DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

CHEMISTRY

19

SYLLABUS : *p*-Block Elements (Gp-13)-1

Max. Marks : 120

Time : 60 min.

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

Q.1 Which of the following statements about H_3BO_3 is not correct?

(a) It is a strong tribasic acid

(b) It is prepared by acidifying an aqueous solution of borax

(c) It has a layer structure in which planar BO_3 units are joined by hydrogen bonds

(d) It does not act as proton donor but acts as a Lewis acid by accepting hydroxyl ion

Q.2 Identify the statement that is not correct as far as structure of diborane is concerned

(a) There are two bridging hydrogen atoms in diborane

(b) Each boron atom forms four bonds in diborane

(c) The hydrogen atoms are not in the same plane in diborane

(d) All B - H bonds in diborane are similar

Q.3 Aluminium chloride exists as dimer, Al_2Cl_6 in solid state as well as in solution of non-polar solvents such as benzene. When dissolved in water, it gives

(a) $[Al(OH)_6]^{3-}+3HCl$

(b) $2[Al(H_2O)_6]^{3+}+6Cl^-$

(c) $Al^{3+}+3Cl^-$

(d) Al_2O_3+6HCl

Q.4 Boron forms covalent compounds due to

(a) Higher ionization energy

(b) Lower ionization energy

(c) Small size

(d) Both (a) and (c)

RESPONSE GRID 1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ

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Q.5 Which of the following is formed when aluminium oxide and carbon are strongly heated in dry chlorine gas?

(a) Aluminium chloride

(b) Hydrated aluminium chloride

(c) Anhydrous aluminium chloride

(d) None of these

Q.6 Which of the statements about anhydrous aluminium chloride is correct?

(a) It exists as $AlCl_3$ molecule

(b) It is not easily hydrolysed

(c) It sublimes at 100°C under vacuum

(d) It is a strong Lewis base

Q.7 Aluminium vessels should not be washed with materials containing washing soda since

(a) Washing soda is expensive

(b) Washing soda is easily decomposed

(c) Washing soda reacts with aluminium to form soluble aluminate

(d) Washing soda reacts with aluminium to form insoluble aluminium oxide

Q.8 Which one of the following is a correct statement?

(a) The hydroxide of aluminium is more acidic than that of boron

(b) The hydroxide of boron is basic, while that of aluminium is amphoteric

(c) The hydroxide of boron is acidic, while that of aluminium is amphoteric

(d) The hydroxides of boron and aluminium are amphoteric

Q.9 In the purification of bauxite by Hall's process

(a) Bauxite ore is heated with NaOH solution at 50°C

(b) Bauxite ore is fused with Na_2CO_3

(c) Bauxite ore is fused with coke and heated at 1800°C in a current of nitrogen

(d) Bauxite ore is heated with $NaHCO_3$

Q.10 For the electrolytic refining of aluminium, the three fused layers consist of

	Bottom Layer	Middle Layer	Upper Layer
(a)	Cathode of pure Al	Cryolite and fluorspar	Anode of Al and Cu alloy
(b)	Cathode of Al and Cu alloy	Bauxite and cryolite	Anode of pure Al
(c)	Anode of Al and Cu alloy	Cryolite and fluorspar	Cathode of pure Al
(d)	Anode of impure Al	Bauxite, cryolite and fluorspar	Cathode of pure Al

Q.11 For purification of alumina, the modern processes most useful when (i) the impurity present in a lot of iron oxides and (ii) the impurity present in a lot of silica, are

(a) For (i) Hall's process; for (ii) Baeyer's process

(b) For (i) Hall's process; for (ii) Serpeck's process

(c) For (i) Serpeck's process; for (ii) Baeyer's process

(d) For (i) Baeyer's process; for (ii) Serpeck's process

Q.12 In the electrolytic method of obtaining aluminium from purified bauxite, cryolite is added to the purified alumina in order to

(a) Minimize the heat loss due to radiation

(b) Protect aluminium from oxygen

(c) Lower the melting point of the mixture and render it a conductor of electricity

