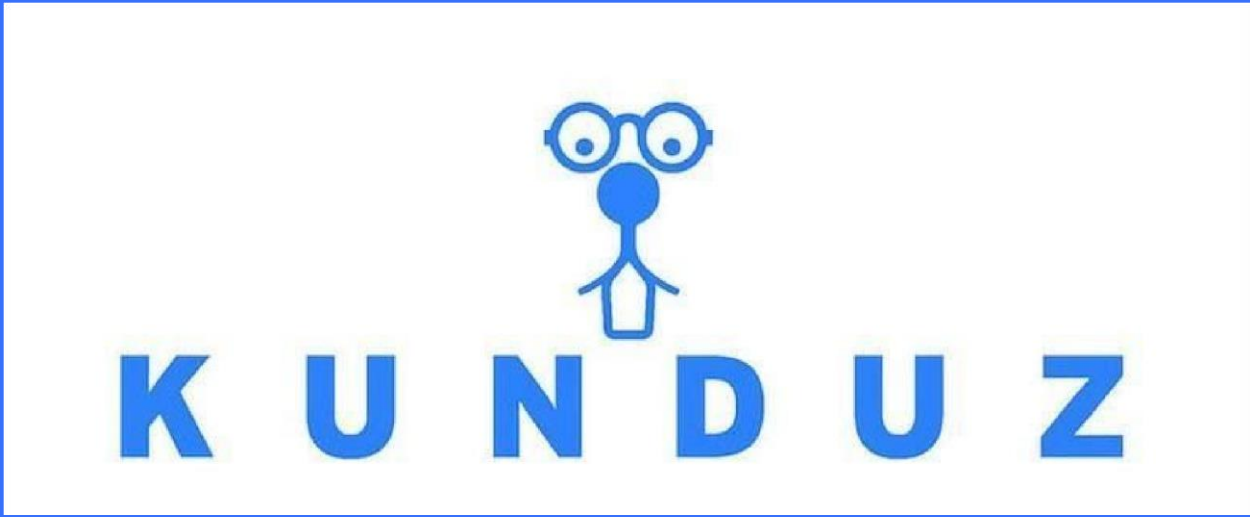


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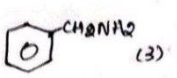
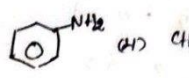
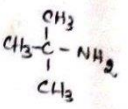
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Question number

Question and Answers

1

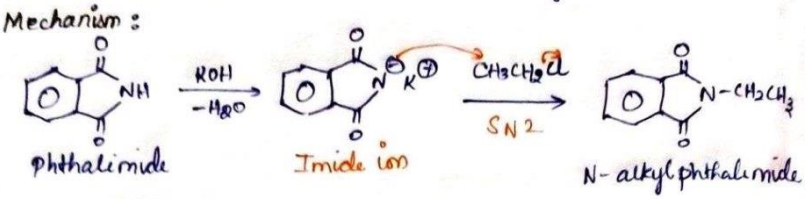
1. Which of the following major product can be obtained from Gabriel phthalimide synthesis?

(1) $CH_2=CH-NH_2$ (2)  (3)  (4) 

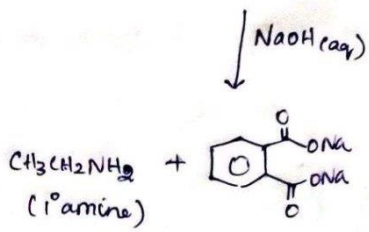
Solution:

Gabriel phthalimide synthesis involves conversion of primary alkyl halides into primary amines. It is a nucleophilic substitution reaction on the alkyl halide and creates an intermediate - N-alkyl phthalimide.

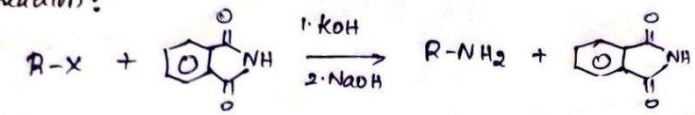
Mechanism:



Phthalimide — Imide ion — N-alkyl phthalimide



Reaction:



Arylamines cannot be prepared via Gabriel phthalimide synthesis as aryl halides don't undergo simple nucleophilic substitution. In the given options, only (2) is a

Note: all are 1° amines in the given options. But (2) has 1° alkyl group. S_N2 happens at fast rate in 1° > 2° alkyl halides. option (1) and (4) are 2° and 3° alkyl groups respectively

2

Qn:

2) Column I (Polymers) | Column - II (Monomers)

(I) Natural Rubber — a) Styrene

(II) Neoprene — b) Isoprene

(III) Buna-N — c) chloroprene

(IV) Buna-S — d) Acylonitrile.

