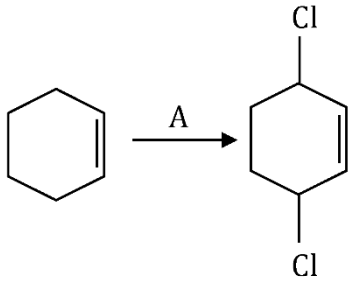
JEE MAIN 16th March Shift-2 2021 (Chemistry)

Section A

1.

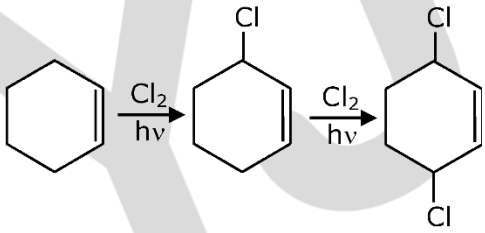


Identify the reagent(s) 'A' and condition(s) for the reaction:

a. A = HCl; Anhydrous $AlCl_3$
b. A = HCl, $ZnCl_2$
c. A = Cl_2, dark, Anhydrous $AlCl_3$
d. A = Cl_2; UV Light

Ans: (d)

Solution:



2. The INCORRECT statement regarding the structure of C_{60} is:

a. It contains 12 six-membered rings and 24 five-membered rings.
b. Each carbon atom forms three sigma bonds.
c. The five-membered rings are fused only to six-membered rings.
d. The six-membered rings are fused to both six and five-membered rings.

Ans: (a)

Solution:

It contains 12 five membered ring & 20 six membered rings.

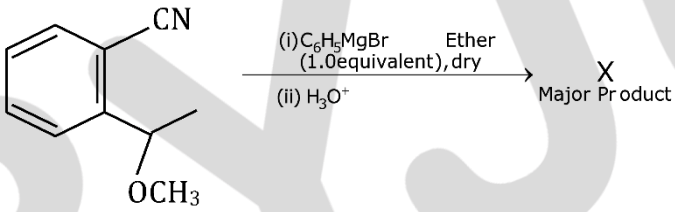
3. Match List-I with List-II:

List-I **Test/Reagents/Observation(s)**		**List-II** **Species detected**
(a) Lassaigne's Test	(i)	Carbon
(b) Cu(II) oxide	(ii)	Sulphur
(c) Silver nitrate	(iii)	N, S, P and halogen
(d) The sodium fusion extract gives black precipitate with acetic acid & lead acetate	(iv)	Halogen Specifically

a. (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
b. (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)
c. (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)
d. (a)-(i), (b)-(ii), (c)-(iv), (d)-(iii)

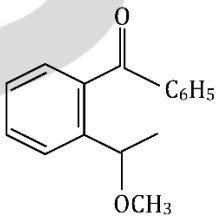
Ans: (a)
Solution:
(a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

4.

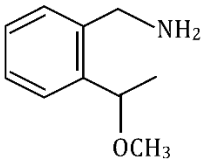


The structure of X is:

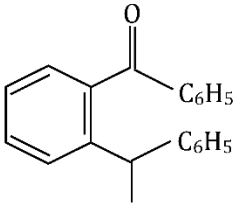
a.



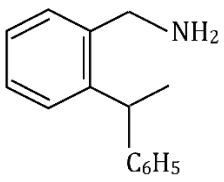
b.



c.

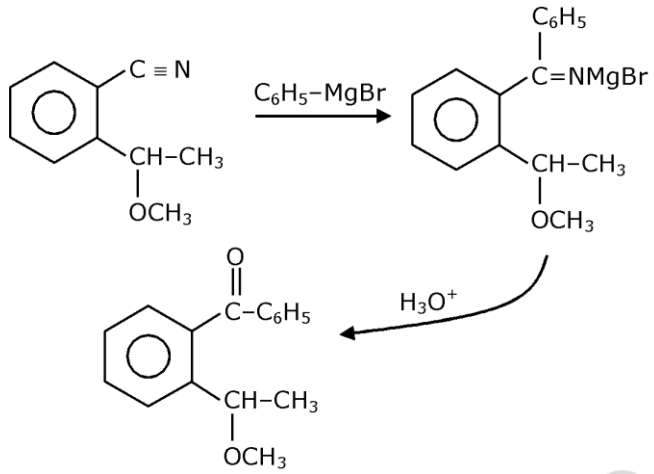


d.



