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Answers Key:

Answer the following questions.

1. **Zone refining :**

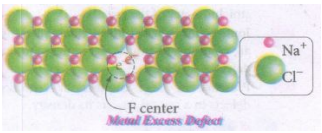
1. Zone refining method is based on the principles of fractional crystallisation.
2. When an impure metal is melted and allowed to solidify, the impurities will prefer to be in the molten region. In this process the impure metal is taken in the form of a rod.
3. One end of the rod is heated using a mobile induction heater which results in melting of the metal on that portion of the rod.
4. When the heater is slowly moved to the other end the pure metal crystallises while the impurities will move on to the adjacent molten zone.
5. As the heater moves further away, the molten zone containing impurities also moves along with it.
6. The process is repeated several times by moving the heater in the same direction again and again to get pure metal.
7. This process is carried out in an inert gas atmosphere to prevent the oxidation of metals.
8. Elements such as germanium (Ge), silicon (Si) and galium (Ga) that are used as semiconductor are refined using this process.

2.

S. No	Crystalline Solids	Amorphous Solids
1.	Long range orderly arrangement of constituents.	Short range, random arrangement of constituents.
2.	Definite shape	Irregular shape
3.	Anisotropic in nature	They are "isotropic" like liquids
4.	They are true solids	They are considered as pseudo solids (or) super cooled liquids
5.	Definite Heat of fusion	Heat of fusion is not definite
6.	They have sharp melting points.	Gradually soften over a range of temperature and so can be moulded.
7.	Eg: NaCl, diamond etc.	Eg: Rubber, plastics, glass etc.

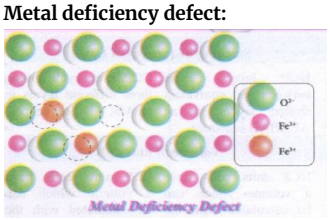
3. **Metal excess defect:**

(i) It arises due to the presence of more number of metal ions as compared to anions.
(ii) Examples: NaCl, KCl
(iii) The electrical neutrality of the crystal can be maintained by the presence of anionic vacancies equal to the presence of extra cation.



(iii) For example, when NaCI crystals are heated in the presence of sodium vapour, Na^+ ions are formed and are deposited on the surface of the crystal.
(iv) Chloride ions (Cl^-) diffuse to the surface from the lattice point and combines with Na^+ ion.
(v) The electron lost by the sodium vapour diffuse into the vacancy created by the Cl^- ions.
(vi) Such anionic vacancies which are occupied by unpaired electrons are called F centers. Hence, the formula of NaCl can be written as $Na_{1+x}Cl$.

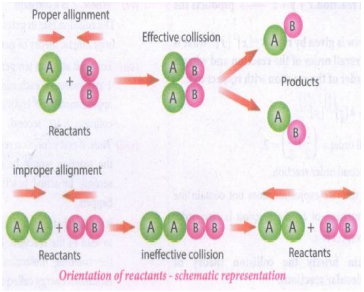
Metal deficiency defect:



(i) Metal deficiency defect arises due to the presence of less number of cations than the anions. This defect is observed in a crystal in which, the cations have variable oxidation states.
(ii) **For example,** In FeO crystal, some of the Fe^{2+} ions are missing from the crystal lattice. To maintain the electrical neutrality, twice the number of other Fe^{2+} ions in the crystal is oxidized to Fe^{3+} ions. In such cases, overall number of Fe^{2+} and Fe^{3+} ions is less than the O^{2-} ions.