(d) Dissolve bauxite

Q.13 The structure of diborane (B_2H_6) contains

(a) Four 2c-2e$^-$ bonds and two 3c-2e$^-$ bonds

(b) Two 2c-2e$^-$ bonds and four 3c-2e$^-$ bonds

(c) Two 2c-2e$^-$ bonds and two 3c-3e$^-$ bonds

(d) Four 2c-2e$^-$ bonds and four 3c-2e$^-$ bonds

Q.14 Acidic strength of boron trihalides are in order

(a) $BF_3 < BCl_3 < BBr_3 < BI_3$

(b) $BI_3 < BBr_3 < BCl_3 < BF_3$

(c) $BBr_3 < BCl_3 < BF_3 < BI_3$

(d) $BF_3 < BI_3 < BCl_3 < BBr_3$

RESPONSE GRID	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ

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Q.15 In the Hoope's process for refining of aluminium, the fused materials form three different layers and they remain separated during electrolysis also. This is because
- (a) The upper layer is kept attracted by the cathode and the lower layer is kept attracted by the anode
- (b) There is special arrangement in the cell to keep the layers separate
- (c) The 3 layers have different densities
- (d) The 3 layers are maintained at different temperatures

Q.16 In the commercial electrochemical process for aluminium extraction, the electrolyte used is
- (a) $Al(OH)_3$ in NaOH solution
- (b) An aqueous solution of $Al_2(SO_4)_3$
- (c) A molten mixture of Al_2O_3 and Na_3AlF_6
- (d) A molten mixture of $AlO(OH)$ and $Al(OH)_3$

Q.17 Aluminium is more reactive than iron. But aluminium is less easily corroded than iron because
- (a) Aluminium is a noble metal
- (b) Oxygen forms a protective oxide layer
- (c) Iron undergoes reaction easily with water
- (d) Iron forms mono and divalent ions

Q.18 Aluminium (III) chloride forms a dimer because
- (a) Higher coordination number can be achieved by aluminium
- (b) Aluminium has high ionization energy
- (c) Aluminium belongs to III group
- (d) It cannot form a trimer

Q.19 Aluminium is obtained by
- (a) Reducing Al_2O_3 with coke
- (b) Electrolysing Al_2O_3 dissolved in Na_3AlF_6
- (c) Reducing Al_2O_3 with chromium
- (d) Heating alumina and cryolite

Q.20 In diborane, the two H – B – H angles are nearly
- (a) 60°, 120° (b) 95°, 120°
- (c) 95°, 150° (d) 120°, 180°

Q.21 When orthoboric acid (H_3BO_3) is heated, the residue left is
- (a) Metaboric acid (b) Boron
- (c) Boric anhydride (d) Borax

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes:
- **(a)** 1, 2 and 3 are correct
- **(b)** 1 and 2 are correct
- **(c)** 2 and 4 are correct
- **(d)** 1 and 3 are correct

Q.22 Select the correct statements for diborane :
- (1) Boron is approximately sp^3 hybridized
- (2) There are only 12 bonding electrons
- (3) There are two terminal B – H bonds for each boron atom
- (4) B – H – B angle is 180°

Q.23 $Mg_3B_2 \xrightarrow{HCl\,(aq)} [X] + MgCl_2$

$[X] + H_2O \xrightarrow{HCl(aq)} [Y] + H_2$

For [X] and [Y] the correct choice is :
- (1) [X] is B_2H_6 and [Y] is H_3BO_3
- (2) [X] with air and [Y] on strong heating (red heat) give same compound.
- (3) In [Y], B completes its octet by removing OH^- from water molecule.
- (4) [X] is BCl_3 and [Y] is H_3BO_3

Q.24 Which of the following statements about anhydrous aluminium chloride is correct ?
- (1) It fumes in moist air
- (2) It exists as dimer both in the vapour state below 350°C and in non-polar solvents
- (3) It is prepared by heating Al_2O_3 in a stream of sulphur chloride (S_2Cl_2) vapour and chlorine
- (4) It sublimes at 250°C

RESPONSE GRID					
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ
	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ

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DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

Compound X on reduction with $LiAlH_4$ gives a boron hydride (Y) containing 21.72% hydrogen along with other products. The compound (Y) reacts with air explosively resulting in a compound (Z)

Q.25 X is

(a) BX_3 (b) B_2H_6

(c) B_2O_3 (d) BH_3

Q.26 Y is

(a) BX_3 (b) B_2H_6

(c) B_2O_3 (d) BH_3

Q.27 Z is

(a) BX_3 (b) B_2H_6

(c) B_2O_3 (d) BH_3

DIRECTIONS (Q.28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement - 1 is False, Statement-2 is True.

(d) Statement - 1 is True, Statement-2 is False.

Q.28 Statement 1 : Boron is a metalloid.

Statement 2 : Boron shows metallic nature.

Q.29 Statement 1 : Al forms $[AlF_6]^{3-}$ but B does not form $[BF_6]^{3-}$.