Which of the following combination is correct:

1) (I)-b ; (II)-c ; (III)-d ; (IV)-a

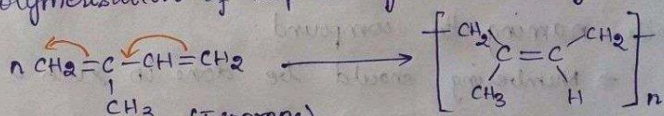
2) (I)-c ; (II)-b ; (III)-d ; (IV)-a

3) (I)-b ; (II)-c ; (III)-a ; (IV)-d

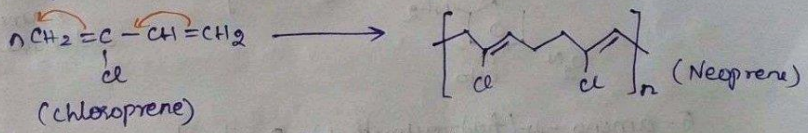
4) (I)-d ; (II)-b ; (III)-c ; (IV)-a

Solution: Ans: option (1)

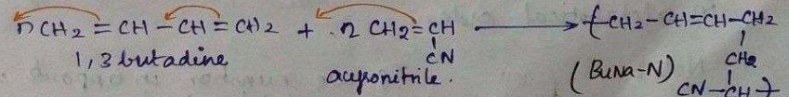
(1) polymerisation of isoprene gives cis-polyisoprene (Natural Rubber)



(2) polymerisation of chloroprene gives neoprene.



(3) copolymerization of 1,3 butadiene with acrylonitrile gives Buna-N rubber (N- stands for Nitrile)

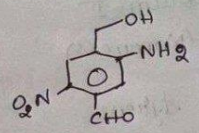


(4) n CH2=CH-CH=CH2 + CH=CH2 (C6H5 styrene) → (Buna-S)

S- stands for styrene.

3

3) The correct IUPAC name of given compound is



(1) 5-formyl-2-(hydroxymethyl)4-nitro benzene

(2) 1-Amino-5-formyl-2(hydroxymethyl)-4-nitrobenzene

(3) 3-Amino-4-(hydroxymethyl)-6-nitro benzene carbaldehyde

(4) 5-Amino-4-(hydroxymethyl)-2-nitro benzene carbaldehyde

Solution: option (4)

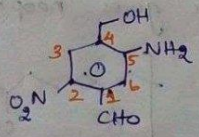
Seniority of functional groups:

$-COOH > -COOR > -COX > -CONH_2 > CN > -CHO > -\overset{O}{\overset{\|}{C}}- >$

$> -OH > -NH_2 > -ROR > -NO_2 > -X.$

While naming the compound:

→ Numbering should be done in such a way that the substituents gets least number.

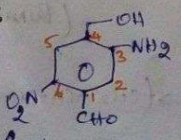


Seniority: -CHO (parent name) aldehyde.

5-amino-4-(hydroxymethyl)-2-nitro benzene carbaldehyde

If more substituents are present; it should be written in alphabetical order.

Note:



(Incorrect numbering)

If we number in opposite way Here substituents are at 3, 4, 6 th positions whereas in previous case we had at 2, 4, 5 th position which is the least number.

4

4. | Column I | Column II |
|---|---|
| (I) Benzene | (a) H_2 - Pd - $BaSO_4$, Quinoline |
| (II) Benzonitrile | b) CO, HCl / Anhyd. $AlCl_3$, CuCl |
| (III) Benzoyl chloride | c) $SnCl_2$ + HCl / $H_3O^{\oplus}$ |

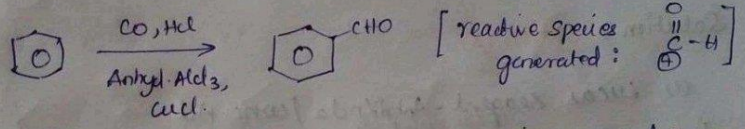
Which combination gives benzaldehyde as a major product.

