# CSIR- NET 2022 Chemical Science

MOCK

1.The average of ten numbers is 72. The average of the first four numbers is 69 and that of the next three numbers is 74. The 8th number is 6 more than the 9th number and 12 more than the 10th number. What is the average of the 8th and 9th numbers?

A. 76

B. 76.5

C. 77

D. 77.5

2.If Cosec θ = 25/7, then what is the value of Cot θ?

A. 24/25

B. 7/24

C. 7/25

D. 24/7

3.In the given Venn diagram, the 'circle' represents 'computer', the 'triangle' represents 'not working', and the 'rectangle' represents 'Intel'. The numbers given in the diagram represent the number of persons in that particular category.
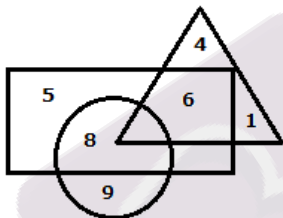
How many computers of Intel are working?

A. 11

B. 6

C. 8

D. 3

4.The length and breadth of a square are increased by 40% and 20% respectively. Find the percentage increase in the area of the rectangle so formed with respect to that of the original square.

A. 56%

B. 57.5%

C. 65%

D. 68%

E. None of the above

5.Which is the main element used in the conversion of solar energy into electricity?
A. Copper
B. Carbon
C. Sulphur
D. Silicon

6.A train with a uniform speed passes a platlorm, 122 metres long, in 17 seconds and a bridge, 210 metres long, in 25 seconds. The speed of the train is
A. 46.5 km/hour
B. 37.5 km/hour
C. 37.6 km/hour
D. 39.6 km/hour
E. 39.5 km/hour

7.A series is given with one term missing. Select the correct alternative from the given ones that will complete the series.
3, 6, 8, 16, 18, 36, ?
A. 40
B. 39
C. 31
D. 38

8.The height of a tree increases annually by $1/9^{th}$ of its height. Find the increase in its height in 2 years, if its present height is 81 cm.
A. 29 cm
B. 100 cm
C. 19 cm
D. 16 cm

9.Find the value of k for which the lines 5x + 3y + 2=0 and 3x - ky + 6 = 0 are perpendicular to each other
A. 8
B. 7
C. 6
D. 5

10.Secondary colours are made by a mixture of three primary colours, Red, Green and Blue, in different proportions; each of the primary colours comes in 8 possible levels. Grey corresponds to equal proportions of Red, Green and Blue. How many shades of grey exist in this scheme?
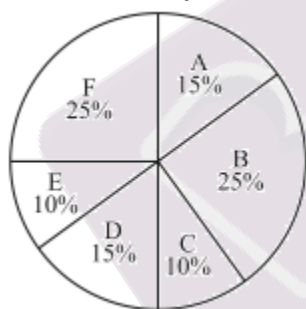A. 8^3
B. 8
C. 3^8
D. 8×3

Direction: Two pie charts are given. First pie chart represents the expenditure and saving of Ram and second pie chart represents that of Mohan. Study the charts carefully and answer the related questions.
Total salary of Ram = 54000
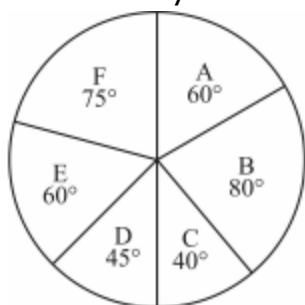
Total Salary of Mohan = 50000

Where,
A- Transport
B- Food
C- Clothing
D- Interest paid
E- Other expenditures
F- Savings

11. Total expenditure of Ram is what percent of that of Mohan?
A. 96%
B. 114%
C. 125%
D. 75%

12. If 12 (20) 16 and 21 (35) 28, then what is value of A in 48 (80) A?
A. 50
B. 56
C. 64
D. 72

13. If the force acting on a body is doubled what happens to acceleration?
A. It will be doubled
B. It will be decrease
C. It will be halved
D. None of these

14. The two stations X and Y be 240 km apart. Paul and Sam travel from X to Y, but Sam starts from X when Paul is already 30 km away from X. Both travel at a speed of 60 kmph for the 80 km, at 45 kmph for the next 80 km, and at 30 kmph for the last 80 km. Find the distance, in km, between Sam and Y when Paul reaches Y.
A. 15 km
B. 40 km
C. 20 km
D. 30 km

15. The following observations 17, 21, 19, 23, 27 constitute a random sample from an unknown population with mean μ and standard deviation σ. The point estimation of population mean is:
A. 22
B. 23
C. 20
D. 21

16.Identify which among the following obey 18 electron rule:

(i)



(ii)
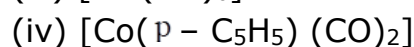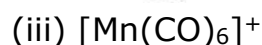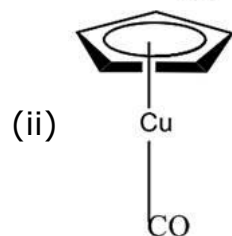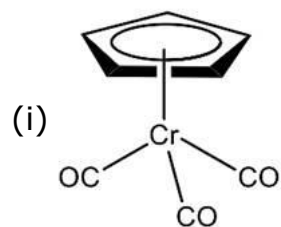
(iii) $[Mn(CO)_6]^+$
(iv) $[Co(p - C_5H_5)(CO)_2]$
A. Only (i)
B. (i) and (iv) both
C. (ii), (iii) and (iv)
D. (ii) and (iv)

17.The correct statement about μ-oxodimer among the following is:
A. Metal ion is Fe^{3+}(LS) and able to transport O_2
B. Metal ion is Fe^{3+}(HS) and unable to transport O_2
C. Metal ion is Fe^{2+}(HS) and unable to transport O_2
D. Metal ion is Fe^{2+}(LS) and able to transport O_2

18.Identify the most acidic species among the options given below.

A.

B.
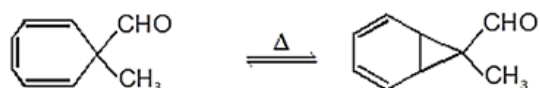

C.

D.
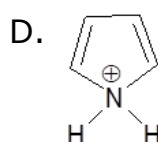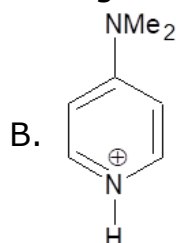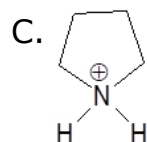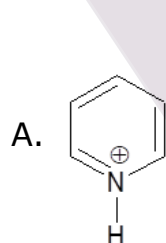
19. At what frequency does, Raman Spectroscopy shows stretching band for oxyhemerythrin?

A. 844 cm^{-1}

B. 744 cm^{-1}

C. 1150 cm^{-1}

D. 1650 cm^{-1}

20. NO_2^- shape according to VSEPR theory is:

A. Bent

B. Linear

C. Tetrahedral

D. None of these

21. For the conversion given below, select the correct classification of reaction.

A. Disrotatory electrocyclic reaction

B. Conrotatory electrocyclic reaction

C. $[\pi^4 s + \pi^2 a]$ cycloaddition reaction

D. Valence Isomerization

22. Equal numbers of molecules with $M_1 = 20000$, $M_2 = 200000$ are mixed. Calculate number average molar mass (Z)?

A. 55000

B. 120000

C. 110000

D. 100000

23. The structure of $[Fe_4(CO)_{12}C]^{2-}$ is:

A. Nido

B. Arachano

C. Closo

D. Supercloso

24. The correct order of infrared stretching frequency V_{CO} of P – S is:

(P) $[Mn(CO)_6]^+$

(Q) CO

(R) $H_3B \leftarrow CO$

(S) $[V(CO)_6]^-$

A. Q > S > P > R

B. R > Q > P > S

C. P > R > S > Q

D. S > P > R > Q

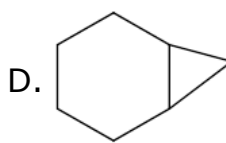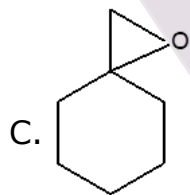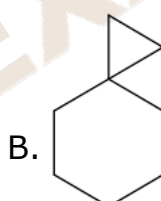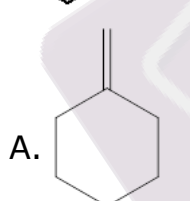25. The number of signals observed in ^1HNMR spectrum of 3, 5-dibromo toluene is:

A. 3

B. 2

C. 4

D. 6

26. What is the product of the reaction?
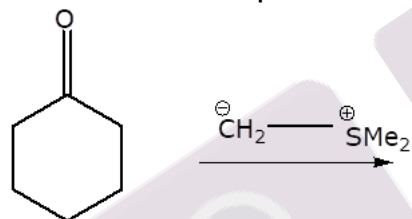
27.Choose the correct IUPAC name of the given compound.
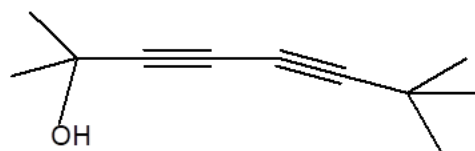
A. 2,7,7-trimethyl-3,5-octadiyne-2-ol
B. 2,2,7-trimethyl-3,5-octadiyne-7-ol
C. 2,7,7-trimethyl-3,5-heptadiyne-2-ol
D. 2,2,7-trimethyl-3,5-heptadiyne-7-ol

28.The number of C=C present in the chemical structure of Arachidonic fatty acid is:
A. 1
B. 2
C. 3
D. 4

29.For an ideal monatomic gas, the partical function 'q' is
A. $[8\pi mKT/h^2]^{3/2}$ V
B. $[2\pi mKT/h^2]^{3/2}$ V
C. $[h^2/8\pi mKT]^{3/2}$ V
D. $[h^2/2\pi mKT]^{3/2}$ V

30.For the reaction given below, determine the major product.

A.

B.

C.

D.