Statement 2 : 'B' does not react with F_2.

Q.30 Statement 1 : Borax bead test is not suitable for Al(III).

Statement 2 : Al_2O_3 is insoluble in water.

RESPONSE GRID	25.ⓐⓑⓒⓓ 26.ⓐⓑⓒⓓ 27.ⓐⓑⓒⓓ 28.ⓐⓑⓒⓓ 29. ⓐⓑⓒⓓ 30.ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 19 - CHEMISTRY			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	36	Qualifying Score	64
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

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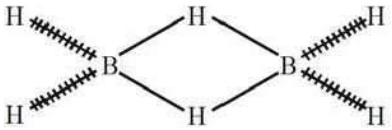
(1) **(a)** Boric acid is a weak monobasic acid as it is not able to release H^+ ions on its own. It receives OH^- ions from water to complete its octet and in turn releases H^+ ions.

(2) **(d)** B_2H_6 has two types of B - H bonds.



B 119pm H (Terminal bond)

B 134pm H (Bridge bond)

(3) **(b)** $Al_2Cl_6 + 12H_2O \rightarrow 2[Al(H_2O)_6]^{3+} + 6Cl^-$

(4) **(d)** Boron forms only covalent compounds due to its exceptionally small size and high I.E.

(5) **(c)** The reaction is :

$$Al_2O_3 + 3Cl_2 + 3C \xrightarrow{\text{Heat}} 2AlCl_3 + 3CO$$

(6) **(c)** Anhydrous $AlCl_3$ exists as a dimer and being electron deficient, it acts as a Lewis acid. Also, it is hydrolysed by atmospheric moisture to liberate HCl gas. Thus, options (a), (b) and (d) are incorrect. Only (c) is correct option.

(7) **(c)** $Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2$

$2NaOH + 2Al + 6H_2O \rightarrow 2Na[Al(OH)_4] + 3H_2$

(8) **(c)** $B(OH)_3$ dissolves in alkalies forming metal borates, i.e.

$B(OH)_3 + NaOH \longrightarrow NaBO_2 + 2H_2O$

$Al(OH)_3$ is amphoteric. It dissolves in acids as well as bases :

$Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$

$Al(OH)_3 + 3HCl \longrightarrow AlCl_3 + 3H_2O$

(9) **(b)** In Hall's process

$Al_2O_3.2H_2O + Na_2CO_3 \rightarrow 2NaAlO_2 + CO_2 + 2H_2O$

$2NaAlO_2 + 3H_2O + CO_2 \xrightarrow{333K}$

$2Al(OH)_3 \downarrow + Na_2CO_3$

$2Al(OH)_3 \xrightarrow{1473K} Al_2O_3 + 3H_2O$

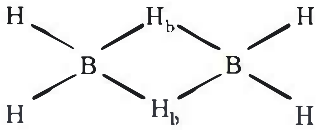
(10) **(c)**

(11) **(d)** Iron oxide impurity - Baeyer's process

Silica impurity - Serpeck's process

(12) **(c)** In electrolytic method of obtaining aluminium from purified bauxite, cryolite is added to the charge because it reduces the melting point of bauxite (from 1200°C to 800° – 900°C) and also increases electrical conductivity of the mixture.

(13) **(a)**



Two 3c-2e$^-$: $B-H_b-B$; Four 2c-2e$^-$: H_b-B-H

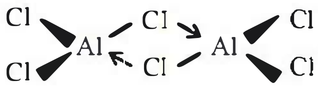
(14) **(a)** The strength of Lewis acid of boron trihalides increases in the following order:

$BF_3 < BCl_3 < BBr_3 < BI_3$.

This is due to back-donation in BF_3 (from three F-atoms into vacant 2*p*-orbital of B) due to which the electron deficiency of B decreases and thus BF_3 is weakest Lewis acid. As the size of halogen increases, the extent of overlap between 2*p*-orbital of B and bigger *p*-orbital of halogen decreases and consequently electron-deficiency of B increases and Lewis acid character also increases.

