[A] S_N1 mechanism [B] S_N2 mechanism

[C] E2 mechanism [D] Neighbouring group mechanism

10. Identify the incorrect statement from the following:

[A] diastereomers will have different chemical and physical properties
[B] all enantiomers rotate plane polarized light
[C] all enantiomerically pure compounds contain stereogenic centers
[D] enantiomers will have different chemical properties in a chiral environment

11. Which of the following is the most abundant organic polymer on earth?

[A] Rubber [B] Chitin [C] Cellulose [D] Silica

12. Arrange the following in the increasing order of bond lengths: H-C, H-N, C-C and C-O

[A] H-C < H-N < C-C < C-O [B] H-N < H-C < C-O < C-C

[C] C-O < H-C < H-N < C-C [D] C-C < C-O < H-C < H-N

13. The basic condition for a chemical reaction to occur spontaneously is that the:

[A] free energy change of the reaction should be positive

[B] entropy change of the reaction should be positive

[C] total entropy change (of reaction system + surroundings) should be positive

[D] enthalpy change of the system should be negative

14. The reason why the solution of a chiral molecule shows the phenomenon of optical rotation is that the right and left circularly polarized components of plane polarized light passing through it:

[A] are absorbed to different extents

[B] have different refractive indices

[C] are transmitted with different intensity

[D] are reflected differently

15. An elementary step A → B has a reaction enthalpy of −50 kJ mol^{-1} and an activation energy of 10 kJ mol^{-1}. The activation energy for the reverse step B → A is:

[A] 10 kJ mol^{-1} [B] 40 kJ mol^{-1}

[C] 50 kJ mol^{-1} [D] 60 kJ mol^{-1}

16. The depth of a symmetric double well potential, $V(x) = -\frac{1}{2}ax^2 + \frac{1}{4}bx^4$, is given by (where a and b are positive):

[A] $\frac{a^2}{4b}$ [B] $\frac{a^2}{2b}$

[C] $\frac{b^2}{4a}$ [D] $\frac{b^2}{2a}$

17. The ionic strength of 1.0 mmol kg^{-1} $CaCl_2$ (aq.) solution at 25 °C is:

[A] 2.0 mmol kg^{-1} [B] 3.0 mmol kg^{-1}

[C] 4.0 mmol kg^{-1} [D] 6.0 mmol kg^{-1}

18. The scientist who coined the term "photon" for light particle is:

[A] A. Einstein [B] A. H. Compton

[C] M. Planck [D] G. N. Lewis

19. Plants absorb dissolved nitrates from soil and ultimately convert them into:

[A] free nitrogen [B] urea

[C] ammonia [D] proteins

20. Which of the following pigments is responsible for dark skin?

[A] flavoxanthin [B] melanin

[C] carotene [D] xanthophyll

Part-B

21. The 'g' value and expected magnetic moment (in BM) for Ce^{3+} are, respectively.

[A] $\frac{1}{2}$ and 1.41 [B] $\frac{3}{2}$ and 2.54

[C] $\frac{6}{7}$ and 2.54 [D] $\frac{5}{6}$ and 3.58

22. The equilibrium constants for the following reactions (i) and (ii) are, respectively,
(i) CdI_2 (s) + CaF_2 (s) ⇌ CdF_2 (s) + CaI_2 (s)
(ii) $[CuI_4]^{2-}$ (aq) + $[CuCl_4]^{3-}$ (aq) ⇌ $[CuCl_4]^{2-}$ (aq) + $[CuI_4]^{3-}$ (aq)

[A] > 1 and > 1 [B] < 1 and > 1

[C] < 1 and < 1 [D] > 1 and < 1

23. In a trigonal bipyramidal molecule MF_5, the axial and equatorial M-F distances are 1.60 Å and 1.40 Å, respectively. The distances (in Å) between the (i) axial and equatorial fluorines and (ii) two equatorial fluorines, respectively are close to:

[A] 2.13 and 2.42 [B] 2.42 and 2.13

[C] 3.00 and 2.42 [D] 2.13 and 2.13

24. The expected number of ^{19}F NMR (ignoring coupling to iodine, if any) lines for $[IF_2]^{2-}$ and IF_3 (on the basis of shapes predicted by VSEPR theory) are respectively:

[A] 1 and 2 [B] 1 and 5

[C] 2 and 3 [D] 4 and 5

25. The packing fractions of body centered cubic (bcc) and simple cubic lattices are respectively:

[A] 0.68 and 0.52 [B] 0.48 and 0.32

[C] 0.87 and 0.74 [D] 0.52 and 0.86

26. The half reactions involving (i) oxidation of water to molecular oxygen, and (ii) reduction of molecular nitrogen to ammonia, are associated respectively with:

[A] 2 and 4 electrons [B] 3 and 3 electrons

[C] 4 and 6 electrons [D] 6 and 8 electrons

27. The correct statements about $[Ru_6C(CO)_{17}]$ among the following are:

(i) It does not exist
(ii) Carbon is tetravalent
(iii) An octahedral Ru_6 core interacts with the carbon, which resides at the center
(iv) It has a *closo* structure

[A] (i) and (ii)
[B] (ii) and (iv)
[C] (iii) and (iv)
[D] All of the above

28. X-ray diffraction of a crystal with cubic system shows systematic absences such that only peaks corresponding to Miller planes (h, k, l) with h + k + l being an even number are observed. The Bravais lattice of the crystal is:

[A] Primitive
[B] Body centered
[C] Edge centered
[D] Face centered

29. Identify the total number of stereoisomers including pairs of enantiomers for a Ma_2bcde octahedron. All ligands (a,b,c,d and e) are monodentate.

[A] 30
[B] 15
[C] 20
[D] 11

30. Identify the point group of $[Co(en)_3]^{3+}$, where en = ethylenediamine.

[A] C_3
[B] D_3
[C] D_{4h}
[D] C_{4h}

31. The ground state term symbol for Nd^{3+} ($4f^3$ configuration) is:

[A] $^4I_{9/2}$ [B] $^5I_4$

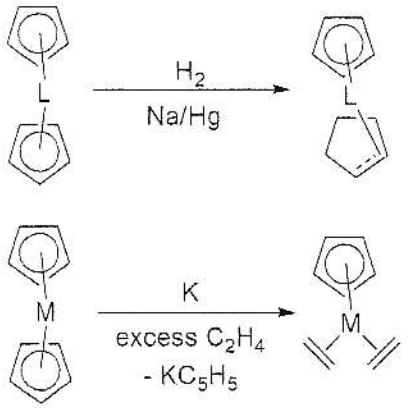
[C] $^3H_4$ [D] $^6H_{5/2}$

32. ESR spectrum of 1, 4-pyrazine radical ion ($I = \frac{1}{2}$ for proton and $I = 1$ for nitrogen) shows:

[A] 25 lines [B] 5 lines

[C] 10 lines [D] 12 lines

33. Identify L and M in the following reactions based on 18 e^- rule.



[A] Ni and Co [B] Cr and Mn

[C] V and Ti [D] Cu and Zn

34. Ethylene glycol, $C_2H_4(OH)_2$ is a colorless liquid used as automobile antifreeze. If the density at 20 °C of a 4.028 molal solution of ethylene glycol in water is 1.0241 g mL^{-1}, what is the molarity of the solution? The molar mass of ethylene glycol is 62.07 g mol^{-1}.