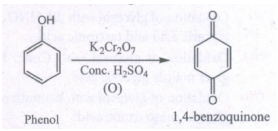
4. (i) Collision theory is based on the kinetic theory of gases. According to this theory, a chemical reaction occurs as a result of collisions between the reacting molecules.
(ii) Let us understand this theory by considering the following reaction.
$A_2(g) + B_2(g) \longrightarrow 2AB(g)$
(iii) If we consider that, the reaction between A_2 and B_2 molecules proceeds through collisions between them, then the rate would be proportional to the number of collisions per second.
(iv) Rate ∝ number of molecules colliding per litre per second (collision rate).
(v) The number of collisions is directly proportional to the concentration of both A_2 and B_2.
Collison rate ∝ $[A_2][B_2]$
Collision rate = Z $[A_2][B_2]$
(vi) Where, Z is a constant
(vii) A fraction of effective collisions (f) is given by the following expression
$f = e^{\frac{-E_a}{RT}}$

(xiv) This fraction of collisions is further reduced due to orientation factor i.e., even if the reactant collides with sufficient energy, they will not react unless the orientation of the reactant molecules is suitable for the formation of the transition state.
(viii) The diagram illustrates the importance of proper alignment of molecules which leads to reaction.

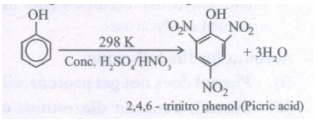


(ix) The fraction of effective collisions (f) having proper orientation is given by the steric factor p.
⇒ Rate = p x f x collision rate
$\Rightarrow Rate = p \times e^{\frac{-E_a}{RT}} \times Z\,[A_2]\,[B_2] \quad \ldots(1)$
As per the rate law,
Rate = $k = [A_2]\,[B_2] \quad \ldots(2)$
Where k is the rate constant
On comparing equation (1) and (2), the rate constant k is
$k = pZe^{\frac{-E_a}{RT}}$

5. (a) Phenol undergoes oxidation with air or acidified $K_2Cr_2O_7$ with cone. H_2SO_4 to form 1,4-benzoquinone.

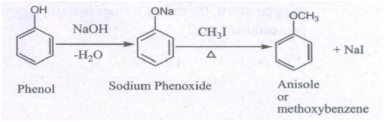


(b) When phenol reacts with nitrating mixture cone. H_2SO_4 and cone. HNO_3, the product formed is picric acid.

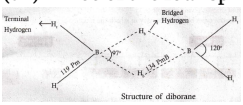


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(c) When phenol reacts with diazo methane in alkaline medium, anisole is formed.



6. (i) In diborane two BH_2 units are linked by two bridged hydrogens.
(ii) It has eight B-H bonds.
(iii) Diborane has only 12 valance electrons.
(iv) The four terminal B-H- bonds is 2c - 2e bond (two centre - two electron bond.)
(v) Two three centred B - H - B bonds two electrons each. (3c - 2e).
(vi) In diborane, the boron is sp^3 hybridised
(vii) Three of the four sp^3 hydridised orbitals contains single electron and the fourth orbital is empty.



7.
8.
9.
10.

Answer any six questions. Qn no 33 is compulsory

11. **Mond process for refining nickel:**
The impure nickel is heated in a stream of carbon monoxide at around 350 K. The nickel reacts with the CO to form a highly volatile nickel tetracarbonyl. The solid impurities are left behind.
$Ni_{(s)} + 4CO_{(g)} \rightarrow [Ni(CO)_4]_{(g)}$
(ii) When the Nickel Carbonyl Complex is heated at 460 K, it decomposes to give pure nickel.
$[Ni(CO)_4]_{(g)} \xrightarrow{460\ K} Ni_{(s)(\text{pure})} + 4CO_{(g)}$
12. (i) Helium is used to provide inert atmosphere in electric-arc welding of metals.
(ii) Helium has lowest boiling point hence used in cryogenics.
(iii) It is much less denser than air and hence used for filling air balloons.
13. A hydride of 2^{nd} period alkali metal (A) is lithium hydride (LiH).
Lithium hydride (A) reacts with diborane (B) to give lithium borohydride (C) which is acts as a reducing agent.