(1) (I) - a ; (II) - c ; (III) - b (2) (I) - b ; (II) - c ; (III) - a

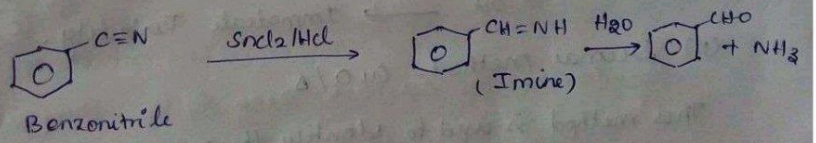
(3) (I) - c ; (II) - b ; (III) - a (4) (I) - c ; (II) - a ; (III) - b.

Solution : option (2)

(I) Benzene → Benzaldehyde conversion can be obtained using Gatterman Koch Reaction (Reagents: CO, HCl / Anhyd. $AlCl_3$, CuCl)

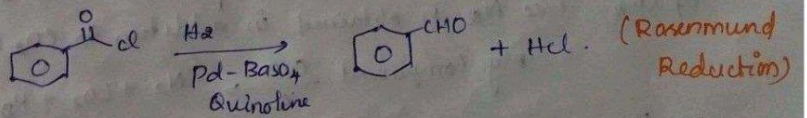


(II) Benzonitrile → Benzaldehyde conversion can be achieved by reduction followed by hydrolysis. This reaction is called Stephen's Reaction.



Benzonitrile

(III) Benzoyl chloride upon reduction is converted to Benzaldehyde.



Here to stop the reduction at aldehyde stage, catalytic poison ($BaSO_4$) is used.

5

5) Column I — Column II

(I) Lucas reagent — a) $C_6H_5SO_2Cl$ /aq. NaOH

(II) Duma's method — b) Conc. H_2SO_4 / Δ

(III) Kjeldahl's method — c) CuO / Δ

(IV) Heinsberg method — d) anhyd. $ZnCl_2$ / conc. HCl

Which of the following combination is correct:

1) (I)-b ; (II)-c ; (III)-d ; (IV)-a

2) (I)-c ; (II)-b ; (III)-d ; (IV)-a

3) (I)-d ; (II)-c ; (III)-b ; (IV)-a

4) (I)-d ; (II)-b ; (III)-c ; (IV)-a

Solution : Option (3)

(I) Lucas Reagent - Anhyd $ZnCl_2$ / conc. HCl

Lucas Test is a distinguishable test for 1°, 2° and 3° alcohol

1° alcohol $\xrightarrow[\text{Reagent}]{\text{Lucas}}$ No Reaction

2° alcohol ⟶ Turbidity after 5-10 min

3° OH ⟶ Immediate Turbidity.

(II) Duma's method - CuO / Δ

This method is used to identify the presence of nitrogen in the given compound by heating it with CuO in atmosphere of CO_2. Free N_2 is obtained in addition to CO_2 and H_2O.

Org Compound $\xrightarrow[\Delta]{CuO}$ $N_2 + CO_2 + H_2O + 2Cu$.

(III) Kjeldahl's method - Conc. H_2SO_4 / Δ [estimation of N_2]

(IV) Heinsberg method - $C_6H_5SO_2Cl$ /aq. NaOH

Test for detection of 1°, 2° and 3° amines.

1° amine $\xrightarrow{\text{reagent}}$ Soluble in Base

2° amine ⟶ Insoluble in Base

3° amine ⟶ No Reaction.

6

6. Which statement is incorrect regarding Lactose.

1) It is composed of β- D (+) Galactose and β- D(+) glucose.

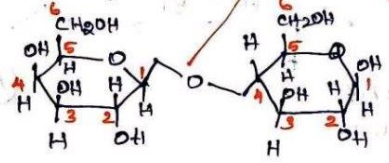
2) It is a reducing sugar.

3) It is a disaccharides ($C_{12}H_{22}O_{11}$) having eight -OH groups

4) It has glycosidic linkage of C_1 of glucose and C_4 of galactose.

Solution: Ans: Option (4)

Structure of Lactose → glycosidic linkage



galactose ring . . glucose ring

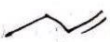
The linkage is between C_1 of galactose and C_4 of glucose.

* Lactose is a disaccharide with molecular formula $C_{12}H_{22}O_{11}$. It is also called as milk sugar. It contains 8 -OH groups. and is a reducing sugar. Lactose is made up of D(+) glucose and D(+) galactose.