Ans: (a)

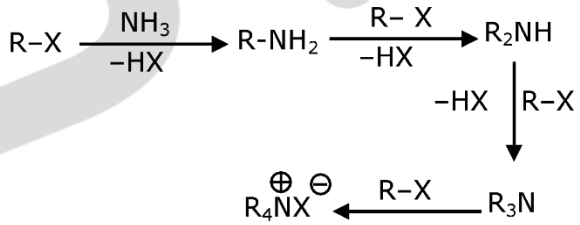
Solution:



5. Ammonolysis of alkyl halides followed by the treatment with NaOH solution can be used to prepare primary, secondary and tertiary amines. The purpose of NaOH in the reaction is:
   a. to remove basic impurities
   b. to activate NH_3 used in the reaction
   c. to increase the reactivity of alkyl halide
   d. to remove acidic impurities

Ans: (d)

Solution:



During the reaction HX (acid) is form.
Hence, we use NaOH to remove these acidic impurities.

6. Arrange the following metal complex/compounds in the increasing order of spin only magnetic moment. Presume all the three, high spin system.
(Atomic numbers Ce = 58, Gd = 64 and Eu = 63)
(1) $(NH_4)_2[Ce(NO_3)_6]$ (2) $Gd(NO_3)_3$ and (3) $Eu(NO_3)_3$
a. (1) < (3) < (2)
b. (1) < (2) < (3)
c. (3) < (1) < (2)
d. (2) < (1) < (3)

Ans: (a)
Solution:
$(NH_4)_2[Ce(NO_3)_6]$ $(n = 0) \Rightarrow \mu = 0$ B.M
$Eu(NO_3)_3$ $(n = 6) \Rightarrow \mu = 6.93$ B.M
$Gd(NO_3)_3$ $(n = 7) \Rightarrow \mu = 7.94$ B.M

7. Identify the elements X and Y using the ionisation energy values given below:
Ionization energy (kJ/mol)

	1st	2nd
X	495	4563
Y	731	1450

a. X = F; Y = Mg
b. X = Mg; Y = F
c. X = Na; Y = Mg
d. X = Mg; Y = Na

Ans: (c)
Solution:
2nd I. E of Alkali metals very high as compared to 1st.

8. The INCORRECT statements below regarding colloidal solutions is:
a. A colloidal solution shows colligative properties.
b. An ordinary filter paper can stop the flow of colloidal particles.
c. A colloidal solution shows Brownian motion of colloidal particles.
d. The flocculating power of Al^{3+} is more than that of Na^{+}.

Ans: (b)
Solution:
Colloidal solutions can pass through ordinary filter paper but cannot pass through special filter colloidal solution coated paper.

9. The characteristics of elements X, Y and Z with atomic numbers, respectively, 33, 53 and 83 are:
   a. X and Z are non-metals and Y is a metalloid.
   b. X and Y are metalloids and Z is a metal
   c. X, Y and Z are metals.
   d. X is a metalloid, Y is a non-metal and Z is a metal.

Ans: (d)
Solution

Atomic No.		Element
(1) 33	⟶	As (Metalloid)
(2) 53	⟶	I (Non-metal)
(3) 83	⟶	Bi (Metal)

10. The exact volumes of 1 M NaOH solution required to neutralise 50 mL of 1 M H_3PO_3 solution and 100 mL of 2 M H_3PO_2 solution, respectively, are:
   a. 100 mL and 50 mL
   b. 50 mL and 50 mL
   c. 100 mL and 100 mL
   d. 100 mL and 200 mL

Ans: (d)
Solution:

(1) $2NaOH + H_3PO_3 \longrightarrow Na_2HPO_3 + 2H_2O$
100mmole 50mmole
$100mmole = M \times V_{ml}$
$100mmole = 1 \times V_{ml}$
$V_{ml} = 100\ ml$

(2) $NaOH + H_3PO_2 \longrightarrow NaH_2PO_2 + H_2O$
200mmole 200mmole
$200mmole = M \times V_{ml}$
$200\ mmole = 1 \times V_{ml}$
$V_{ml} = 200\ ml$

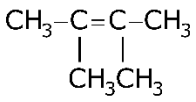
11. Which of the following reduction reaction CANNOT be carried out with coke?
   a. $Fe_2O_3 \longrightarrow Fe$
   b. $ZnO \longrightarrow Zn$
   c. $Al_2O_3 \longrightarrow Al$
   d. $Cu_2O \longrightarrow Cu$

Ans: (c)

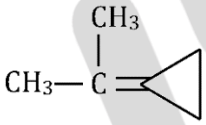
Solution:
Al is extracted by electrolytic reduction of Al_2O_3.

12. An unsaturated hydrocarbon X on ozonolysis gives A. Compound A when warmed with ammoniacal silver nitrate forms a bright silver mirror along the sides of the test tube. The unsaturated hydrocarbon X is:

a. $CH_3–C\equiv C–CH_3$

b. 

c. $HC\equiv C–CH_2–CH_3$

d. 