$B_2H_6 + 2\ LiH \xrightarrow{ether} 2\ LiBH_4$

[Diborane (B)] [Lithium hydride (A)] [Lithium borohydride (C)]

Result:

Compound	Formula	Name
A	LiH	Lithium hydride
B	B_2H_6	Diborane
C	$LiBH_4$	Lithium borohydride

14.

	hcp structure	ccp structure
1.	This is 'aba' pattern of arrangement.	This is 'abc' pattern of arrangement.
2.	The spheres can be arranged so as to fit into the depression in such a way that the third layer is directly over a first layer.	The third layer may be placed over the second layer in such a way that all the spheres of the third layer fit in octahedral voids.
3.	The tetrahedral voids of the second layer are covered by the spheres of the third layer.	This arrangement of the third layer is different from other two layers and the stacking of layers continued.
4.	6 spheres are present	4 spheres are present

15. **Pseudo first order reaction:**

A second order reaction can be altered to a first order reaction by taking one of the reactants in large excess, such reaction is called pseudo first order reaction.

Example: Acid Hydrolysis of an ester,

$CH_3COOCH_{3(aq)} + H_2O_{(l)} \xrightarrow{H^+} CH_3COOH_{(aq)} + CH_3OH_{(aq)}$

Rate = $k\,[CH_3COOCH_3]\,[H_2O]$

If the reaction is carried out with a large excess of water, there is no significant change in the concentration of water during hydrolysis. i.e., the concentration of water remains almost constant.

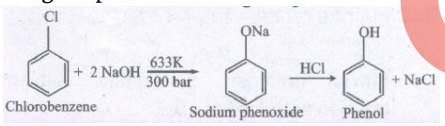
Now, we can define k $[H_2O]$ = k′; Therefore the above rate equation becomes

Rate = $k'\,[CH_3COOCH_3]$

Thus it follows first order kinetics.

16. **(i) Chloro benzene:**

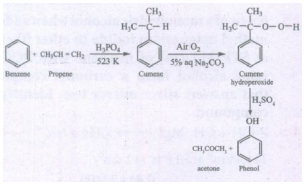
When Chlorobenzene is hydrolysed with 6-8% NaOH at 300 bar and 633K in a closed vessel, sodium phenoxide is formed which on treatment with dilute HCl gives phenol.



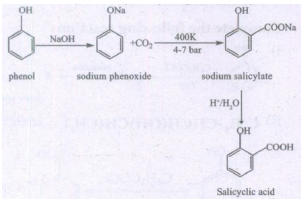
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(ii) isopropyl benzene:

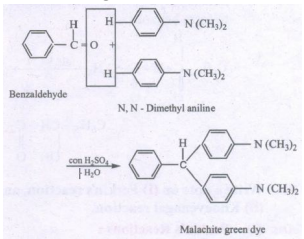
A mixture of benzene and propene is heated at 523K in a closed vessel in presence of H_3PO_4 catalyst gives cumene (isopropylbenzene). On passing air to a mixture of cumene and 5% aqueous sodium carbonate solution, cumene hydro peroxide is formed by oxidation. It is treated with dilute acid to get phenol and acetone. Acetone is also an important byproduct in this reaction.



17. In this reaction, phenol is first converted into sodium phenoxide which is more reactive than phenol towards electrophilic substitution reaction with CO_2, Treatment of sodium phenoxide with CO_2 at 400 K, 4-7 bar pressure followed by acid hydrolysis gives salicylic acid.



18. Benzaldehyde condenses with tertiary aromatic amines like N, N - dimethyl aniline in the presence of strong acids to from triphenyl methane dye or malachite green dye.



19. For a First order reaction

$k = \frac{2.303}{t}\log\frac{a}{a-x}$

$k = \frac{2.303}{40}\log\frac{100}{100-60}$

$k = \frac{2.303}{40}\log\frac{10}{40} = \frac{2.303}{40}\log 2.5$

k = 2.291 x 10^{-2} s^{-1}

$\therefore t_{1/2}$ of the decomposition reaction is

$t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{2.291\times10^{-2}s^{-1}}$

= 30.25 s^{-1}

Answer any six questions.qn no 24 is compulsory

20. In this extraction, a basic flux, quick lime (CaO) is used, since the silica gangue present in the ore is acidic in nature. The quick lime combines with it to form calcium silicate (slag).
$CaO_{(s)} + Sio_{2(s)} \longrightarrow CaSio_{3(s)}$
Flux Gangue Slag