31. The g value for a free an unpaired electron in gaseous atom is
A. 0
B. 1
C. 3
D. 2

32. Arrange the following in decreasing order of their ionization energy?
A. S>P>Mg>Al
B. S>P>Al>Mg
C. P>S>Al>Mg
D. P>S>Mg>Al

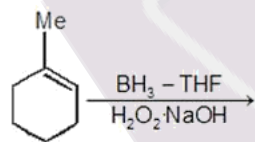33. According to HSAB principle, which of the following stable complexes are formed by Co^{2+} & Pd^{2+} ions.
A. $[Pd (SCN)_4]^{-2}$ and $[Co (NCS)_4]^{-2}$
B. $[Pd (SCN)_4]^{-2}$ and $[Co (SCN)_4]^{-2}$
C. $[Pd (NCS)_4]^{-2}$ and $[Co (NCS)_4]^{-2}$
D. $[Pd (NCS)_4]^{-2}$ and $[Co (SCN)_4]^{-2}$

34. What is the energy of 2-D SHO and 3-D SHO?
A. $(n_x+1/2)hv$ and $(n_x+1/2)hv$
B. $(n_x+ n_y +1)hv$ and $(n_x+ n_y +n_z+3/2)hv$
C. $(n_x+1/2)hv$ and $(n_x+ n_y +n_z+3/2)hv$
D. $(n_x+ n_y +1/2)hv$ and $(n_x+1/2)hv$

35. What is the value of Huckel's number n in the following annulene?
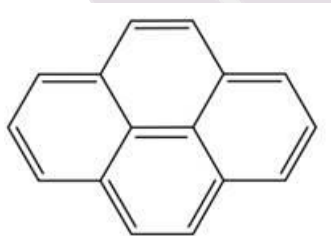
A. 3.5
B. 4
C. 3
D. 5

36. The product [structure: 2-methyl-2-butanol with OH] is not given by which of the following reaction

A.
   propyl-MgBr + (acetone) →(1) Et$_2$O (2) H$_3$O$^+$

B. [isobutyl-MgBr] + (acetaldehyde, with H) →(1) Et$_2$O (2) H$_3$O$^+$

C. [butanoate ester, OMe] + 2 CH$_3$MgI →(1) Et$_2$O (2) H$_3$O$^+$

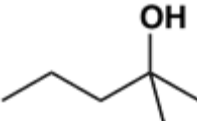D. [2-butanone] + CH$_3$MgI →(1) Et$_2$O (2) H$_3$O$^+$
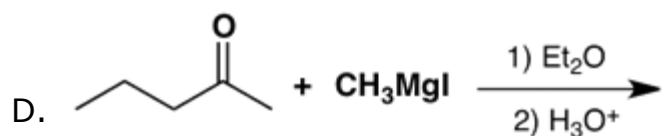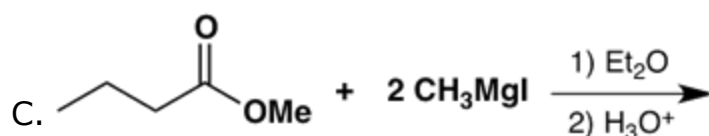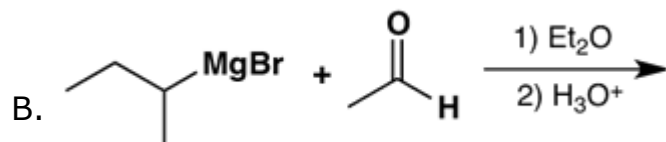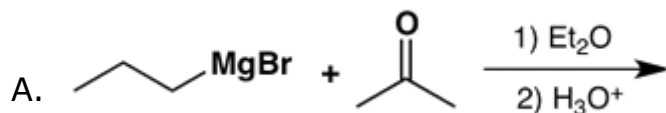
37. The point group of the organic molecule structure is:

[structure with H and H]
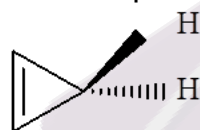
A. C$_{2v}$
B. C$_{2h}$
C. D$_{2h}$
D. D$_{2d}$

38. Calculate the molar residual entropy of an AX crystal in which the molecule can adopt 4 orientations of equal energy.
A. 18.526 JK^{-1} mol^{-1}
B. 11.526 JK^{-1} mol^{-1}
C. 10.526 JK^{-1} mol^{-1}
D. 14.526 JK^{-1} mol^{-1}

39. Predict the correct order of LMCT energies for the species given below.

A. $MnO_4^- > CrO_4^{-2} < VO_4^{-3}$

B. $MnO_4^- < CrO_4^{-2} < VO_4^{-3}$

C. $MnO_4^- > CrO_4^{-2} > VO_4^{-3}$

D. $MnO_4^- > CrO_4^{-2} < VO_4^{-3}$

40. Calculate the standard enthalpy of the aqueous potassium, K^+ ion. Dissolving 1 mol of KCl in a large amount of water at 25°C produces an enthalpy change of 16.33 kJ. The standard enthalpy of KCl(s), is -435.75 kJ. The standard enthalpy of Cl^-(aq), obtained above is -167.16 kJ.
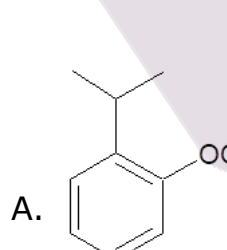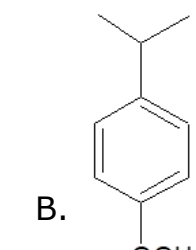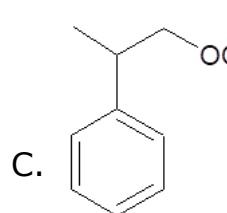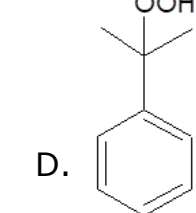
A. $\Delta H_f^o[K^+(aq)]=-252.26\ kJ$

B. $\Delta H_f^o[K^+(aq)] = -602.91kJ$

C. $\Delta H_f^o[K^+(aq)] = -619.24kJ$

D. $\Delta H_f^o[K^+(aq)] = -248.23kJ$

41. What is the point group of trans -1,2-dichloroethylene

A. C_{2v} B. C_{2h}

C. D_{3h} D. C_1

42. Select the most probable product for the reaction given below.
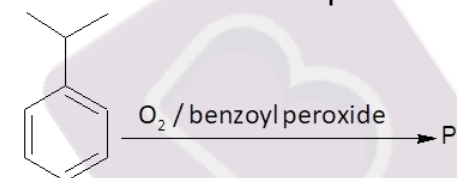
43. With increase in temperature, the rate of chemical reaction changes as follows:

A. Decreases the rate of both exothermic and endothermic reaction.

B. Increases the rate for exothermic and decreases for endothermic.

C. Decreases the rate for exothermic and increases for endothermic.

D. Increases the rate of both exothermic and endothermic reaction.

44. Identify correct decreasing order of ionic character.

A. $BaCl_2 > CaCl_2 > MgCl_2 > BeCl_2$

B. $MgCl_2 > BeCl_2 > BaCl_2 > CaCl_2$

C. $BaCl_2 > CaCl_2 > BeCl_2 > MgCl_2$

D. $BeCl_2 > MgCl_2 > CaCl_2 > BaCl_2$

45. A system absorbs 2×10^{20} quanta of light per second. After 20 min. it is observed that 1 mole of the molecule has reacted. Calculate the quantum efficiency.

A. 3.5

B. 2.5

C. 6.5

D. 4.5

46. The degeneracy of quantum particles in a cubic box having energy three times the lowest energy is:

A. 2

B. 3

C. 1

D. 4

47. Calculate the EAN of the metal in the $[PtCl_3(C_2H_4)]^-$.

A. 89

B. 84

C. 85

D. 86

48. What is the coordination number of "C" in Be_2C_3 whose structure is correlated with that of CaF_2.

A. 2
B. 4
C. 6
D. 8

49. For the reaction given below, identify P.

A.

B.

C.

D.
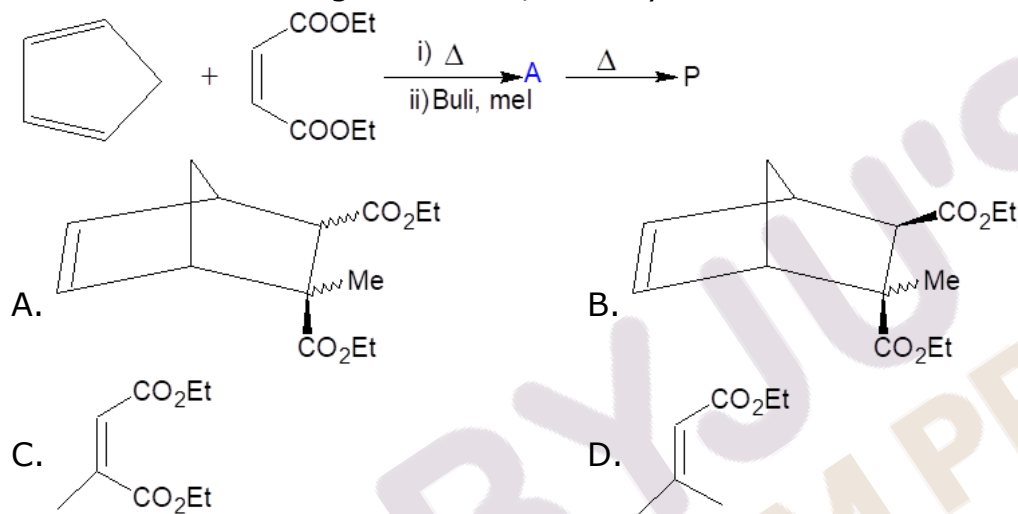
50. Consider the synthone given below:

Identify the synthetic equivalent (reagent) for this synthone.

A.

B.

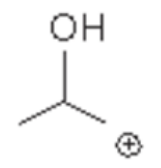C.

D.
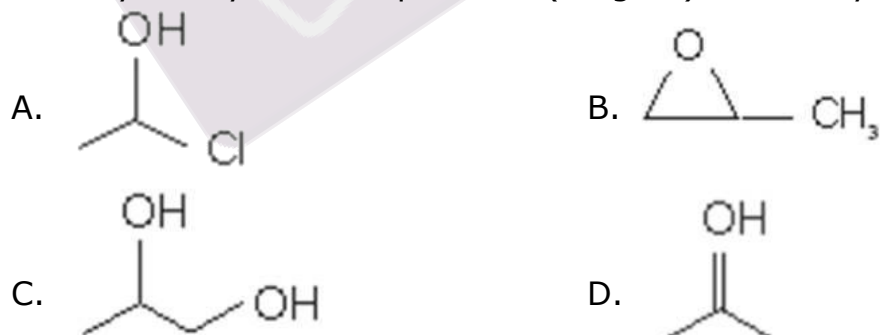
51. Designate the following complexes X Y and Z as inert or labile

$X = [Al(C_2O_4)_3]^{3-}$, $Y = [V(H_2O)_6]^{2+}$, $Z = [Cr(C_2O_4)_3]^{3-}$
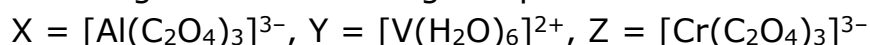
A. X and Y are inert; Z is labile

B. X and Z are labile; Y is inert

C. X is labile; Y and Z are inert

D. X is inert; Y and Z are labile

52. What will be the correct order if we arrange the following species Cl_2O_7, PbO_2, CaO, SO_3 in order of increasing acidic character ?