7

7. complete the given reactions and compare the boiling points of their products.

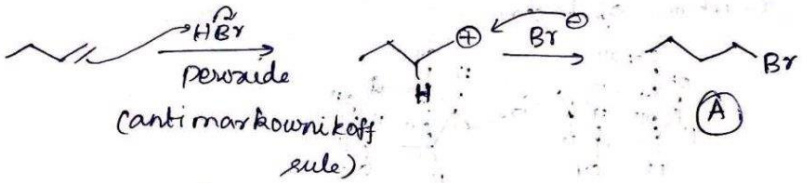
(i)  $\xrightarrow[\text{Peroxide}]{HBr}$ A

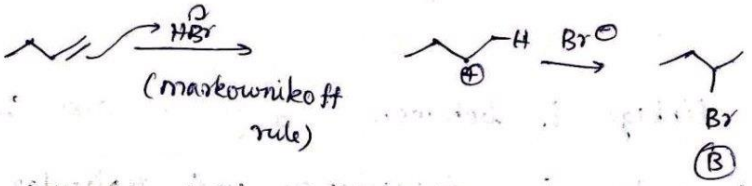
(ii)  $\xrightarrow{HBr}$ B

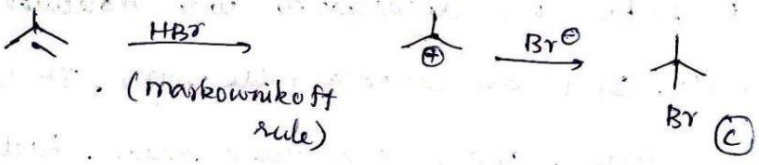
(iii)  $\xrightarrow{HBr}$ C

(1) A > B > C (2) A > C > B (3) B > C > A (4) C > B > A.

Solution: Option (1) A > B > C







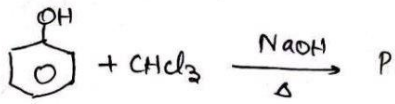
The larger the surface area of the compound, higher the boiling point. (i.e) As Branching increases, Boiling point decreases (surface Area decreases).

So. B.pt of A is higher than B and C.

Order: A > B > C.

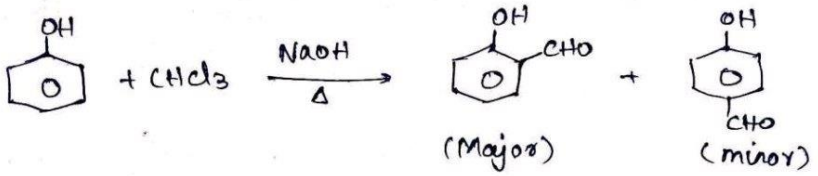
8

8) Complete the given reaction and find the percentage weight of carbon in the product.



Solution:

The above reaction is called as Riemer-Tiemann formylation reaction.



The active species generated in this reaction is $:CCl_2$ (Di chloro carbene).

Molecular formula of the product - $C_7H_6O_2$.

Molecular weight of product = 122 $(7\times12 + 6\times1 + 2\times16)$

Mass of Carbon present = 84 (7×12)

$$\% \text{ weight of carbon} = \frac{\text{Mass of Carbon}}{\text{Mol. wt of compound}} \times 100$$

$$= \frac{84}{122} \times 100 = 68.85\%$$

Ans: 68.85 %.

9

9. For an equilibrium reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ $K_c = 64$. What is the equilibrium constant for the reaction $NH_3 \rightleftharpoons \frac{1}{2} N_2 + \frac{3}{2} H_2$

(1) 1/8 (2) 1/4 (3) 1/64 (4) 1/2

Solution: option (1) - 1/8

$$NH_3 \rightleftharpoons \frac{1}{2} N_2 + \frac{3}{2} H_2 \Rightarrow K_c' \quad \text{—(1)}$$

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \Rightarrow K_c = 64 \quad \text{—(2)}.$$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = 64$$

$$K_c' = \frac{[N_2]^{1/2}\,[H_2]^{3/2}}{[NH_3]}$$

K_c is related to K_c' as

$$K_c' = \frac{1}{\sqrt{K_c}} = \frac{1}{\sqrt{64}} = \frac{1}{8}.$$

10

10) Which of the following is the correct electronic configuration in octahedral complex with d^4 configuration?