21. The reaction of CO with hydrogen at a pressure of less than 50 atm using metal catalysts at 500 - 700 K yields saturated and unsaturated hydrocarbons.
$nCO + (2n+1)H_2 \longrightarrow C_nH_{(2n+2)} + nH_2O$
$nCO + 2nH_2 \longrightarrow C_nH_{2n} + nH_2O$

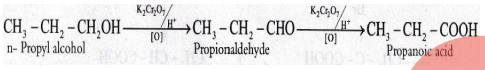
22. (i) In heavier post transition metals, the outers electrons (ns) have a tendency to remain inert and show reluctance to take part in the bonding, which is known as inert pair effect.
(ii) This effect is also observed in groups 14, 15 and 16.

23. The structural units of an ionic crystal are cations and anions. They are bound together by strong electrostatic attractive forces. To maximize the attractive force, cations are surrounded by as many anions as possible and vice versa. Hence they are hard and brittle.

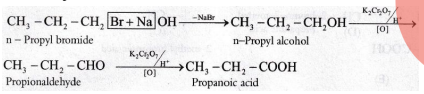
24. K = 1.54 $\times$ $10^{-3}s^{-1}$; $t_{1/2}$ = ?
$t_{\frac{1}{2}} = \frac{0.693}{k}$
$= \frac{0.693}{1.54\times10^{-3}}$
= 450 s

25. Anionic vacancies which are occupied by: unpaired electrons are called F centers. Hence, the formula of NaCI which contains excess Na^+ ions can be written as Na_{1+x} Cl.

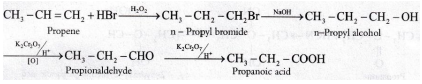
26. **An alcohol:**



An alkylhalide:

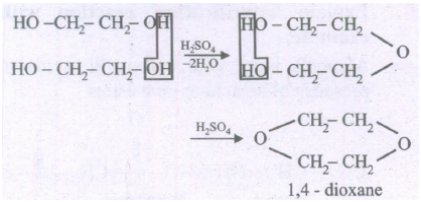


An alkene:



27. Ethers having same molecular formula, but alkyl groups attached to the oxygen atom are different. This phenomenon is known as metamerism.
Metamers of 2- methoxy propane
$C_2H_5 - O - C_2H_5 -$ diethyl ether
$CH_3 - O - CH_2 - CH_2 - CH_3$ methyl n-propyl ether

28. When ethylene glycol is treated with cone. H_2SO_4 two molecules of water are removed and the product formed is dioxane.



Choice Correct Question

29. (b) Al_2O_3
30. (a) Al
31. (b) B_3H_6
32. (d) $(SiO_4)^{4-}$
33. (b) 2
34. (d) NeF_2
35. (b) $(\frac{\pi}{6})$
36. $\rho = \frac{n\times M}{a^3 N_A}$
For bcc n =2, M = 39 nearest distance 2r = 4.52 A^0
$a = \frac{4r}{\sqrt{3}} = \frac{2\times4.52\times10^{-10}}{\sqrt{3}}$
$\rho = \frac{(5.21\times10^{-10})^3\times(6.023\times10^{-23})}{2\times39}$
ρ = 915 kgm^{-3}
37. A catalyst provides a new path to the reaction with low activation energy. i.e., it lowers the activation energy.
38.

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$k = \frac{2.303}{t}\log\frac{[A_0]}{[A]}$

$[A_0] = 100$: $[A] = 25$

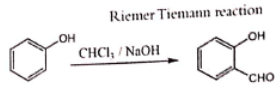
$6.909 = \frac{2.303}{t}\log\frac{[100]}{[25]}$

$t = \frac{2.303}{6.909}\log(4)$

$t = \frac{1}{3}\log(2^2)$

$= \left(\frac{2}{3}\right)\log 2$

39. (c) 4– nitrophenol



40. trichloro methane

41. (b) Fehling's solution

42. (d) Wolf kishner reduction

43. (c) $r = \frac{\sqrt{3}}{4}a$

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