A. $CaO < SO_3 < Cl_2O_7 < PbO_2$

B. $Cl_2O_7 < SO_3 < PbO_2 < CaO$

C. $CaO < SO_3 < PbO_2 < Cl_2O_7$

D. $CaO < PbO_2 < SO_3 < Cl_2O_7$

53. Considering the quadrupolar nature of M-M bond in $[Re_2Cl_8]^{2-}$, what will be the M-M bond order of $[Re_2Cl_4(PMe_2Ph)_4]^+$ and $[Re_2Cl_4(PMe_2Ph)_4]$ respectively

A. 3.5 and 3.0

B. 3.0 and 3.5

C. 3.5 and 3.5

D. 3.0 and 3.0

54. $CuFeS_2 + O_2$ (excess) $\xrightarrow{\Delta}$ X(s) + Y(s) (Unbalanced Equation):

Which option is correct for (X) and (Y)?

A. (X) liberates iodine from soluble iodides like Kl

B. (Y) on heating liberates SO_3 only

C. (X) forms bluish white ppt, with sodium hydroxide which redissolves in excess of sodium hydroxide.

D. (Y) on reaction with potassium ferricyanide gives brown ppt.

55. High dose of dietary supplement $ZnSO_4$ for the cure of Zn deficiency

A. increases myoglobin.

B. increases iron level in blood.

C. increases copper level in blood.

D. reduces copper, iron and calcium levels in body.

56.Compound 'X' is formed when cerium (III) oxalate heated in the presence of air.

I. X is white when pure.

II. X has antifluorite type structure.

III. X is soluble in acids but NOT in alkalies.

The correct statements (s) about X is /are

A. I only

B. II only

C. I and II

D. I, II and III

57.Which of the following statements are correct regarding f-f transition?

I) Color of lanthanide ion is characteristics of metal cation.

II) Depend on surrounding ligands

III) Appear as sharp band

A. Only I

B. I AND II

C. II AND III

D. I and III

58.When a triatomic molecule of type AB_2 exhibits two IR absorption lines and one IR - Raman line, the molecule's structure is :

A. B – A – B

B. B – B – A

C.

D.

59.The major product of the following reaction will be :

A.

B.

C.

D.

16
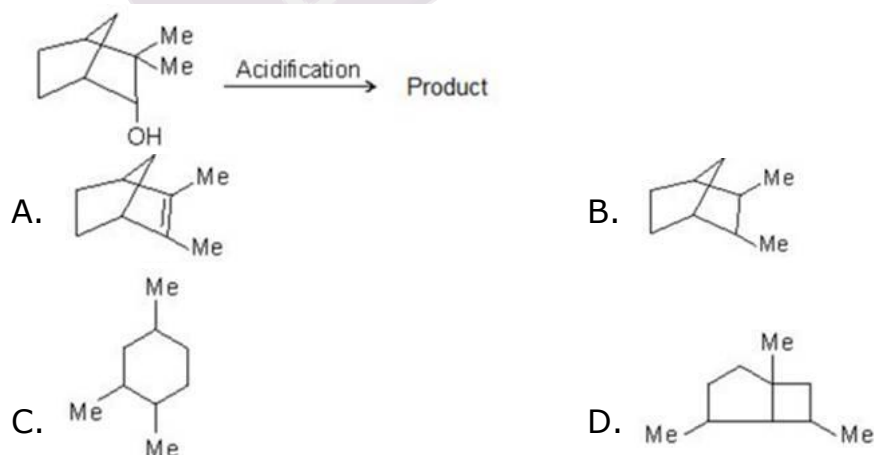
60. Calculate value of λ_{max} for the following structure.
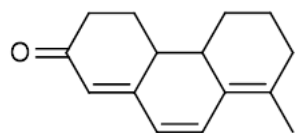
A. 369 nm
B. 351 nm
C. 309 nm
D. 321 nm

61. The final product (P) in the given reaction sequence is:
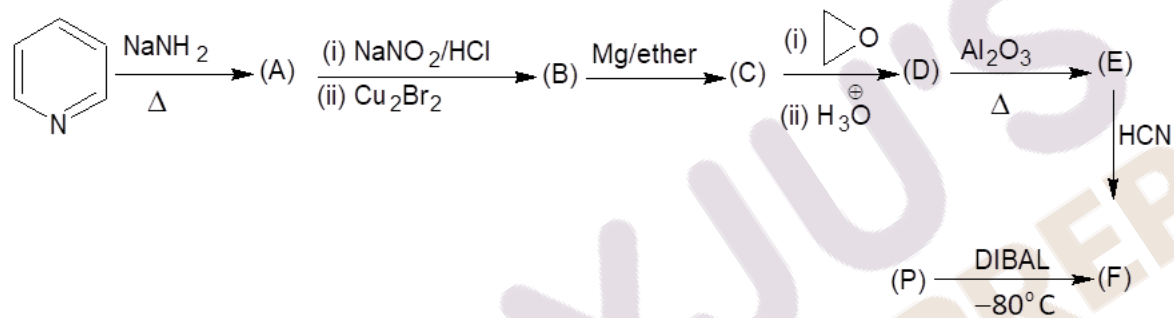
A.

B.

C.

D.

62. For the following reaction, give products P and Q:

A. P = (pyrrolidine) Q = (cyclohexene with CH₂—C=CH₂ / H substituent)

B. P = (pyrrolidine enamine) Q = (cyclohexane with Cl and CH₂—C=CH₂ / H substituents)

C. P = (pyrrolidine enamine) Q = (cyclohexanone with CH₂—C—CH₃ / H₂, O)

D. P = (pyrrolidine enamine) Q = (cyclohexanone with CH₂—C=CH₂ / H)
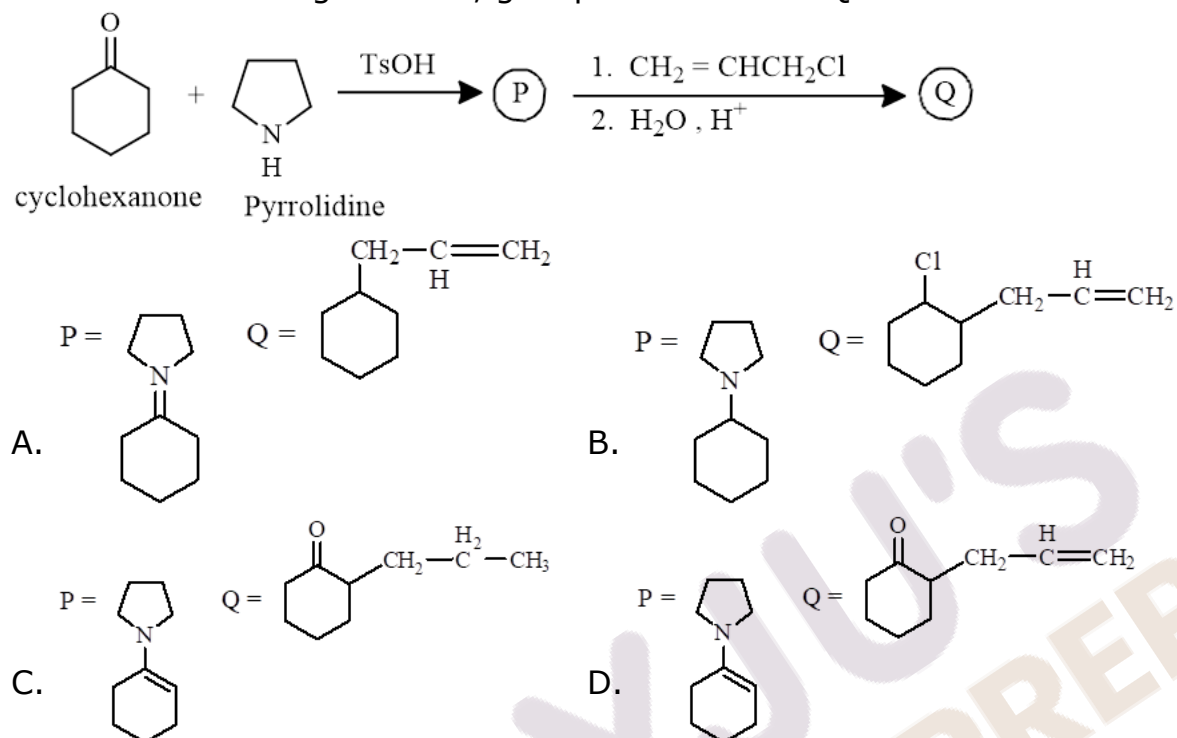
63. In the following thermal reaction, identify the product that is formed.

A.

B.

C.

D.
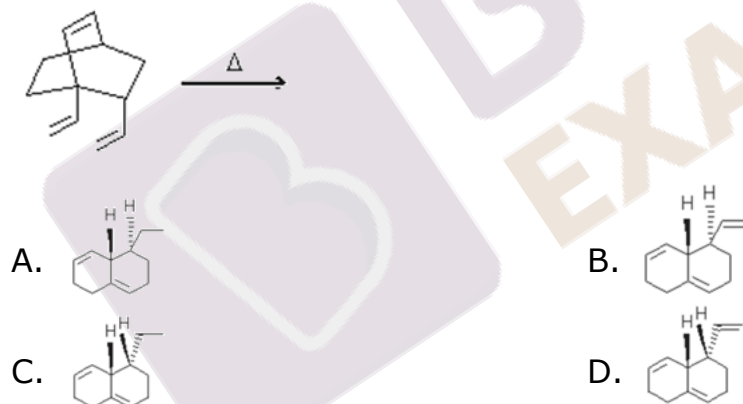
64. In the given transformation, the number of aldol reaction(s) that occur is:

A. 4

B. 1

C. 2

D. 3
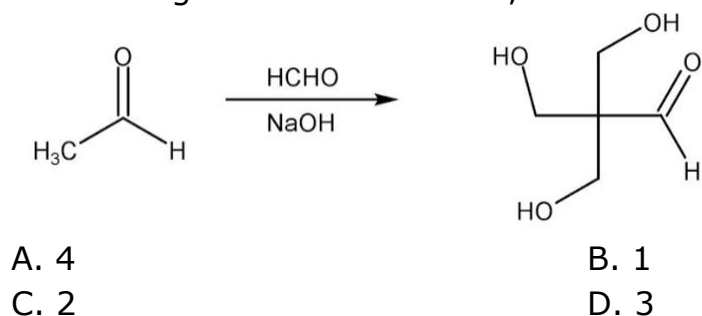
65. The product of the following reaction is:

A.

B.

C.