[A] 3.29 M [B] 2.56 M

[C] 1.85 M [D] 5.65 M

35. The following cell has a potential of 0.55 V at 25 °C. What is the pH of the solution in the anode compartment? [Given $E^\circ = 0.28$ V]

$$Pt(s) \mid H_2(1\ atm) \mid H^+(x\ M) \parallel Cl^-(1\ M) \mid Hg_2Cl_2(s) \mid Hg(s)$$

[A] 4.6 [B] 5.5

[C] 6.7 [D] 8.9

36. The active sites of water oxidase (PS II), sulfite oxidase, and carboxypeptidase are associated respectively with the metals:

[A] Co, Mg and V [B] Mn, Mo and Zn

[C] Fe, Mn and Co [D] Mg, Mn and Mo

37. The correct statements among the following regarding complexation of dinitrogen are:
(i) It forms end-on complex
(ii) It forms side-on complex
(iii) It leads to strengthening of N-N bond
(iv) It leads to weakening of N-N bond

[A] (i) and (iv) [B] (i), (ii) and (iv)

[C] (i), (ii) and (iii) [D] (ii), and (iv)

38. Major product(s) formed in the following two reactions is/are:

$SiCl_4 + 4H_2O \rightarrow$

$CCl_4 + 4H_2O \rightarrow$

[A] $Si(OH)_4$ and $C(OH)_4$, respectively.

[B] SiO_2 and CO_2, respectively.

[C] No reaction will proceed in the two cases.

[D] Siloxane polymer and no reaction with CCl_4.

39. The titration of 0.2121 g of pure $Na_2C_2O_4$ (134.00 g/mol) required 43.31 mL of $KMnO_4$. What is the molarity of the $KMnO_4$ solution? The chemical reaction is:

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

[A] 0.01462 M

[B] 0.146 M

[C] 0.00158 M

[D] 0.06855 M

40. A student analyzed a sample for Cl by precipitating and weighing AgCl. A 0.8625 g sample gave a precipitate of AgCl weighing 0.7864 g. By mistake the student used the atomic weight of Cl as 35.345 rather than the correct value of 35.453. Calculate the absolute error in the percentage of Cl that the student would make and comment on the type of error (atomic weight of Ag = 107.868).

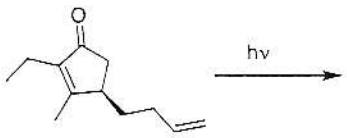
[A] + 0.30, determinate error

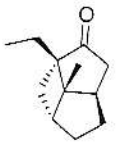
[B] – 0.91, random error

[C] + 22.50, indeterminate error

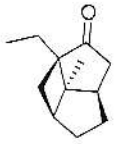
[D] – 0.05, determinate error

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





[A]



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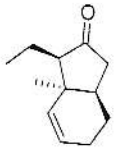
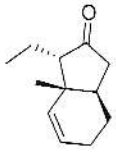
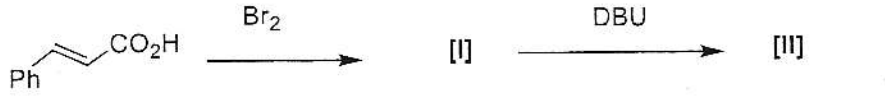


[C]



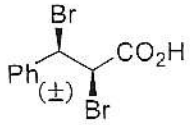
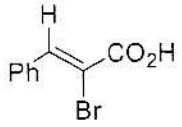
[D]

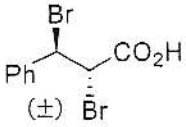
42. Predict the products appropriately in the following reaction sequence.

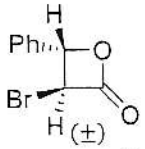
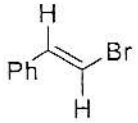


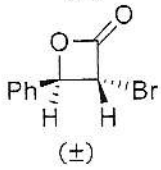
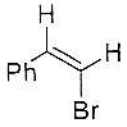
[I]=

[II]=

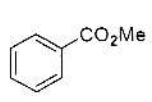
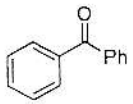
[A]  

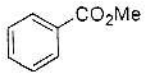
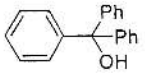
[B]  

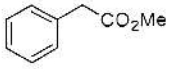
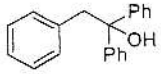
[C]  

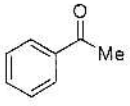
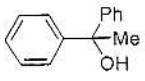
[D]  

43. Benzoic acid reacts with CH_2N_2 to produce a compound X, which on treatment with excess of phenylmagnesium bromide gives a compound Y. What are X and Y?