(1) t_{2g}^4, eg^0; $\Delta_o < P$ (2) t_{2g}^3, eg^1; $\Delta_o > P$

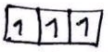
(3) t_{2g}^2, eg^2; $\Delta_o < P$ (4) t_{2g}^3, eg^1; $\Delta_o < P$.

Solution: option (4) t_{2g}^3, eg^1; $\Delta_o < P$

For d^4 configuration, if $\Delta_o < P$ (pairing energy is higher than splitting energy)



eg^1.



t_{2g}^3

$d^4 - (\Delta_o < P)$ Ans: option (4)

Note:

if $\Delta_o > P$ (splitting energy is higher)



eg^0



t_{2g}^4

$d^4 - t_{2g}^4 eg^0$ $(\Delta_o > P)$

11

(1) Which of the following method is used to produce dihydrogen of high degree purity (>99.95%) in maximum amount

(1) Zn + NaOH

(2) With electrolysis of warm aqueous Barium hydroxide solution between Nickel electrodes.

(3) By electrolysis of Brine solution

(4) By electrolysis of alkaline water using platinum electrodes.

Solution: option (2)

Electrolysis of warm aqueous Barium hydroxide solution $Ba(OH)_2$ between Ni electrodes yields highly pure (99.95%) dihydrogen.

At cathode:

$$Ba^{2+} + 2e^- \longrightarrow Ba$$

$$Ba + H_2O \longrightarrow Ba(OH)_2 + H_2 \uparrow$$

At anode:

$$2OH^- \longrightarrow 2OH + 2e^-$$

$$2OH \longrightarrow O^{2-} + H_2O$$

$$2O^{2-} \longrightarrow O_2 \uparrow$$

12

12) In a metal oxide, oxide ions crystallises in ccp lattice in which metal M_1 occupies 50% of octahedral voids and metal M_2 occupies 12.5% of tetrahedral voids. Then the oxidation states of metal M_1 and M_2 respectively are

(1) +2, +4 (2) +1, +3 (3) +3, +2 (4) +3, +1.

solution: Option (3)

In ccp lattice of oxide ions,

no. of O^{2-} ions $= \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right)$

corners face

$= 4$.

In ccp lattice,

no. of octahedral voids = 4

No. of tetrahedral voids = 8.

Given: M_1 occupies 50% of octahedral voids and M_2 occupies 12.5% of tetrahedral voids

No. of M_1 metal atoms $= 4 \times \frac{50}{100} = 2$

No. of M_2 metal atoms $= 8 \times \frac{12.5}{100} = 1$.

formula of compound $= (M_1)_2 (M_2) O_4$.

This is of spinel oxide type AB_2O_4 where A and B are metals and can also be written as $(A^{2+})(B^{3+})_2 O_4$

Similarly we have $(M_1^{3+})_2 (M_2^{2+}) O_4$.

So oxidation states of M_1 and M_2 are +3 and +2

13

13. For the given concentration cell

$Cu(s) \mid Cu^{2+}(c_2\,M) \parallel Cu^{2+}(c_1\,M) \mid Cu(s)$

Gibb's energy (ΔG) is negative if

(1) $C_2 = \frac{C_1}{\sqrt{2}}$ 2) $C_2 = 2C_1$ 3) $C_2 = \sqrt{2}C_1$ 4) $C_1 = C_2$.

Solution: option (1)

Reactions: $Cu^{2+}(aq)_c \longrightarrow Cu^{2+}(aq)_A$

Anode: $Cu(s) \longrightarrow Cu^{2+}(aq)_A$

Cathode: $Cu^{2+}(aq)_c \longrightarrow Cu(s)$

Formula: $\Delta G = -nFE_{cell}$

Given: $\Delta G = -ve$; then E should be positive

$E_{cell} = E^\circ_{cell} - \frac{0.059}{2} \log \frac{C_2}{C_1}$ $[E^\circ_{cell} = 0]$ for concentration cell.

for $E_{cell} > 0$, $C_2 < C_1$

Note: If $C_2 = C_1$ or $C_2 > C_1$, we will get -ve value for E_{cell}

14

14. Main constituent part of Misch Metal alloy is.

(1) Lanthanides (2) Actinides

(3) Transition metal (4) Both by Lanthanides and Actinides

Solution: Option (1)

Misch metal contains 95% Lanthanides (55% cerium, 25% Lanthanum, 15-18% neodymium with other rare earth metals) and ~ 5% iron and traces of C, S, Ca & Al.