D.
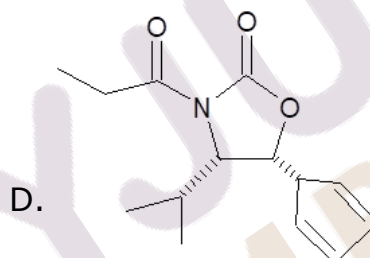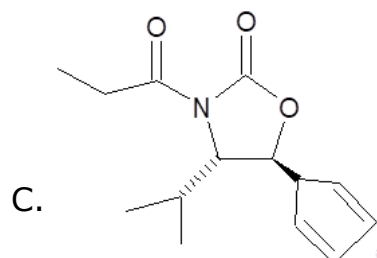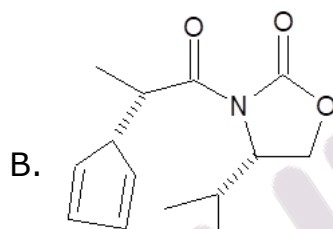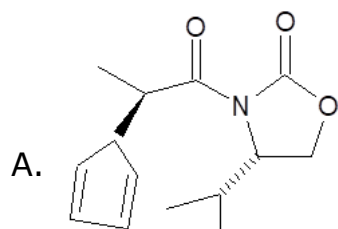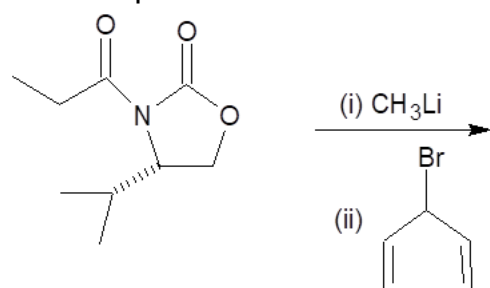
66. What is the major product in the following reaction?

A.

B.

C.

D.
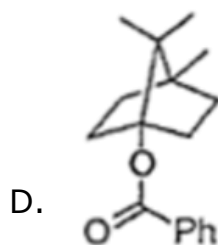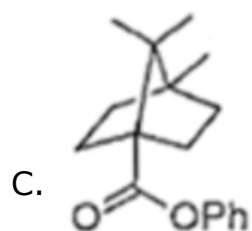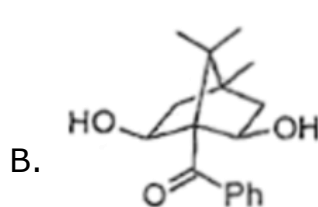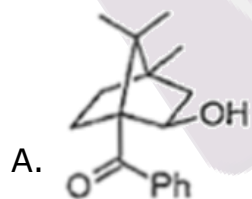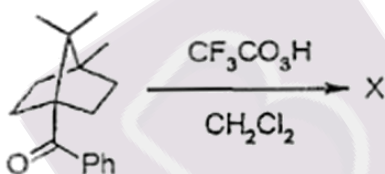
67. the geometries of the complexes $\left[Re(CH_3)_6\right]$ and $\left[Fe(CN)_6\right]^{2-}$ respectively are:
A. Tetrahedral and Trigonal Prismatic
B. Tetrahedral and octahedral
C. Octahedral and Tetrahedral
D. Trigonal Prismatic and octahedral

68. Consider the reaction:
$$P \xrightarrow{K_1} Q \xrightarrow{K_2} R$$
It is given that $[P]_0 = 1.0M$; $K_1 = 1 \times 10^{-3}s^{-1}$ and $K_2 = 1 \times 10^{-4}s^{-1}$. Find the time at which the concentrations of Q and R are 0.5966 M and 0.0355 M, respectively.
A. 520s
B. 250s
C. 1000s
D. 1200s
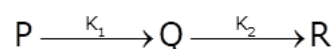
69. The number and type of symmetry of H_2O's normal modes of vibration are
A. 3 and $2A_1 + B_2$
B. 3 and $2A_1 + A_2$
C. 3 and $2A_1 + B_1$
D. 4 and $3A_1 + B_2$

70. Calculate the two roots of the secular equation of ethene are calculated using the Huckel molecular orbital approximation
A. $\alpha + \sqrt{2}\beta, \alpha - \sqrt{2}\beta$
B. $\alpha + \beta, \alpha$
C. $\alpha + \beta, \alpha - \beta$
D. $\alpha + 2\beta, \alpha - 2\beta$

71. A Chemical Reaction has a rate constant of 9.5×10^{-5} s^{-1} at 407K and 1.9×10^{-4} s^{-1} at 420K. Calculate the value of frequency factor.
A. 6.04×10^5 s^{-1}
B. 3.02×10^{-5} s^{-1}
C. 5.04×10^5 s^{-1}
D. 5.04×10^{-5} s^{-1}

72.In List-I, compounds are given and in List-II, structure/property is given. Select the correct match.

List–I	List–II
(a) $(Ph_3P)_3RhCl$	(i) Spinel
(b) LiC_6	(ii) Intercalation
(c) PtF_6	(iii) Oxidising agent
(d) Ni_3S_4	(iv) Catalyst for alkene hydrogenation

A. a–iii, b–i, c–ii, d–iv
B. a–iv, b–iii, c–ii, d–i
C. a–iii, b–ii, c–i, d–iv
D. a–iv, b–ii, c–iii, d–i

73.The probability of finding the particle between 0 to $\frac{1}{4}$ is 9%. If a particle is in its ground state and restricted to move in a 1-D box of length 0 to 1. Calculate probability of finding particle between $\frac{1}{4}$ to $\frac{51}{4}$.

A. P= 1

B. $P = -\left(1 + \frac{1}{\pi\sqrt{2}}\right)$

C. $P = \frac{1}{\pi} + \frac{1}{\pi\sqrt{2}}$

D. P = 0

74.If the overpotential of an electrolysis process is increased from 0.5 V to 0.6 V, then the ratio of current densities $\left(\ln\frac{J_{0.6}}{J_{0.5}}\right)$ of the electrolysis will be equal to (given transfer co-efficient = 0.5)

A. $0.5\frac{F}{RT}$

B. $0.05\frac{F}{RT}$

C. $0.1\frac{F}{RT}$

D. $0.01\frac{F}{RT}$

75. The following graph explains the adsorption isotherm on charcoal at 90K. Given that only 10% of charcoal sites are occupied completely by O_2 at pressure 50 torr. Find out the closest ratio of rate constant for adsorption to rate constant of desorption (in $torr^{-1}$):
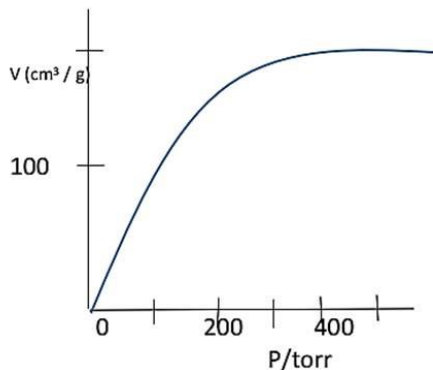
A. 0.002
B. 0.001
C. 0.004
D. 0.006

ANSWERS

1. Ans. C.
Sum of ten numbers = 72 × 10 = 720
Sum of first four number = 4 × 69 = 276
Sum of next three numbers = 3 × 74 = 222
If 9th number is x , then 8th number = (x + 6) and 10th number = (x-6)
Sum of ten numbers:
276 + 222 + x+6 + x + x − 6 = 720
3x = 222
X = 74
8th number = 74 + 6 = 80
Average of 8th and 9 th number : $\frac{74+80}{2} = 77$

2. Ans. D.
$$cosec\theta = \frac{25}{7}$$
$$cot\theta = \sqrt{(cosec^2\theta - 1)}$$
$$cot\theta = \sqrt{\frac{625}{49} - 1}$$
$$= \sqrt{\frac{576}{49}}$$
$$cot\theta = \frac{24}{7}$$

3. Ans. C.
As shown in figure:
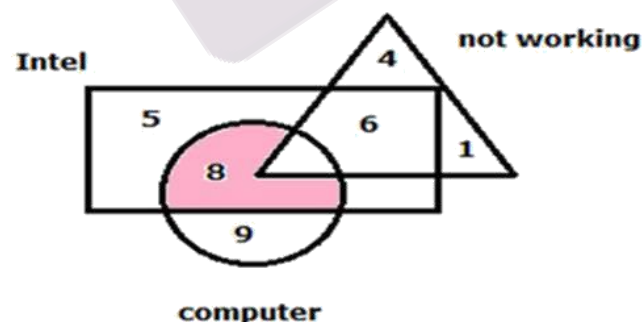
computer

Number of working Intel computers is 8.
Hence, C is the correct answer.

4. Ans. D.

Let length = 100 m and breadth = 100 m

Area of square = 100^2 = 10000 m^2

New length = 140 m, New breadth = 120 m

New area = (140×120) m^2 = 16800 m^2

Increase in area = 16800 – 10000 = 6800 m^2

Increase percentage $= \left(\dfrac{6800}{10000} \times 100 \right)\% = 68\%$

5. Ans. D.

• **Silicon is a semiconductor material which can capture solar energy and convert it into electricity.**

• It is a chemical element with the symbol 'Si' and atomic number 14.

• Photo voltaic cells are used to convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun. These are made primarily from semiconductors such as silicon, germanium, etc.

6. Ans. D.

Let the length of the train be x m.

According to the question,

Speed of the train = (x + 122)/17 = (x + 210)/25

⇒ 25x + 3050 = 17x + 3570

⇒ 25x – 17x = 3570 – 3050

⇒ 8x = 520

⇒ x = 520/8 = 65 m

∴ Speed of the train = (65 + 122)/17 = 187/17 m/sec.

= 11 m/sec.

or 11 × (18/5) = 39.6 kmph

7. Ans. D.

The series will be,

3x2 = 6

6+2 = 8

8x2 = 16

16+2 = 18

18x2 = 36

36+2 = 38

Hence, option D is the correct answer.

8. Ans. C.

Let the height of the tree after 2 years will be H cm. Then, as per question:

$$H = 81\left(1 + \frac{1}{9}\right)^2$$

H = 81 × (100/81) = 100 cm

Increase in the height = 100 – 81 = 19 cm

9. Ans. D.

$$5x + 3y + 2 = 0 \Rightarrow 3y = -5x - 2 \Rightarrow y = \frac{-5}{3}x - \frac{2}{3} \Rightarrow 3x - ky + 6 = 0$$

$$\Rightarrow ky = 3x + 6 \Rightarrow y = \frac{3}{k}x + \frac{6}{k}$$

The lines will be perpendicular to each other if

$$\frac{-5}{3} \times \frac{3}{k} = -1 \Rightarrow k = 5$$

Hence, $k = 5$

10. Ans. A.

Given here the Grey corresponds to equal proportions of Red, Green and Blue. And each color has 8 possible level.

Therefore, number of possibilities are 8 Â 8 Â 8 = 8³

Therefore, Correct option is (A)

11. Ans. B.

Total expenditure of Ram = 54000 × $\frac{360-75}{360}$ = 54000 × $\frac{285}{360}$ = 42750

Total expenditure of Mohan = 50000 × $\frac{100-25}{100}$ = 37500

Required % = $\frac{42750}{37500}$ × 100 = 114%

12. Ans. C.

Analyzing the given group of numbers –

12 (20) 16

20 ÷ 5 = 4 ⟹ 12 + 4 = 16,

21 (35) 28

35 ÷ 5 = 7 ⟹ 21 + 7 = 28,

Similarly,

48 (80) A

80 ÷ 5 = 16 ⟹ 48 + 16 = 64 =A.