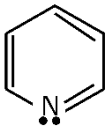
Ans: (c)
Solution:

$$CH_3CH_2{\equiv}CH \xrightarrow[(ii)\ H_2O]{(i)\ O_3} CH_3CH_2COOH + \underset{\underset{O}{\|}}{H–C–OH}$$

$$HCOOH \xrightarrow[\text{Tollen's reagent}]{[Ag(NH_3)_2]^+} CO_2\uparrow + H_2O + 2Ag\downarrow$$

13. **Statement-I:** Sodium hydride can be used as an oxidising agent.
Statement-II: The lone pair of electrons on nitrogen in pyridine makes it basic.
Choose the CORRECT answer from the options given below:
a. Statement I is true but statement II is false
b. Both statement I and statement II are false
c. Both statement I and statement II are true
d. Statement I is false but statement II is true

Ans: (d)
Solution:
⇒ NaH is used as reducing agent.
⇒ The l.p. on nitrogen in pyridine makes it basic.



14. Which of the following polymer is used in the manufacture of wood laminates?

a. Melamine formaldehyde resin
b. *cis*-poly isoprene
c. Phenol and formaldehyde resin
d. Urea formaldehyde resin

Ans: (a)

Solution:

Melamine formaldehyde resin is used in the manufacture of wood laminates.

15. The correct statements about H_2O_2 are:

(1) used in the treatment of effluents.
(2) used as both oxidizing and reducing agents.
(3) the two hydroxyl groups lie in the same plane.
(4) miscible with water.

Choose the correct answer from the options given below:

a. (1), (3) and (4) only
b. (1), (2) and (4) only
c. (1), (2), (3) and (4)
d. (2), (3) and (4) only

Ans: (b)

Solution:

(1) Used in treatment of effluents as it is oxidizing agent.
(2) In H_2O_2 oxidation of oxygen is-1. Therefore, it acts both as O.A and R.A.
(3) H_2O_2 has open book structure in which both –OH group are not in same plane
(4) H_2O_2 is miscible in water due to inter molecular H-Bonding.

16. The greenhouse gas/es is (are):

1. Carbon dioxide
2. Oxygen
3. Water vapour
4. Methane

Choose the most appropriate answer from the options given below:

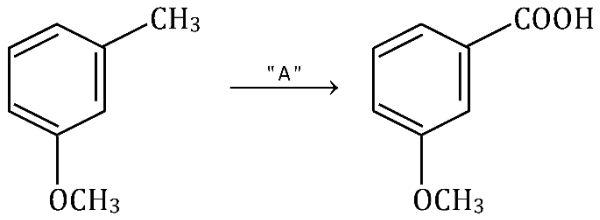
a. (1) and (2) only
b. (1), (3) and (4) only
c. (1) and (3) only
d. (1) only

Ans: (b)

Solution:

The greenhouse gases are CO_2, CH_4 & H_2O vapor.

17.

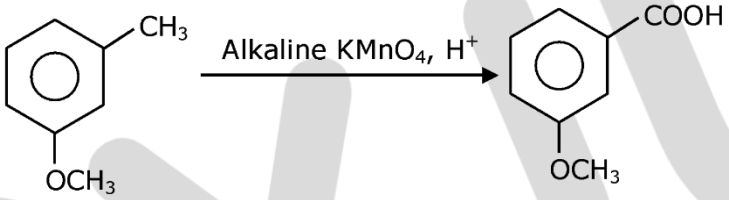


In the above reaction, the reagent "A" is:

a. $NaBH_4$, H_3O^+
b. HCl, Zn-Hg
c. Alkaline $KMnO_4$, H^+
d. $LiAlH_4$

Ans: (c)

Solution:

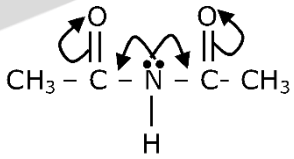


18. Which of the following is least basic?

1. $(CH_3CO)_2\ddot{N}H$
2. $(CH_3CO)\ddot{N}HC_2H_5$
3. $(C_2H_5)_3\ddot{N}$
4. $(C_2H_5)_2\ddot{N}H$

Ans: (a)

Solution:



Due to higher resonance, lp of N is not available for accepting H^+.

So, it is least basic.

19. Fex_2 and Fey_3 are known when x and y are:

a. x=Cl, Br, I and y=F, Cl, Br, I
b. x=F, Cl, Br, I and y=F, Cl, Br
c. x=F, Cl, Br, I and y=F, Cl, Br, I
d. x=F, Cl, Br and y =F, Cl, Br, I

Ans: (b)
Solution:

FeI_3, does not form because of I^- being very good reducing agent.