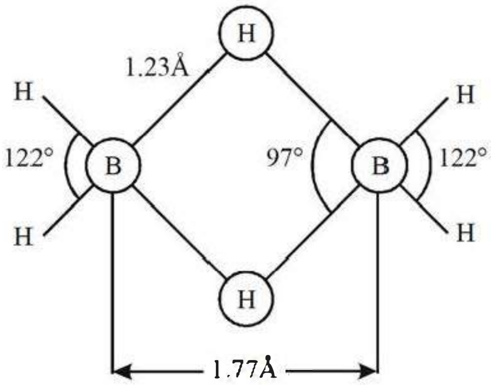
(15) **(c)** **(16)** **(c)** **(17)** **(b)**

(18) **(a)** Due to its bigger size and availability of vacant *d*-orbitals, Al can easily accommodate four big sized Cl atoms around it. Since in $AlCl_3$, there are only six electrons around Al-atom, therefore, it completes its octet by accepting a lone pair of electrons from Cl atom of another $AlCl_3$ molecule resulting in a bridged dimeric structure.



(19) **(b)**

(20) **(b)** Dilthey in 1921 proposed a bridge structure for diborane. Four hydrogen atoms, two on the left and two on the right, known as terminal hydrogens and two boron atoms lie in the same plane. Two hydrogen atoms forming bridges, one above and other below, lie in a plane perpendicular to the rest of molecule.



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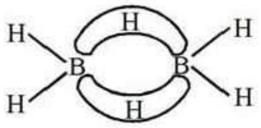
(21) **(c)** $2H_3BO_3 \rightarrow B_2O_3 + 3H_2O$.

(22) **(a)**



B is sp^3 hybridized

Only 12 bonding electrons available

BHB angle is 97° not 180°.

(23) **(a)**

$$Mg_3B_2 \xrightarrow[\text{Hydrolysis}]{\text{HCl (aq)}} MgCl_2 + B_2H_6[X]$$

$$B_2H_6 + 6H_2O \xrightarrow[\text{(aq)}]{\text{HCl}} 2H_3BO_3\,[Y] + 6H_2$$

Both [X] and [Y] gives B_3O_3 ,

$$\underset{(X)}{B_2H_6} + 3O_2 \longrightarrow B_2O_3 + 3H_2O$$

$$\underset{(Y)}{H_3BO_3} \xrightarrow[\text{heat}]{\text{Red }\Delta} B_2O_3$$

$$\underset{(Y)}{B(OH)_3\,(aq)} + 2H_2O \longrightarrow B(OH)_4^- + H_3O^+(aq)$$

(24) **(a)**

(1) $AlCl_3 + 3H_2O \longrightarrow Al(OH)_3 + 3HCl\uparrow$ (fumes)

(2) It exists as dimer in non-polar solvents like benzene and in vapour state below 350°C.

(3) $4Al_2O_3 + 3S_2Cl_2 + 9Cl_2 \longrightarrow 8AlCl_3 + 6SO_2\uparrow$

(4) Anhydrous $AlCl_3$ sublimes at 100°C.

Hence option (4) is incorrect.

(25)(a), 26 (b), 27 (c)

Reduction of (X) with $LiAlH_4$ gives a boron hydride (Y) having 21.72% hydrogen; (Y) should be B_2H_6 and hence (X) as boron trihalide, BX_3. The reactions are shown as :

$$\underset{(X)}{4BX_3} + 3LiAlH_4 \longrightarrow \underset{(Y)}{2B_2H_6} + 3LiX + 3AlX_3$$

(X = Cl or Br)

$$\underset{(Y)}{B_2H_6} + 3O_2 \longrightarrow \underset{(Z)}{B_2O_3} + 3H_2O + \text{heat}$$

(28) **(d)** Boron is a metalloid. Thus statement-1 is correct. Metalloids possess, metallic as well as non-metallic nature. Hence, statement-2 is false.

(29) **(d)** Statement-1 is true but statement-2 is false.

B does not have vacant d-orbitals as second shell is the outermost shell.

(30) **(b)** Borax bead test is not suitable for Al(III) because its oxidising as well as reducing flame is colourless in both hot as well as cold.

Alumina is insoluble in water as they exist in hydrated form like $Al_2O_3.2H_2O, Al_2O_3.H_2O$, etc.

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(1) **(a)**

(2) **(b)** Graphite is thermodynamically more stable than diamond because its free energy of formation is 1.9 kJ mol^{-1} lower at room temperature and ordinary P.

(3) **(d)** Each silicon atom in crystalline structure of Si is tetrahedrally surrounded by four other Si atoms. This structure is similar to that of diamond.

(4) **(c)** Compounds in lower O.S. are more ionic than compounds in higher O.S. Thus, MCl_2 is more ionic than MCl_4.

(5) **(c)** Beryl has cyclic structure. Beryl containing 1-2% Cr having grass green colour is called emerald.