15

15. Distillation process is used for purification of

(1) Zn (2) Ge (3) Ni (4) Co.

Solution: Option (4) - Zn

Zn, Cd and Hg are purified fractional distillation process. Ge is purified by zone refining method, Co can be purified by electro refining process and Ni can be purified through Mond's process.

16

16. What is the product of the following reaction,

$NO + NO_2 \longrightarrow$

(1) N_2O (2) N_2O_3 (3) N_2O_4 (4) N_2O_5

Solution: option (2) – N_2O_3

$NO + NO_2 \rightarrow N_2O_3$

Dinitrogen trioxide.

When equal parts of nitric oxide and nitrogen dioxide is mixed and cooled below $-21^\circ C$, N_2O_3 is formed.

17

17. In 180 gm water 10 gm each of A, B and C are mixed separately, then correct order of vapour pressure of these solution is. (Given Molar masses of A, B and C are 100, 150 & 125 g/m respectively)

(1) A > B > C (2) B > C > A (3) A > C > B (4) C > B > A

Solution:

Ans: option (2) - B > C > A

Relative lowering in vapour pressure is given as

$$\frac{\Delta P}{P^\circ} = X = \frac{W_B \times M_A}{W_A \times M_B}$$

where W_B = mass of solute.

M_B = Molar mass of solute.

W_A = Mass of solvent

M_A = Molar mass of solvent.

Relative lowering of Vapour pressure $\propto \frac{1}{\text{Molar mass of solute}}$

Greater the molar mass of solute, lower will be Vapour pressure (Relative lowering) and higher will be vapour pressure

order: B > C > A.

18

18. Average Atomic mass of chlorine is 35.5, then the correct naturally occuring molar ratio of ^{35}Cl & ^{37}Cl is

(1) 4:1 (2) 2:1 (3) 3:1 (4) 1:1

Ans: option (3) - 3:1

Solution:

Avg. Atomic wt of Cl = 35.5

If Cl^{35} is present as x % then (100-x)% of Cl^{37} is present.

$$\text{Avg. Atomic wt} = \frac{(\% \text{ of } Cl^{35} \times \text{at. wt}) + (\% \text{ of } Cl^{37} \times \text{at. wt})}{100}$$

$$35.5 = \frac{(x \times 35) + (100-x) \times 37}{100}$$

$$35.5 = \frac{3700 - 2x}{100}$$

$$\boxed{x = 75\%} \rightarrow Cl^{35}$$

$(100 - x) = (100 - 75) = 25\%$ of Cl^{37}.

Molar ratio of $Cl^{35} : Cl^{37} = 75 : 25$

$= 3 : 1.$

19

19. Match the compounds listed in Column I with use in column II

Column I	Column II
(i) $Ca(OH)_2$	a) White wash
(ii) $CaSO_4 \cdot \frac{1}{2} H_2O$	b) Antacid
(iii) Nacl.	c) Washing soda preparation
(iv) $Mg(OH)_2$	d) In Making molds for plaster statues.

1) (i) - b ; (ii) - d ; (iii) - c ; (iv) - a

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

3) (i) - a ; (ii) - d (iii) - c (iv) - b

4) (i) - a ; (ii) - d (iii) - b (iv) - c

Solution: optim (3)

(i) $Ca(OH)_2$, calcium hydroxide is used in white wash.

(ii) $CaSO_4 \cdot \frac{1}{2} H_2O$, plaster of paris is used in making of molds for plaster statues.

(iii) Nacl is used in the preparation of Washing soda. (Na_2CO_3)

(iv) Milk of magnesia ($Mg(OH)_2$ in water) is used as antacid.

20

20) Sulphur on reaction with conc. H_2SO_4 gives 'x' which on reaction with NaOH gives 'Y'. Y on further reaction with dil. H_2SO_4 gives 'x' again. Then X and Y are respectively

(1) S, Na_2SO_3 (2) SO_2, Na_2SO_3 (3) SO_2, Na_2SO_4 (4) SO_3, Na_2SO_3

Soln: option (2) - SO_2, Na_2SO_3

$$S + \text{conc. } H_2SO_4 \longrightarrow \underset{(X)}{SO_2} \xrightarrow[-H_2O]{2NaOH} \underset{\substack{(Y)\\ \text{Sodium sulphite}}}{Na_2SO_3} \xrightarrow[H_2SO_4]{\text{dil}} \underset{(X)}{SO_2} + NaCl + H_2O$$

21

21) What is the atomic number of an element whose IUPAC name is Unnilunium.