20. The secondary structure of protein is stabilized by:

a. van der Waals forces
b. Peptide bond
c. Hydrogen bonding
d. Glycosidic bond

Ans: (c)
Solution:
The secondary structure of protein is stabilized by H-bonding.

Section B

1. At 25°C, 50 g of iron reacts with HCl to form $FeCl_2$. The evolved hydrogen gas expands against a constant pressure of 1 bar. The work done by the gas during this expansion is _____ J. (Round off to the nearest integer).
[Given: R = 8.14 J mol^{-1} K^{-1}. Assume, hydrogen is an ideal gas]
[Atomic mass of Fe is 55.85 u]

Ans: 2218
Solution:

$Fe + 2HCl \longrightarrow FeCl_2 + H_2(g)$
50g

$$\text{Moles of Fe} = \frac{50}{55.85}\text{ mol} = \text{Moles of } H_2$$

$$W_{irrev} = -P_{ext}.\Delta V$$
$$= -\text{moles of } H_2 \times RT$$
$$= -\frac{50}{55.85} \times 8.314 \times 298$$
$$= -2218.05\text{ J}$$

Nearest integer = 2218

2. A 5.0 m $moldm^{-3}$ aqueous solution of KCl has a conductance of 0.55 mS when measured in a cell of cell constant 1.3 cm^{-1}. The molar conductivity of this solution is _____ mSm^2mol^1. (Round off to the nearest integer).

Ans: 14

Solution:

$G_{KCl} = 0.55\ mS = 55 \times 10^{-5}\ s$

Cell constant $= l/A = 1.3\ cm^{-1}$

λ_M =??

$K = G(l/A) = 55 \times 10^{-5} \times 1.3\ Scm^{-1}$

$$\lambda_M = \frac{K \times 1000}{Molarity} = \frac{55 \times 1.3 \times 10^{-5} \times 1000}{5 \times 10^{-3}}$$

$\lambda_M = 11 \times 1.3 \times 10 = 11 \times 13 = 143\ Scm^2mol^{-1}$

$$\lambda_M = \frac{143 \times 1000 \times 10^{-3} S}{(10^{-2}\ m)^{-2}} mol^{-1}$$

$\lambda_M = 143 \times 1000 \times 10^{-4}\ (m.S)m^2.mol^{-1}$

$\lambda_M = 14.3\ (m.S)m^2.mol^{-1}$

Nearest integer $= 14$

3. The number of orbitals with $n = 5$, $m_1 = +2$ is _____. (Round off to the nearest integer).

Ans: 3

Solution:

For $n = 5$

$l = 0, 1, 2, 3, 4$

$l = 2 \longrightarrow m = -2, -1, 0, +1, +2$

$l = 3 \longrightarrow m = -3, -2, -1, 0, +1, +2, +3$

$l = 4 \longrightarrow m = -4, -3, -2, -1, 0, +1, +2, +3, +4$

Total no. of orbitals $= 3$

4. A and B decompose via first order kinetics with half-lives 54.0 min and 18.0 min respectively. Starting from an equimolar non-reactive mixture of A and B, the time taken for the concentration of A to become 16 times that of B is _____ min. (Round off to the nearest integer).

Ans: 108

Solution:

$A \xrightarrow{1^{st}\ order} t_{1/2}(A) = 54$ $\qquad$ $B \xrightarrow{1^{st}\ order} t_{1/2}(B) = 18$

$A_0 = B_0 = N_0$

$A_t = \frac{A_0}{2^{t}/54}$ $\quad\quad$ $B_t = \frac{B_0}{2^{t}/18}$

$\Rightarrow A_t = 16.B_t$

$\Rightarrow \frac{A_0}{2^{t}/54} = 16 \times \frac{B_0}{2^{t}/18}$

$\Rightarrow 2^{t/18 - t/54} = 16$

$\Rightarrow 2^{2t/54} = 16 = 2^4$

$\Rightarrow \frac{2t}{54} = 4$

$\Rightarrow t = 108$ min

5. $[Ti(H_2O)_6]^{3+}$ absorbs light of wavelength 498 nm during a d–d transition. The octahedral splitting energy for the above complex is _____ $\times 10^{-19}$ J. (Round off to the nearest integer).
$h = 6.626 \times 10^{-34}$ Js; $c = 3 \times 10^8$ ms^{-1}.