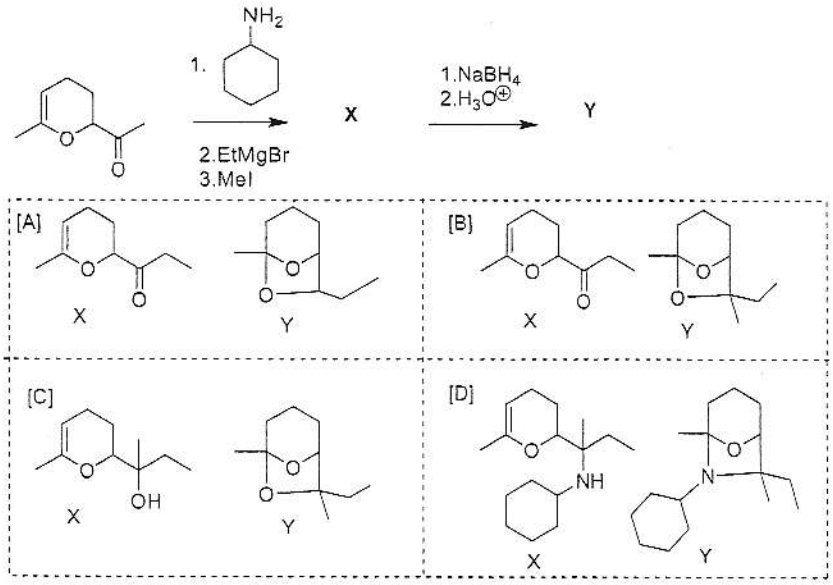
[A]  X  Y

[B]  X  Y

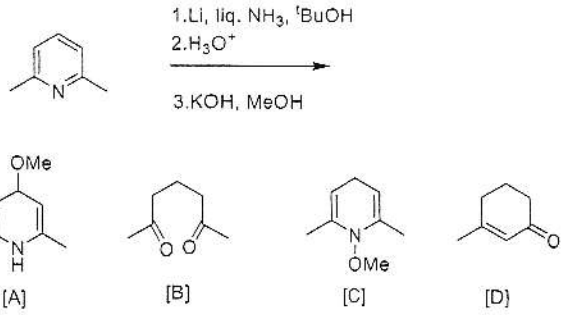
[C]  X  Y

[D]  X  Y

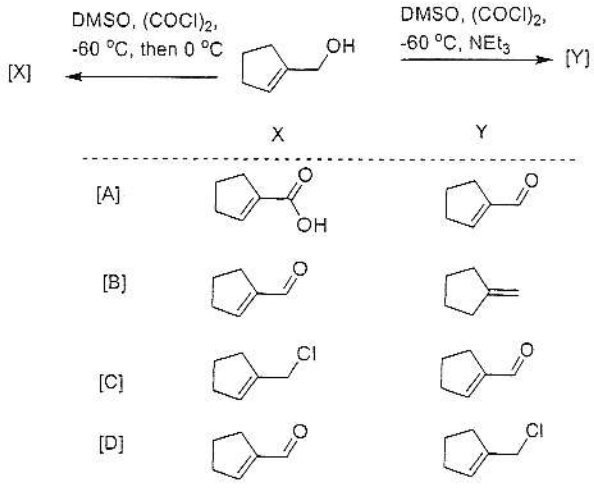
44. Predict the products in the following reaction sequence.



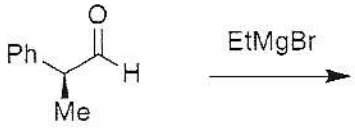
45. Predict the product in the following transformation.