Hence, option C is the correct answer.

13. Ans. A.

• If the net force on an object is doubled, **its acceleration will double.**

• The force is directly proportional to acceleration so acceleration must increase as the force increases.

• If the mass of an object is doubled, the acceleration will be halved .

• If force is constant, as mass is increased, acceleration decreases.

14. Ans. A.

```
    30 km
  ---------------Paul--->
 X ------------------------------240 km------------------------------------------ Y
 Sam ---->
 |-----------80km------------|--------------80km-------------|------------80km-------------|
```

Here, two stations are 240 km apart.

Paul and Sam travel from X to Y, but Sam starts from X when Paul is already 30 km ahead from Sam.

Both travel at a speed of 60 kmph for the first 80 km, then 45 kmph for the next 80 km, and at 30 kmph for the last 80 km.

Paul is 30 km away from X and it travels at 60 kmph. So, the time taken = 30/60 = 1/2 hr = 30 minutes

So, Sam is 30 minutes behind Paul.

Now, we have to find the distance in km, between Sam and Y when Paul reaches Y.

If Paul reaches Y, Sam will take 30 minutes to reach Y.

Distance between Sam and Y = (1/2) × 30 = 15 km

The distance between Sam and Y when Paul reaches Y is 15 km.

15. Ans. A.

Sample mean $\left(\overline{x}\right) = \dfrac{18 + 21 + 19 + 24 + 28}{5} = \dfrac{110}{5} = 22$

Point estimation of population mean = Sample mean = 22

16. Ans. C.

(i) Cr= $3d^5$ $4s^1$ i.e., $6e^-$ and each CO contributes 2 electrons. The ring contributes 5 electrons. So, Total valence electron (TVE) = 5 + 6 + (2 × 3) = $17e^-$

(ii) Cu= $3d^{10}$ $4s^1$ i.e., $11e^-$

So, TVE = 5 + 11+ 2= $18e^-$

(iii) Mn is in +1 oxidation state; Mn^{+1}= $3d^5$ $4s^1$ So, Mn contributes $6e^-$

So, TVE = 6 + (2 × 6) = $18e^-$

(iv) Co is $3d^7$ $4s^2$ = $9e^-$ and (p – C_5H_5) contributes $5e^-$

So, TVE = 9 + 5 + (2 × 2) = $18e^-$

17. Ans. B.

$\mu - \text{oxo dimer} \ (Fe^{III} - O - Fe^{III})$ known as hematein which is without globin chain so unable to transport O_2 .Here, Fe in 3+ oxidation state and HS.

18. Ans. D.

In compound (D), after deprotonation, the resultant product is aromatic in nature.
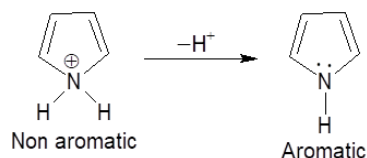
19. Ans. A.

Excitation of oxyhemerythrin with radiation within the envelope of its strong oxygen → iron chargetransfer band generates two Raman frequencies, at 844 cm^{-1} and 500 cm^{-1}. These are assigned to O-O and Fe-O stretching modes.

20. Ans. A.

NO_2^- has 2 bond pairs and 1 lone pair. According to VSEPR theory, it has an angular or bent shape.

21. Ans. A.

AS this system is undergoing (4n +2) electrocyclisation and under thermal conditions disrotatory moton will take place.
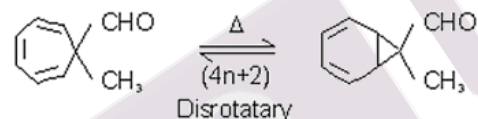
22. Ans. C.

As number of molecules are equal, so,

$N_1 = N_2$

$M_1 = 20000$

$M_2 = 200000$

$Z = \dfrac{N_1 M_1 + N_2 M_2}{N_1 + N_2}$

$Z = \dfrac{N_1 (M_1 + M_2)}{N_1 + N_2}$

$Z = \dfrac{N_1 (20000 + 200000)}{2 N_2}$

Z=N₁(20000 + 200000)/ 2N₁

$Z = \dfrac{220000}{2}$

Z = 110000

23. Ans. B.

For $[Fe_4(CO)_{12}C]^{2-}$,

Total electron count = $8 \times 4 + 12 \times 2 + 4 + 2$

= 62

Polyhedral electron count = Total electron count – nx12

= 62 - 4 × 12

= 62 - 48

= 14

$$X = \frac{\text{Polyhedral electron count}}{2}$$

$$= \frac{14}{2} = 7$$

Convert X into in term of n (n is the number of metal) = n+3

n+3 is arachano.

24. Ans. B.

(P) $[Mn(CO)_6]^+$ 2100 cm^{-1}

(Q) CO 2143 cm^{-1}

(R) $H_3B \leftarrow$ CO 2165 cm^{-1}

(S) $[V(CO)_6]^-$ 1860 cm^{-1}

V_{CO} is directly proportional to positive oxidation state on metal and is inversely related to negative oxidation state on metal. So, according to this, the correct order is:

R > Q > P > S

25. Ans. A.
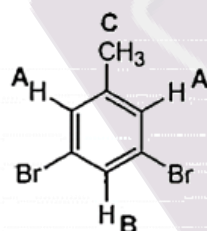
3,5-dibromotoluene

26. Ans. C.

Intermediate
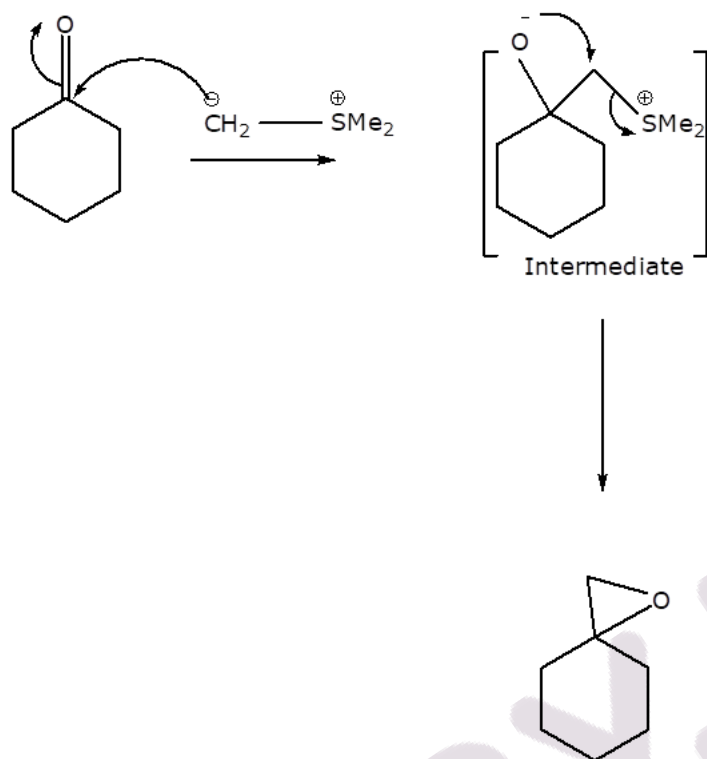
27. Ans. A.

In the given compound, an 8 C parent chain consists of a branch of the methyl group at 2,7,7 position on-chain. the functional group -OH is present at 2-position and two triple bonds at 3&5 position. So during IUPAC naming, suffix ol is used for -OH, and the suffix is- dyne for the triple bond.
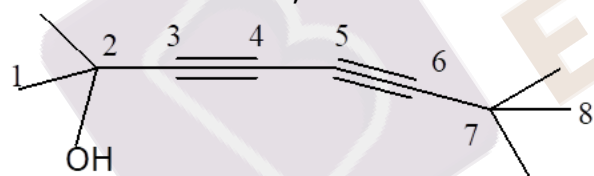
2,7,7-trimethyl-3,5-octadiyne-2-ol

28. Ans. D.

Arachidonic Acid is an unsaturated, fatty acid. It is found in the liver, brain, glandular organs of animals and humans. It has four double bonds of

Arachidonic acid.

29
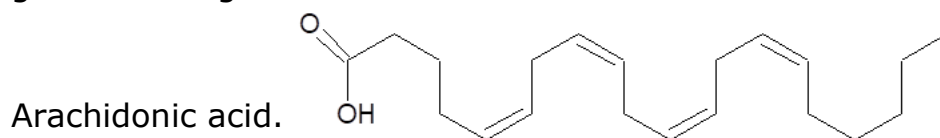
29. Ans. B.

Since we know that-

$q_t = V/\lambda^3$ where $\lambda = h/\sqrt{2\pi mKT}$

$q = V/(h^3 \times (2\pi mKT)^{3/2})$

$q = [2\pi mKT/h^2]^{3/2} V$

30. Ans. C.

It is an Anti-Markovnikov reaction in which substituent gets attached to less substituted carbon. It is a syn-addition.
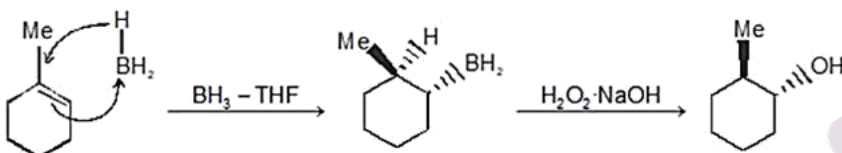
31. Ans. D.

For free electron S=1/2, L=0 and J=1/2

By using the expression,

$g = 1 + [J(J+1) + S(S+1) - L(L+1)]/[2J(J+1)]$

$= 1 + [(3/4) + (3/4) - 0]/(3/2)$

$= 1 + 1 = 2$

32. Ans. D.

Order of ionization energy according to nuclear charge should be:

S>P>Al>Mg But there are some exceptions.

The configuration of P is:

P: $[Ne]3s^2 3p^3$

An electron is removed from half-filled p orbital, therefore, requires highest energy. So, P>S

Similarly, configuration of Mg is:

Mg=$[Ne] 3s^2$

An electron in Mg is removed from full filled 3s orbital, while in Al, electron is removed from 3p orbital so, Mg>Al.

Hence, actual order is:

P>S>Mg>Al
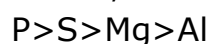
33. Ans. A.

According to the HSAB principle, soft acid prefers to bind with a soft base, and hard acid prefers to bind with a hard base. $[SCN]^-$ is an ambidentate ligand. It coordinates through S-atom to form complex $[Pd (SCN)_4]^{-2}$ because Pd^{2+} is a soft acid that prefers to bind with soft S atom. Whereas with Co^{2+}, a hard acid prefers to bind with hard N-atom to form complex $[Co (NCS)_4]^{-2}$.