Soln: 101. - Unnilunium.

According to IUPAC nomenclature, the naming of elements with atomic no. more than 100 involves different digits which are written in order and ending with ium. For digits following names are used.

0 - nil
1 - un
2 - bi
3 - tri
4 - tetra and so on.

101 - unnilunium

1 0 1

22

22) For a reaction,

$$4M(s) + nO_2(g) \longrightarrow 2M_2O_n(s)$$

The free energy change is plotted as a function of temperature The temperature below which the oxide is stable could be inferred from the plot as the point at which:

(1) the slope change from (+)ve to zero.

(2) the slope changes from negative to positive.

(3) The free energy change shows a change from negative to positive value.

(4) the slope changes from positive to negative.

Sol^n: option (3)

Ellingham diagram is a graph plotted between free energy change and temperature showing the temperature dependant stability of oxides. For oxide to be stable its ΔG value should be negative.

23

23) The rate of a reaction decreased by 3.555 times when the temperature was changed from 40°C to 30°C The activation energy (in kJ mol^{-1}) of the reaction is.

($R = 8.314\ J K^{-1} mol^{-1}$ $\ln 3.555 = 1.268$)

Soln: $T_2 = 40°C = 313K$; $T_1 = 30°C = 303K$.

$$\log\left(\frac{K_2}{K_1}\right) = \frac{Ea}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\log(3.555) = \frac{Ea}{2.303 \times 8.314}\left[\frac{1}{303} - \frac{1}{313}\right]$$

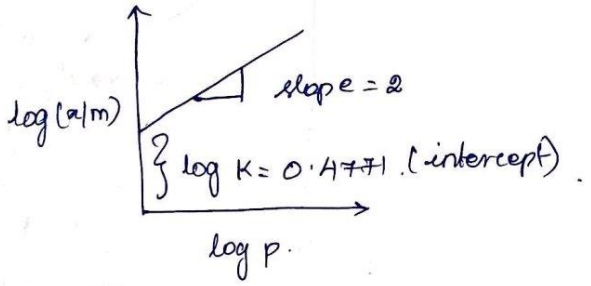
$$1.268 \times 2.303 \times 8.314 \times 303 \times 313 = 10Ea.$$

$$Ea = 100026\ J.$$

$$\boxed{Ea = 100\ KJ}$$

24

24) For Freundlich adsorption isotherm, a plot of $\log(x/m)$ y(axis) and $\log p$ (x-axis) gives a straight line. the intercept and slope for the line is 0.4771 and 2 respectively. The mass of gas adsorbed per gram of adsorbent if the initial pressure is 0.04 atm is ___ $\times 10^{-4}$ g. ($\log 3 = 0.4771$)



$$\frac{x}{m} = K(P)^{1/n}$$

$$\log(x/m) = \log k + \frac{1}{n}\log p.$$

$$\text{slope} = \frac{1}{n} = 2.$$

$$\text{Intercept} = \log K = 0.477.$$

$$K = \text{antilog}(0.477) = 3.$$

$$\left(\frac{x}{m}\right) = K(P)^{1/n}$$

$$= 3(0.04)^2 = 48 \times 10^{-4} \text{ g}.$$

The mass of gas adsorbed/gram of adsorbent $\left(\frac{x}{m}\right) = 48 \times 10^{-4}$ g.

25

25) If the solubility product of AB_2 is $3.20 \times 10^{-11} M^3$, then the solubility of AB_2 in pure water is ——— $\times 10^{-4}$ mol L^{-1} [Assuming that neither kind of ions reacts with water]

Soln:

$$AB_2 \rightleftharpoons A^{2+} + 2B^{\ominus}$$

(S) (2S)

$$K_{sp} = (S)(2S)^2$$

$$\Rightarrow 4S^3 = 3.20 \times 10^{-11}$$

$$S^3 = 0.8 \times 10^{-11}$$

$$S = \sqrt{0.8 \times 10^{-11}} = \boxed{2 \times 10^{-4} \text{ mol } L^{-1}}$$

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