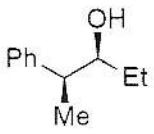


46. Predict the products in the following transformations.

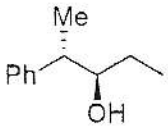


47. Predict the correct stereoisomer formed in the given reaction.

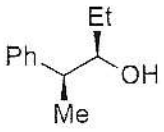




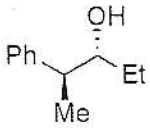
[A]



[B]

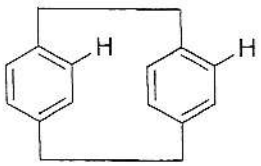


[C]



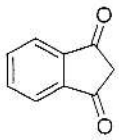
[D]

48. Identify the topicity of the protons (H) shown in the given paracyclophane.



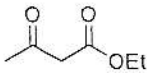
[A] Homotopic
[B] Diastereotopic
[C] Enantiotopic
[D] Enantiotopic and diastereopic

49. Which of the following compounds exhibits a valence tautomerism?

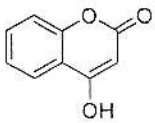


[A]

[B]



[C]

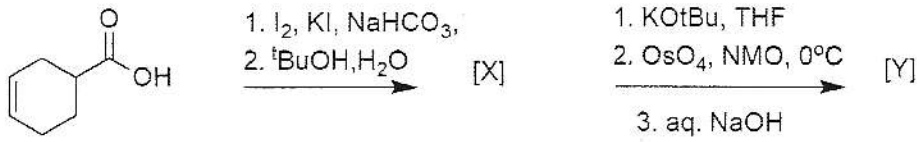


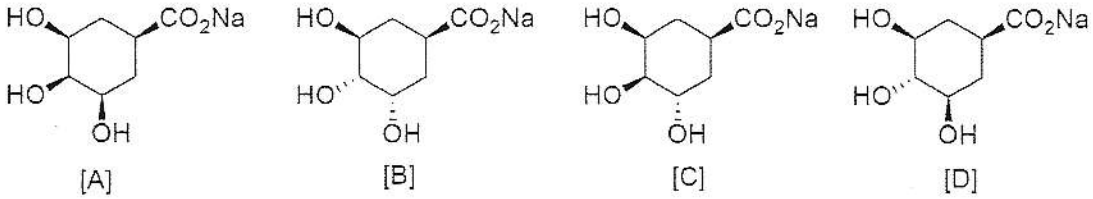
[D]

50. Reactive intermediates in Friedel-Crafts reaction for synthesis of acetophenone and Reimer-Tiemann reaction for obtaining salicylaldehyde respectively are:

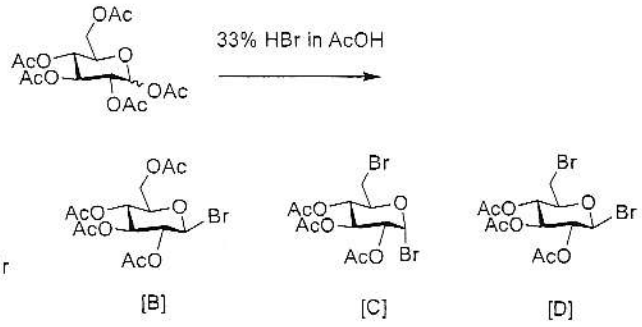
[A] $:CCl_2$, $MeCO^+$
[B] $MeCO^+$, $:CCl_2$
[C] $:CCl_2$, $PhCO^+$
[D] :CHCl, $MeCO^+$