34. Ans. B.

The energy of 1-D SHO is given by $(n_x+1/2)hv$

For 2-D SHO the energy will be $(n_x+ n_y +1)hv$

For 3-D SHO the energy will be $(n_x+ n_y +n_z+3/2)hv$

35. Ans. C.

This Bond donot take part in conjugation

therefore

$4n+2=14$ $(7\times 2e^-)$

$4n=12$

$\boxed{n=3}$
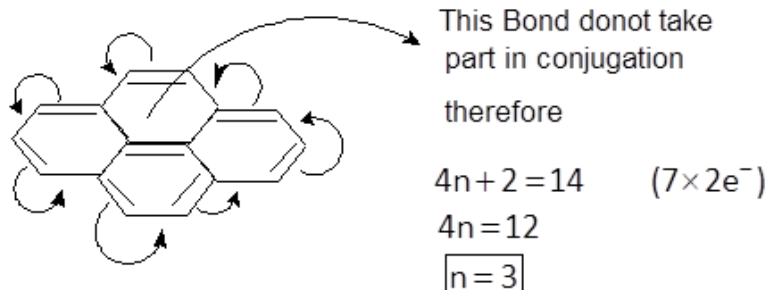
Bond in middle of ring is not included in delocalization. Since no. of double bond are 7 so, no. of electron involved in delocalization are 14. By calculation given above, Huckel no is 3. This no. is always a whole number.

36. Ans. B.
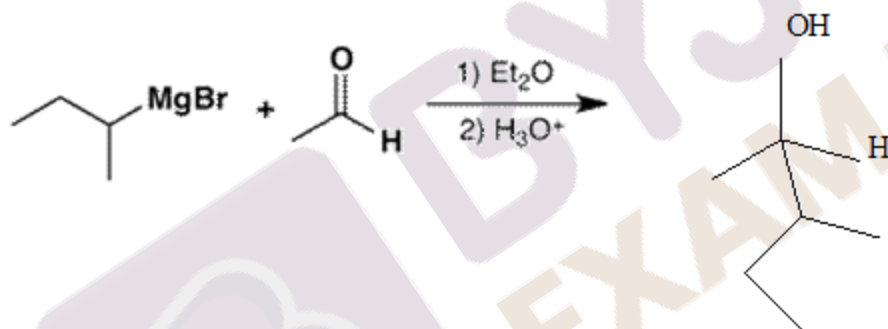
37. Ans. A.
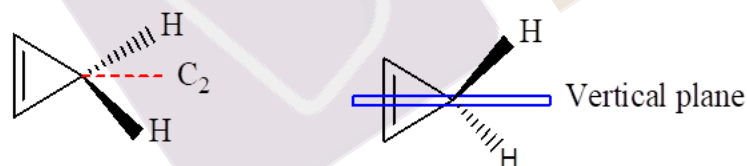
One C_2 , two $\sigma`_v$ (two vertical planes passing through it), and E symmetry elements are present in this structure. So, its point group is C_{2v}.

38. Ans. B.

The residual entropy is given by S= NklnW

Here,

W= Number of orientations=4

N= Number of Particles

For 1 mole,

$N=N_A$

$N_A k$ = R=gas constant= 8.314 $JK^{-1}mol^{-1}$

31

S=Rln4

S=8.314 JK^{-1} mol^{-1} x 2.303 log4

S=8.314 JK^{-1} mol^{-1} x 2.303 x 0.602

S=11.526 JK^{-1} mol^{-1}

39. Ans. B.

As the size of central metal ion increases, trend in LMCT energies will also increase. The order of size is:

V^{+5} > Cr^{+6} > Mn^{+7}

And, order of LMCT energies is:

$MnO_4^- < CrO_4^{-2} < VO_4^{-3}$

40. Ans. A.

$$KCl(s) \xrightarrow{H_2O} K^+(aq) + Cl^-(aq) \Delta H° = 16.33kJ$$

$\Delta H_f^o, KJ$ -435.75 $\Delta H_f^o [K^+(aq)]$ −167.16
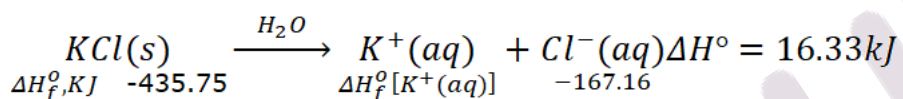
According to given data

$$16.33 = \Delta H_f^o[K^+(aq)] - 167.16 - (-435.75)$$

On solving this equation-

$\Delta H_f^o[K^+(aq)]$=-252.26 kJ

41. Ans. B.

It belongs to point group C$_{2h}$.

It has i centre of inversion, C$_2$ axis, E identity operation and a sigma horizontal plane.

42. Ans. D.

The reaction can be represented as:
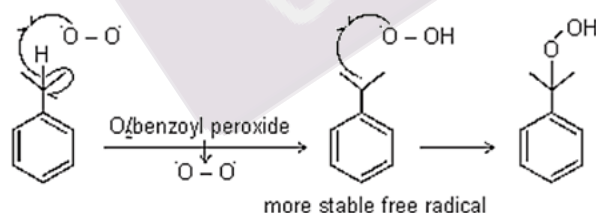
43. Ans. D.

Temperature is directly related with kinetic energy. The rate of chemical reaction increases with increase in temperature as this results in increase in kinetic energy. Also, kinetic energy increase for both exothermic and endothermic reaction.

44. Ans. A.

This question is based on the concept of Fajan rule. Smaller the size of cation, the larger the size of the anion, greater is the covalent character of the ionic bond.

Here, the anion is same in all case while cations are different.

So, the correct order of ionic character is:

$BaCl_2 > CaCl_2 > MgCl_2 > BeCl_2$

45. Ans. B.

Number of molecule reacted in 20 minutes = $1 \times 6.023 \times 10^{23}$
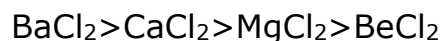
Number of quanta absorbed in 20 minutes = $2.0 \times 10^{20} \times 20 \times 60$

= 24×10^{22}

Quantum efficiency $= \dfrac{6.023 \times 10^{23}}{24 \times 10^{22}} = 2.5$

46. Ans. B.

Energy of cubic box $= \dfrac{(n_x^2 + n_y^2 + n_z^2)h^2}{8ml^2}$

For the lowest energy of cubic box,

$n_x = 1$, $n_y = 1$, $n_z = 1$

For the lowest energy of cubic, box become $= \dfrac{3h^2}{8ml^2}$

Three times energy from the lowest energy $= 3 \times \dfrac{3h^2}{8ml^2} = \dfrac{9h^2}{8ml^2}$

So, $n_x^2 + n_y^2 + n_z^2 = 9$

The possible arrangement of n_x, n_y, n_z that can have the value 9 is:

(2,2,1),(2,1,2),(1,2,2).

Therefore, its degeneracy is 3.

47. Ans. B.

Effective atomic number of metal atom = electron donated/received by metal atom + electron donated by chlorine ligand + electron donated by C_2H_4 ligand.

Electron donated/received by metal atom = 78-2 (Pt^{2+})=76

one Cl^- ligand donates 2 electrons.

Electron donated by Cl^- ligands = 3x2=6

Electron donated by C_2H_4 =2

EAN of metal in $[PtCl_3(C_2H_4)]^-$ =76+6+2=84

48. Ans. D.

Coordination number of "C" in Be_2C_3 is 8.

Structure	Cation	Anion
CaF_2	Ca^{+2} (divalent); CN = 8	F^- (Monovalent); CN = 4
Be_2C_3	Be^+ (monovalent) CN = 4	C_3^{-2} (Divalent); CN = 8

49. Ans. C.
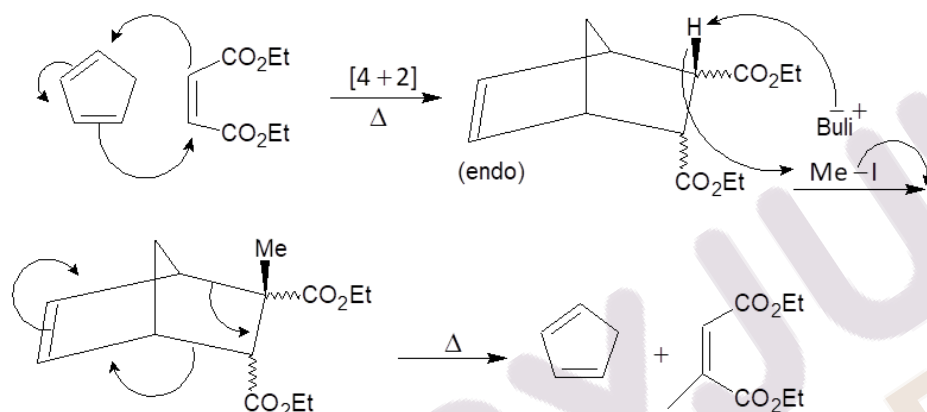
50. Ans. B.

The reaction conversion can be represented as:
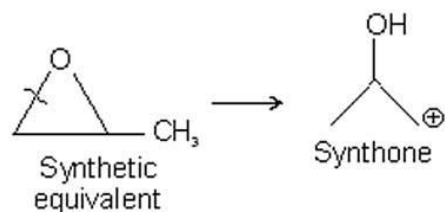
51. Ans. C.

$[Al(C_2O_4)_3]^{3-} = d^0$; $[V(H_2O)_6]^{2+} = d^3$; $[Cr(C_2O_4)_3]^{3-} = d^3$

Inert complexes undergo slow substitution and labile complexes undergo rapid substitution

Weak field octahedral complexes having $d^3 < d^8$ configurations are inert while rest are labile. Hence, Al complex is labile while those of V and Cr are inert

52. Ans. D.

Non-metallic character is directly proportional to the acidic strength.

Non-metallic character increases as follows:

Ca < Pb < S < Cl

Thus the order of acidic strength will also be the same i,e. $CaO < PbO_2 < SO_3 < Cl_2O_7$.