Ans: 4

Solution:

$\Delta_0 = \frac{hc}{I_{abs}} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{498 \times 10^{-9}}$

$= \frac{6.626 \times 3}{498} \times 10^{-17} = 3.99 \times 10^{-19}$

Nearest integer $= 4 \times 10^{-19}$ J

6. Sulphurous acid (H_2SO_3) has $K_{a1} = 1.7 \times 10^{-2}$ and $K_{a2} = 6.4 \times 10^{-8}$. The pH of 0.588 M H_2SO_3 is _____. (Round off to the nearest integer)

Ans: 5

Solution:

$H_2SO_3\,(aq.) \rightleftharpoons HSO_3^-\,(aq.) + H^+\,(aq.)$

$0.588M = C \qquad C\alpha_1 \qquad C\alpha_1 + C\alpha_1\alpha_2$

$HSO_3^-\,(aq.) \rightleftharpoons H^+\,(aq.) + SO_3^{2-}\,(aq.)$

$C\alpha_1(1-\alpha_2) \qquad C\alpha_1\alpha_2 \qquad C\alpha_1\alpha_2$

$+$

$C\alpha_1$

$$\alpha_1 = \sqrt{\frac{1.7\times10^{-2}}{0.588}} = \sqrt{\frac{17}{289\times2}}$$

Therefore, $\alpha_1 << 1 \Rightarrow (1-\alpha_1) \simeq 1$

Hence, $\alpha_2 << 1 \Rightarrow (1-\alpha_2) \simeq 1$

$\therefore [H^+] = C\alpha_1$

$= \sqrt{K_{a1}\times C} = \sqrt{17\times10^{-3}\times0.588}$

$= 0.099$

$pH = -\log_{10}0.099 = 1$

Nearest integer = 1

7. In Duma's method of estimation of nitrogen, 0.1840 g of an organic compound gave 30 mL of nitrogen collected at 287 K and 758 mm of Hg pressure. The percentage composition of nitrogen in the compound is _____. (Round off to the nearest integer). [Given: Aqueous tension at 287 K = 14 mm of Hg]

Ans: 19

Solution:

$$\text{Moles of } N_2 = \frac{758-14}{760}\times\frac{30\times10^{-3}}{0.0821\times287}$$

$$= 1.246\times10^{-3}\text{ mol}$$

Mass of $N = 1.246\times10^{-3}\times28$

$$\text{Mass \% of 'N'} = \frac{\text{mass of N}}{\text{total mass}}\times100$$

$$= \frac{1.246\times28\times10^{-3}}{0.184}\times100$$

$$= \frac{124.6\times28}{0.184}\% = 18.96\%$$

Nearest integer = 19%

8. Ga (atomic mass 70 u) crystallizes in a hexagonal close packed structure. The total number of voids in 0.581 g of Ga is _____ $\times 10^{21}$. (Round off to the nearest integer).
[Given: $N_A = 6.023 \times 10^{23}$]

Ans: 15

Solution:

No. of moles of Ga $= \frac{0.581}{70}$

No. of atoms of Ga $= \frac{0.581}{70} \times N_A$

$\therefore$ Total number of voids $= \frac{0.581}{70} \times N_A \times 3$

$= 0.0249 \times 6 \times 10^{23}$

$= 15 \times 10^{21}$

(As there is one octahedral void and two tetrahedral voids per atom)

9. When 35 mL of 0.15 M lead nitrate solution is mixed with 20 mL of 0.12 M chromic sulphate solution, _____ $\times 10^{-5}$ moles of lead sulphate precipitate out. (Round off to the nearest integer).

Ans: 525

Solution:

$3Pb(NO_3)_2$ + $Cr_2(SO_4)_3$

35 ml 20 ml

0.15 M 0.12 M

= 5.25 mmol = 2.4 mmol

$3PbSO_4 \downarrow + 2Cr(NO_3)_3$

Moles of $PbSO_4$ = moles of $Pb(NO_3)_2$

= 5.25 mmol

$= 525 \times 10^{-5}$ mol

= 525

10. At 363 K, the vapour pressure of A is 21 kPa and that of B is 18 kPa. One mole of A and 2 moles of B are mixed. Assuming that this solution is ideal, the vapour pressure of the mixture is _____ kPa. (Round off to the nearest integer).

Ans: 19

Solution:

$X_A = \frac{1}{1+2} = \frac{1}{3}$ $\quad\quad$ $X_A = \frac{2}{3}$

$P_A^0 = 21$ kPa $\quad\quad$ $P_B^0 = 18$ kPa

$P_{total} = P_A^0 X_A + P_B^0 X_B$

$= 21 \times \frac{1}{3} + 18 \times \frac{2}{3}$

$= 7 + 12$

$= 19$ kPa