51. Predict the final product **Y** in the following transformation.

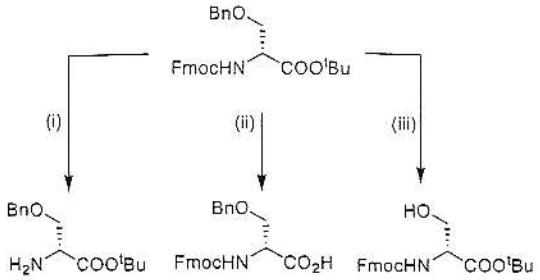




52. Identify the product of the following reaction.

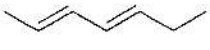


53. Identify the suitable reagents for the following reactions.



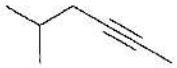
[A] (i) CF_3CO_2H; (ii) Pd/C, H_2, MeOH; (iii) Et_2NH, CH_2Cl_2
[B] (i) Pd/C, H_2, MeOH; (ii) CF_3CO_2H; (iii) Et_2NH, CH_2Cl_2
[C] (i) Pd/C, H_2, MeOH; (ii) Et_2NH, CH_2Cl_2; (iii) CF_3CO_2H
[D] (i) Et_2NH, CH_2Cl_2; (ii) CF_3CO_2H; (iii) Pd/C, H_2, MeOH

54. A hydrocarbon (C_7H_{12}), on catalytic hydrogenation over platinum gives C_7H_{16}. The parent hydrocarbon adds Br_2 and also reacts with $[Ag(NH_3)_2OH]$ to give a precipitate. What is the parent hydrocarbon?

[A] 

[B] 

[C] 

[D] 

55. Who won the Noble Prize in chemistry in 2010 for Palladium-catalyzed cross-couplings in organic synthesis?

[A] Richard F. Heck, Ei-chi Negishi and Akira Suzuki

[B] Joachim Frank, Richard Henderson and Jacques Dobochet

[C] Fraser Stoddart, Jean-Pierre Sauvage and Ben Feringa

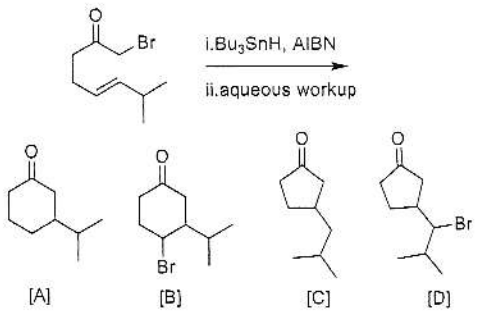
[D] Paul L. Modrich, Tomas Lindahl and Aziz Sancar

56. Identify the reagents from the following which can convert ROH into HCl.

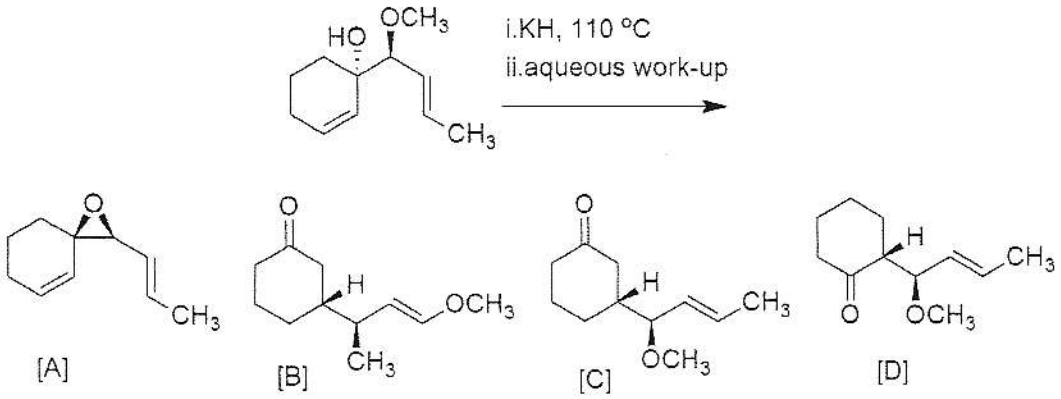
[A] CCl_4 , $SOCl_2$ [B] $PPh_3/CHCl_3$, PCl_3

[C] PPh_3/CH_2Cl_2, $SOCl_2$ [D] PPh_3/CCl_4, $SOCl_2$

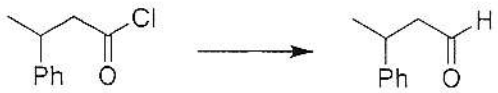
57. Identify the product of the following reaction.