53. Ans. A.

$[Re_2Cl_4(PMe_2Ph)]^+$

Let the oxidation state of 'Re' atom is x

$2x - 4 = +1 \Rightarrow 2x = 5$

$Re^{+2} = 4d^5 \quad Re^{3+} = 4d^4$

Thus, the number of d electron on Re^{+2} and Re^{+3} ions

$= 5 + 4 = 9$

And the Electronic configuration in cluster ion will be

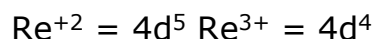$\sigma^2 \pi^4 \delta^2 \delta^{*1}$
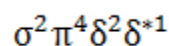
B.O $= \dfrac{1}{2}(8 - 1) = 3.5$

Now, for $[Re_2Cl_4(PMe_2Ph)_4]$

Oxidation state:

$2x - 4 = 0 \Rightarrow 2x = +4 \Rightarrow x = +2$

$Re^{+2} = 4d^5 \quad Re^{+2} = 4d^5$
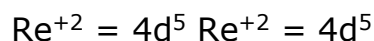
Number of d electrons $= 5 + 5 = 10$

Electronic configuration $= \sigma^2 \pi^4 \delta^2 \delta^{*2} \; ; \; \dfrac{1}{2}(8 - 2) = 3$

54. Ans. A.

$CuFeS_2 + 4O_2 \xrightarrow{\Delta} CuSO_4 + FeSO_4(s)$

A. $CuSO_4 + 4KI \rightarrow Cu_2I_2 + I_2 + 2K_2SO_4$

B. $2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$

C. $CuSO_4 \; 2NaOH \rightarrow Na_2SO_4 + Cu(OH)_2\downarrow$ (in soluble in excess NaOH)

D. $Fe^{2+} + 2K_3[Fe(CN)_6] \rightarrow Fe_3[Fe(CN)_6]_2$

(deep blue)
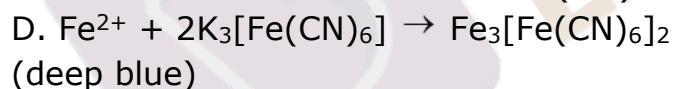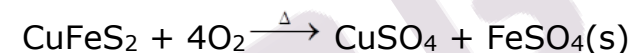
55. Ans. D.

As the body do not store zinc therefore, daily intake of zinc is required to maintain zinc levels in body. If high dose of $ZnSO_4$ is consumed then the sulphate ions present reduces calcium, iron and copper and form their respective sulphate salts. That's why high dose of zinc is not recommended.

56. Ans. A.

The reaction can be represented as:

$$Ce_2(C_2O_4)_3 + 2O_2 \longrightarrow 2CeO_2 + 6CO_2$$
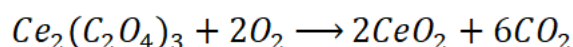
CeO_2 is white in its pure state. It has a fluorite type structure. It is insoluble in acids and alkalies.

57. Ans. D.

In f block complexes, electron in f subshell not screening the nuclear charge effectively hence there is no interaction of these electron with surrounding ligands thus there is no effect of ligands changing. Thus complexes with same f electron appear to be same in color. Hence color is characteristics of metal cation.

The absorption bands of f -block elements are sharp line like peak due to weak metal - ligand interaction.

58. Ans. A.

The molecule's structure is similar to CO_2 or $CS_2(B – A – B)$ (According to Rule of mutual exclusion).

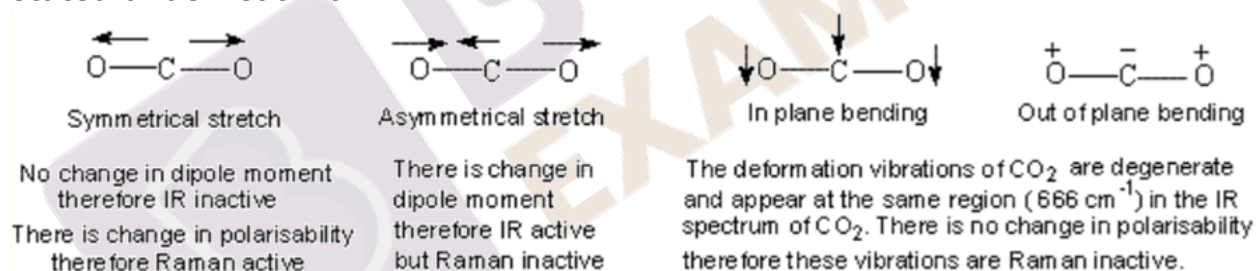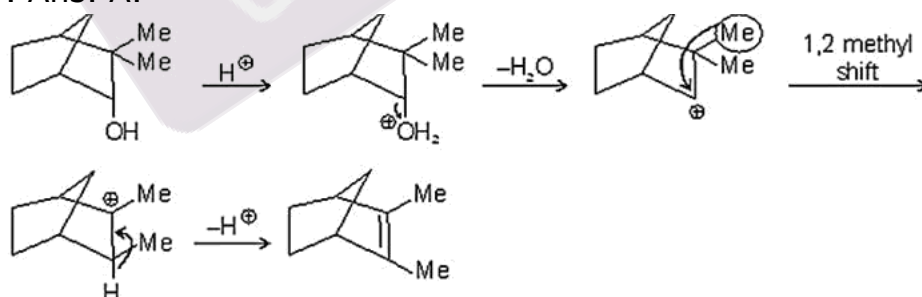Principle of Mutual Exclusion: It has been discovered that vibrational modes that are raman active are infrared inactive and infrared active modes are raman inactive in a molecule with a centre of symmetry.

None of the regular modes of vibration in molecules with an inversion centre will be simultaneously Raman and IR active. This is referred to as the "mutual exclusion principle." CO2 is a simple molecule that follows this rule. Carbondioxide has a symmetry centre or inversion centre. Its regular vibration modes are as follows. Each type of vibration has an IR and Raman active mode stated underneath it.

| Symmetrical stretch	Asymmetrical stretch	In plane bending	Out of plane bending
No change in dipole moment therefore IR inactive. There is change in polarisability therefore Raman active	There is change in dipole moment therefore IR active but Raman inactive	The deformation vibrations of CO_2 are degenerate and appear at the same region (666 cm^{-1}) in the IR spectrum of CO_2. There is no change in polarisability therefore these vibrations are Raman inactive.	

59. Ans. A.

The lone pair on oxygen takes up the proton.water molecules leaves forming a carbocation.1,2 methyl shift takes place to form a stable carbocation.In the last step, deprotonation takes place to form double bond .

60. Ans. B.
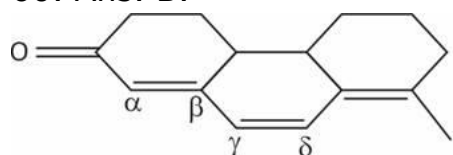
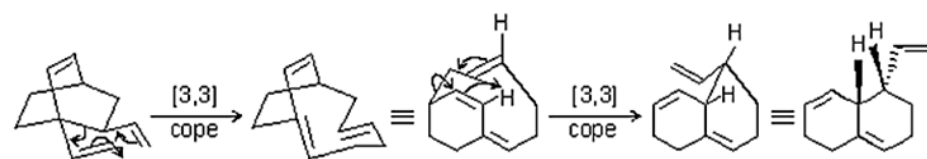|	
Basic Value	= 215 nm
1 β ring residue	
(δ + 1) ring residue	= 18 nm
2(δ + 2) ring residue	= 36 nm
2 double bond extending conjugation 30 × 2	= 60 nm
2 exocyclic double bond	= 10 nm
λ_{max}	$\overline{351}$ nm

61. Ans. B.
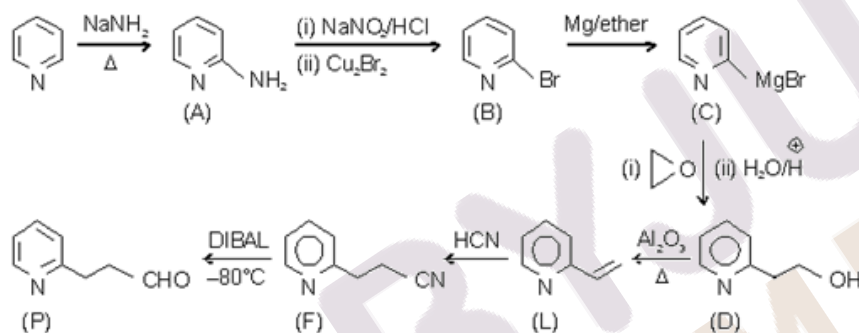
62. Ans. D.
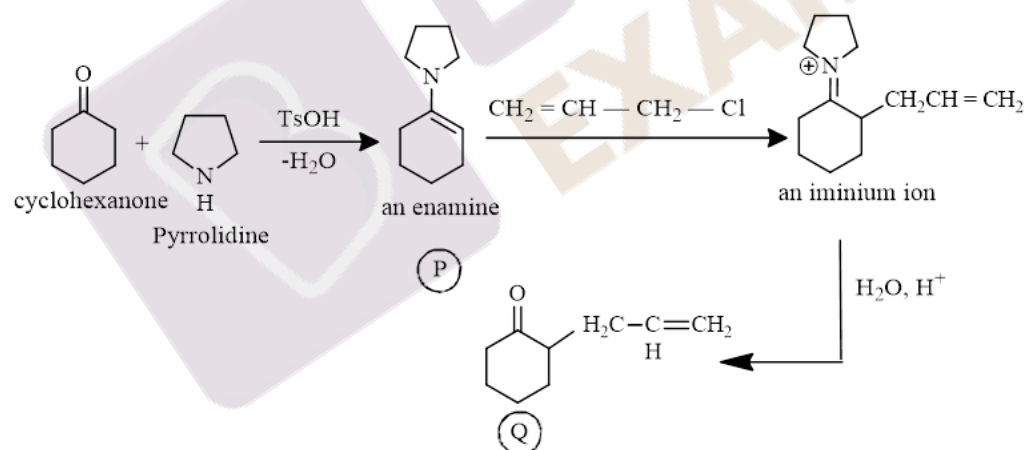
63. Ans. D.

This conversion takes place through two sequential [3, 3] cope rearrangements.

64. Ans. D.

Because acetaldehyde has three α-hydrogens, it undergoes crossover aldol reactions with three moles of formaldehyde, resulting in three aldol reactions.
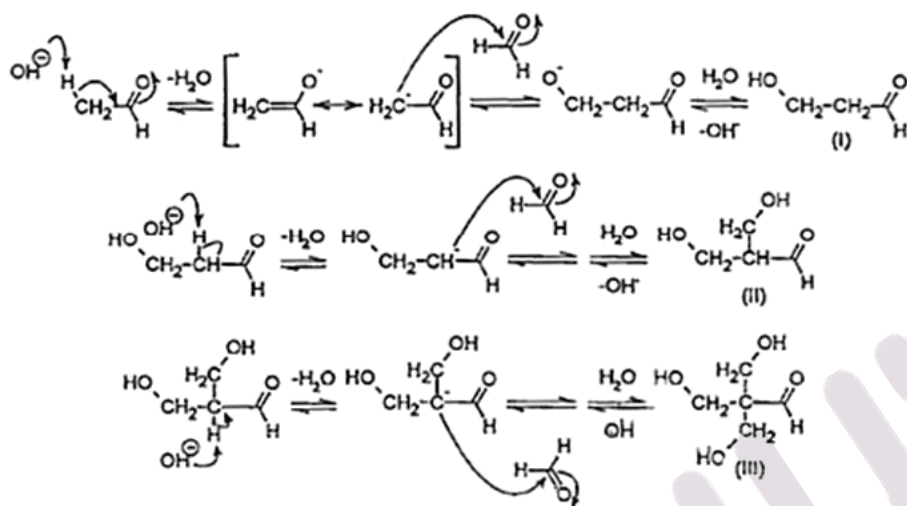
65. Ans. A.