58. Identify the product of the following reaction.

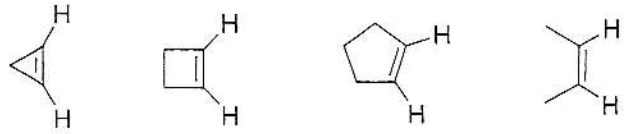


59. Identify the reagent which can perform the following transformation.



[A] $NaBH_4$ [B] $LiAlH(O^tBu)_3$ [C] $LiAlH_4$ [D] $LiBH_4$

60. The order of coupling constants of the olefinic hydrogens in the following compounds is:



(I) (II) (III) (IV)

[A] (I)>(II)>(III)>(IV) [B] (IV)>(III)>(II)>(I)

[C] (III)>(II)>(I)>(IV) [D] (IV)>(I)>(II)>(III)

61. Which of the following set is true for isothermal reversible expansion of a perfect gas [w = work done, q = heat absorbed, ΔU = internal energy change, ΔS = entropy change]?

[A] $w \neq 0; q \neq 0; \Delta U = 0; \Delta S = 0$ [B] $w = 0; q = 0; \Delta U = 0; \Delta S = 0$

[C] $w = 0; q = 0; \Delta U \neq 0; \Delta S \neq 0$ [D] $w \neq 0; q \neq 0; \Delta U = 0; \Delta S \neq 0$

62. Order of the reaction, A → products, is $^3/_2$. Which of the following quantities plotted against time (t), will give a straight line graph?

[A] [A] [B] $[A]^{½}$

[C] $[A]^{-½}$ [D] $[A]^{-1}$

63. EMF of the cell, Pt(s)|H_2 (g, 1bar)|HCl (aq., 0.2 M)||HCl (aq., 0.3 M)|H_2 (g, 1bar)|Pt(s) at 25 °C is (assume that the solutions are ideal):

[A] 0.01 V [B] 0.005 V

[C] 0.00 V [D] - 0.01 V

64. When X-ray of wavelength 1.54 Å is used, the diffraction peak for the (1 1 1) plane of a crystal with face-centered cubic lattice is observed at $2\theta = 28.0°$. Edge length of the unit cell of the crystal is:

[A] 2.840 Å [B] 3.080 Å

[C] 3.182 Å [D] 5.513Å

65. Microwave spectrum of $H^{35}Cl$ shows series of equally spaced lines separated by 6.26×10^{11} Hz. If the reduced mass of $H^{35}Cl$ is 1.63×10^{-27} kg, then the bond length of $H^{35}Cl$ would be:

[A] 0.91 Å [B] 1.25 Å

[C] 2.27 Å [D] 1.61 Å

66. The adsorption of a gas is described by the Langmuir isotherm with K=0.777 kPa^{-1} at 25 °C. The pressure at which the fractional surface coverage becomes 0.2 is:

[A] 1.02 kPa [B] 0.32 kPa

[C] 0.52 kPa [D] 0.26Pa

67. The expression for vibrational partition function, when the energy at the bottom of the potential is taken as zero, is given by:

[A] $e^{-\beta hc\tilde{\nu}/2}$

[B] $\dfrac{1}{e^{-\beta hc\tilde{\nu}/2}}$

[C] $\dfrac{e^{-\beta hc\tilde{\nu}/2}}{1-e^{-\beta hc\tilde{\nu}}}$

[D] $\dfrac{1}{1+e^{-\beta hc\tilde{\nu}}}$

68. A gas phase reaction, A + B → products, is first order with respect to both A and B. The reaction has a half-life of 20 minutes when $p^0_A = p^0_B = 0.05$ atm. The time required for $^3/_4$ th completion of the reaction is:

[A] 30 min

[B] 80 min

[C] 40 min

[D] 60 min

69. The translational partition function of H_2 molecule at 25° C is 2.8×10^{26}. The translational partition function of D_2 molecule at the same temperature and volume is :

[A] 5.6×10^{26}

[B] 7.8×10^{26}

[C] 4.8×10^{26}

[D] 6.8×10^{26}

70. The desorption of gaseous molecules from solid surface follows Arrhenius-type behavior. A physisorbed molecule (E_a = 25 kJ mol^{-1}, A = $10^{12} s^{-1}$ at 25° C) resides on the surface for approximately:

[A] 3.2×10^{-6} s

[B] 2.4×10^{-8} s

[C] 4.6×10^{-8} s

[D] 7.4×10^{-6} s

71. The ground state of Cl atom is $^2P_{3/2}$. An excited state $^2P_{1/2}$ lies at an energy ε above it. The partition function of the system at temperature T is:

[A] $2 + 2\, e^{-\varepsilon/kT}$

[B] $2 + 3\, e^{-\varepsilon/kT}$

[C] $4 + 2\, e^{-\varepsilon/kT}$

[D] $3 + 2\, e^{-\varepsilon/kT}$

72. For a 2-level system with the lower state nondegenerate and upper state doubly degenerate at an energy ε, the ratio of total number of molecules (N) to number of molecules in the upper state (n_u), represented by $^{N}/n_u$, is:

[A] $\frac{1}{2}\, e^{-\beta\varepsilon}\,(1 + 2\, e^{-\beta\varepsilon})$ [B] $\frac{1}{2}\, e^{\beta\varepsilon}\,(1 + 2\, e^{-\beta\varepsilon})$

[C] $e^{-\beta\varepsilon}\,(1 + 2\, e^{-\beta\varepsilon})^{-1}$ [D] $e^{\beta\varepsilon}\,(1 + 2\, e^{-\beta\varepsilon})^{-1}$

73. The rate constant of the reaction, $H^+(aq.) + OH^-(aq.) \rightarrow H_2O(liq.)$, is 1.4×10^{11} $dm^3\ mol^{-1}s^{-1}$ at 25°C. The half-life of the reaction for an initial concentration of 0.10 mol dm^{-3} (for both H^+ and OH^- ions) is:

[A] 7.1×10^{-11} s [B] 7.1×10^{-10} s

[C] 1.7×10^{-10} s [D] 1.7×10^{-11} s

74. Which of the following uncertainty relationships is/are correct?

[A] $\Delta p.\Delta x \sim \hbar$ [B] $\Delta E.\Delta t \sim \hbar$

[C] $\Delta J.\Delta \theta \sim \hbar$ [D] All of the above

75. If $\hat{H} = \frac{p^2}{2m} + V(x)$, then $[\hat{x}, \hat{H}]$ equation is given as:

[A] $\frac{i\hbar\hat{p}}{m}$ [B] $-\frac{\hbar\hat{p}}{im}$

[C] $-\frac{i\hbar\hat{p}}{m}$ [D] $\frac{\hbar\hat{p}}{im}$

76. Which among the following is a well-behaved quantum mechanical function?

[A] $e^{-x}\ (0 \leq x \leq \infty)$ [B] $e^{-x}\ (-\infty \leq x \leq \infty)$

[C] $\sin^{-1}x\ (-1 \leq x \leq 1)$ [D] $e^{-|x|}\ (-\infty \leq x \leq \infty)$

77. The action of L^2 operator on the state function of a H-atom yields $6\hbar$. Upon application of a magnetic field, the number of lines that would appear in its spectrum disregarding the spin is:

[A] 9 [B] 7

[C] 5 [D] 3

78. Diborane molecule belongs to the point group:

[A] C_{2h} [B] C_{2v}

[C] D_{2h} [D] D_{2d}

79. For a particle in a one-dimensional box, the quantity, $\langle E^2 \rangle - \langle E \rangle^2$ is:

[A] $\frac{n^2h^2}{8ml^2}$ [B] 0

[C] 2 [D] n^2

80. A sample of ideal gas with an internal energy U is compressed to half of its original volume while the temperature remains constant. The final internal energy of the ideal gas is:

[A] U [B] $\frac{U}{2}$

[C] $\frac{U}{4}$ [D] 2U

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