Chiral auxiliary are the groups that control the stereo chemistry of the product. Evans type auxiliaries: The molecules having one group below the plane so that it can direct the incoming group above the plane is an example of Evans type chiral auxiliaries. Draw the structure of example of chiral auxiliary.
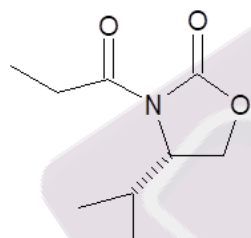
In the first step of the given reaction, methyllithium is a strong base thus abstract the acidic hydrogen of the molecule as shown:
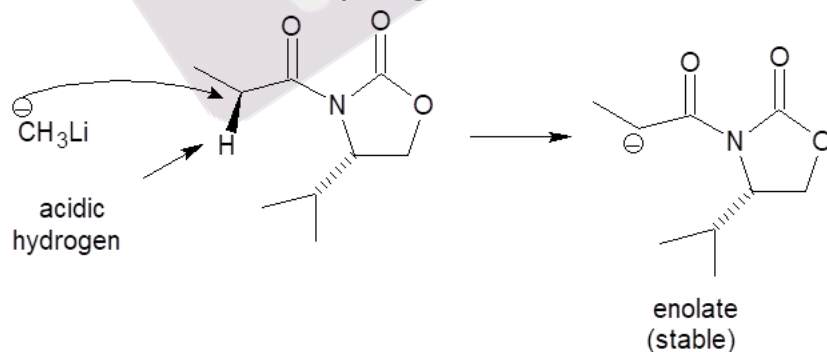
This hydrogen is abstracted because it leads to a stable intermediate enolate.

Now in second step, the nucleophilic substitution occurs with the stereochemistry of new group above the plane because a bulky group is already present below the plane.

66. Ans. D.

Baeyer-Villiger oxidation is the oxidation of a ketone to a carboxylic acid ester using a peroxyacid as the oxidizing agent.It involves migration of 3^0 bridge head carbon since it has more migratory aptitude over phenyl ring.
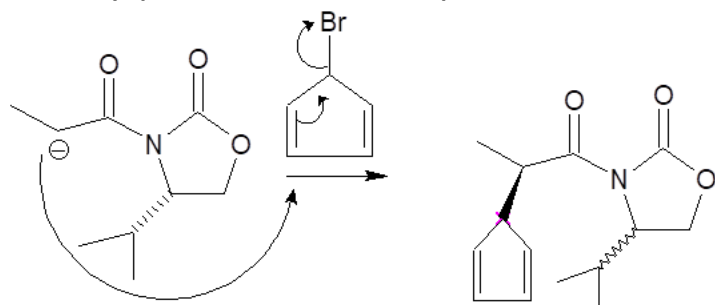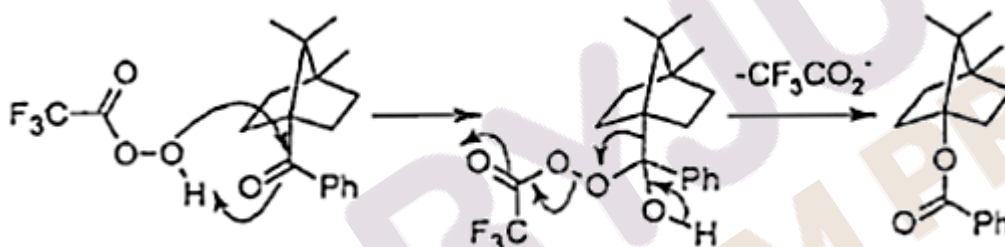

67. Ans. D.

$\left[\text{Re}(\text{CH}_3)_6\right]$ and $\left[\text{Fe}(\text{CN})_6\right]^{2-}$ both the complexes are of coordination number 6 but complex with transition metal with configuration of d^0 or d^1 with bulky organic ligand forms complex of trigonal prismatic geometry.

So, $\left[\text{Re}(\text{CH}_3)_6\right]$ complex has trigonal prismatic geometry whereas $\left[\text{Fe}(\text{CN})_6\right]^{2-}$ has common geometry of complexes with coordination number 6, i.e., octahedral geometry.

68. Ans. C.

The given reaction is:

$$P \xrightarrow{K_1} Q \xrightarrow{K_2} R$$
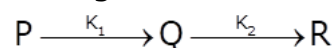
At time t, it can be written as:

$[P]_0 = [P] + [R] + [Q]$

Substitute the given values in above equation:

$1 = [P] + 0.0355 + 0.5966$

$[P] = 0.3679$

As it is first order kinetics, so,

$\ln \dfrac{[P]_0}{[P]} = Kt$

$\ln \left(\dfrac{1}{0.3679} \right) = K_1 t;$

$t = 0.9969 \times 10^3;$

$t = 996.9$ sec ≈ 1000 sec.

69. Ans. C.

For H_2O molecule, non-linear = $(3N - 6) = (3 \times 3 - 6) = 3$ [Normal mode of vibration]

Total number in $H_2O = 3A_1 + 1A_2 + 3B_1 + 2B_2$

Total rotation = $A_2 + B_1 + B_2$ and total translation = $A_1 + B_1 + B_2$

Total number of vibrational = $(3A_1 + A_2 + 3B_1 + 2B_2) - (A_2 + B_1 + B_2 + A_1 + B_1 + B_2) = 2A_1 + B_1$.

70. Ans. C.

Huckel Secular equation for ethane is

$\begin{vmatrix} x & 1 \\ 1 & x \end{vmatrix} = 0$

Where $x = \dfrac{\alpha - E}{\beta}$

$\therefore x^2 - 1 = 0$

$\therefore x^2 = 1$

$\therefore x = \pm 1$

$\therefore \dfrac{\alpha - E}{\beta} = +1$

$\therefore \alpha - E = \beta$

$\therefore E = \alpha - \beta$

$\therefore \dfrac{\alpha - E}{\beta} = -1$

$\therefore \alpha - E = -\beta$

$\therefore E = \alpha + \beta$

$\therefore$ Two roots are $\alpha + \beta$ and $\alpha - \beta$.

71. Ans. C.

According to Arrhenius equation

$\log \dfrac{K_2}{K_1} = \dfrac{E_a}{2.303 \times R} \left[\dfrac{T_2 - T_1}{T_1 T_2} \right]$

Where, E_a = Activation energy

K is the rate constant

T is the time required

$$\log\frac{1.9\times10^{-4}}{9.5\times10^{-5}} = \frac{E_a}{2.303\times8.314}\left[\frac{420-407}{407\times420}\right] \Rightarrow E_a = 75782.3 \text{ J mol}^{-1}$$

Now, $\log K_1 = \log A - \dfrac{E_a}{2.303RT_1}$

or $\log 9.5\times10^{-5} = \log A - \dfrac{75782.3}{2.303\times8.314\times407}$

or $\log\dfrac{A}{9.5\times10^{-5}} = \dfrac{75782.3}{2.303\times8.314\times407} = 9.72$

$A = 5.04 \times 10^5 \text{ s}^{-1}$

72. Ans. D.

(a) $(Ph_3P)_3Rh\ Cl$- It is known as Wilkinson's catalyst and is used to carry out hydrogenation of alkenes.

(b) LiC_6- Intercalation means addition of Li ions into a host material in which no changes in structure of host takes place.

(c) PtF_6- It acts as a strong oxidizing agent and can oxidize Xe and O_2.

So, the correct option is D only.

73. Ans. A.

$x = \dfrac{L}{4}$ to $\dfrac{5L}{4}$

$$P = \int_{\frac{L}{4}}^{5\frac{L}{4}} \sqrt{\frac{2}{L}}\sin\frac{\pi x}{L}\sqrt{\frac{2}{L}}\sin\frac{n\pi}{L}.dx$$

$$P = \frac{2}{L}\int_{\frac{L}{4}}^{5\frac{L}{4}} \sin^2\left(\frac{\pi x}{L}\right)dx$$

$$P = \frac{2}{L}\left[\left[\frac{x}{2}\right]_{\frac{L}{4}}^{5\frac{L}{4}} - \frac{1}{4\pi}\left(\sin\frac{2\pi x}{L}\right)_{\frac{L}{4}}^{5\frac{L}{4}}\right]$$

$$P = \frac{2}{L}\left[\left(\frac{5L}{8}-\frac{L}{8}\right) - \frac{1}{4\pi}\left(\sin\frac{2\pi}{L}\left(\frac{5L}{4}\right) - \sin\frac{2\pi}{L}\left(\frac{L}{4}\right)\right)\right]$$

$$P = \frac{2}{L}\left[\frac{4L}{8} - \frac{1}{4\pi}\left(\sin\frac{5\pi}{2} - \sin\frac{\pi}{2}\right)\right]$$

$$P = \frac{2}{L}\left[\frac{L}{2} - \frac{1}{4\pi}\left(\sin\left(2\pi + \frac{\pi}{2}\right) - 1\right)\right]$$

$$P = \frac{2}{L}\left[\frac{L}{2} - \frac{1}{4\pi}(1-1)\right]$$

$$P = \frac{2}{L}\left(\frac{L}{2} - 0\right)$$

$$P = 1$$

74. Ans. B.

Tafel equation is given by

In $J = J_0 + (1-\alpha)\eta F / RT$

Here, J = current density

J_0 = exchange current density

α = charge transfer coefficient

Now, according to given data,

$\alpha = 0.5$

$\eta_1 = 0.6$

$\eta_2 = 0.5$

In $J_{0.6} = J_0 + (1 - 0.5)0.6 \, F/RT$ …(1)

In $J_{0.5} = J_0 + (1 - 0.5) \, 0.5 \, F/RT$ …(2)

From eq. (1) and (2)

$$\frac{\ln J_{0.6}}{\ln J_{0.5}} = \frac{(1-0.5)F}{RT}(0.6-0.5)$$

= (0.5 × 0.1) F/RT

= 0.05 F/RT

75. Ans. A.

We have to find $\dfrac{K_a}{K_d}$ = K = ?

According to Langmuir Adsorption Isotherm, $q = \dfrac{KP}{1 + KP}$

Here, q = 10/100 = 0.1 and P = 50 torr

So, $q = \dfrac{KP}{1 + KP}$

$0.1 = \dfrac{K \times 50}{1 + K \times 50}$

$0.1 + 5K = 50K$

$0.1 = 50K - 5K$

$0.1 = 45K$

$K = \dfrac{0.1}{45} = 0.0022$

So, K = 0.0022

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