(6) **(c)** Due to inert pair effect, + 2 O.S. of Pb is more stable while + 4 O.S. of Sn is more stable. Thus, (c) is the correct option.

(7) **(a)** The B.O. of CO is 2.5, that of CO_2 is 2 while that of CO_3^{2-} is 1.5. As B.O. decreases, C–O bond length increases. Thus, B.L. of $CO < CO_2 < CO_3^{2-}$.

(8) **(d)** Basic lead carbonate, $2PbCO_3.Pb(OH)_2$ is called white lead.

(9) **(d)**

(10) **(b)** Inert pair effect becomes more predominant down the group and hence, the stability of dihalides increases down the group, i.e., option (b) is correct.

(11) **(a)** $2Pb + O_2 + 2H_2O \rightarrow 2Pb(OH)_2$. This $Pb(OH)_2$ makes water poisonous. The dissolution of Pb in H_2O is called plumbosolvency.

(12) **(b)**

(13) **(d)** H_2 and CO_2 gases are formed.

$2H_2O + O_2 + 2C \rightarrow 2H_2 + 2CO_2$

(14) **(c)** Due to the absence of *d*-orbitals in C, CCl_4 is not hydrolysed.

(15) **(d)** The structure is tetrahedral and hybridisation of Si is sp^3.

(16) **(a)** Pb^{2+} forms a precipitate of $PbCl_2$ (white) with HCl and PbS (black) with H_2S.

(17) **(d)** In graphite, electrons are spread (delocalised) between the structure.

(18) **(c)** Water glass is sodium silicate.

(19) **(a)** **(20)** **(a)**

(21) **(b)** Due to its semi-conducting nature, Si is used in solar cells.

(22) **(a)** Increased stability of lower valent states on descending a group is illustrated by the fact that Ge^{2+} and Sn^{2+} are strong reducing agents. Pb_3O_4 (red lead) is 2PbO. PbO_2 and thus contains both Pb^{2+} and Pb^{4+} ions.

(23) **(d)** The heat of combustion of graphite is –94.052 kcal/mole and that of diamond is –94.505 kcal/mole. However, it can be converted into diamond at 16000°C by a pressure of 5,000 to 60,000 atm.

Graphite is more reactive than diamond due to the presence of a mobile electron on each carbon atom.

(24) **(a)**

(1) It burns in air and evolves a considerable amount of heat.

(2) It forms carboxyhaemoglobin with the haemoglobin of the blood and reduces O_2 carrying capacity of H_b.

(3) $HCOOH + H_2SO_4 \rightarrow CO + H_2O$

(25) **(a)** In CO_3^{2-}, carbon atom (C) shows sp^2 hybridisation.

(26) **(b)** In diamond, the carbon atoms are arranged tetrahedrally i.e., sp^3 hyrbidisation of C. Each C atom is linked to its neighbours by four single covalent bonds.

(27) **(a)** In graphite, the carbon atoms are arranged in regular hexagons in flat parallel layers. Each carbon atom in these layers is bonded to three others by sp^2 covalent bonds.

(28) **(a)** (i) Due to smaller size of F; steric repulsions will be less in SiF_6^{2-}.

(ii) Interaction of F lone pair electrons with Si is stronger than that of chlorine lone pairs.

(29) **(d)** Si – Si bonds are weaker than Si – O bonds. Si has no tendency to form double bonds with itself.

(30) **(c)** PbI_4 is not a stable compound and iodine can not stabilize higher oxidation states. Pb shows (II) oxidation state more frequently than Pb (IV) due to inert pair effect.

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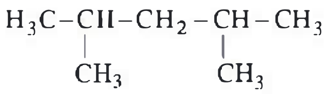
(21)

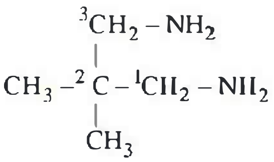
(1) **(b)**



$$\begin{array}{l} H_3C-CH-CH_2-CH-CH_3 \\ \qquad\;\; | \qquad\qquad\quad | \\ \quad\;\; CH_3 \qquad\quad\;\; CH_3 \end{array}$$

2, 4 - Dimethylpentane is the hydrocarbon having two 3° carbon & one 2° carbon atom. It has four 1° carbon atoms.

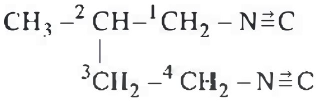
(2) **(c)**



$$\begin{array}{l} \qquad\quad {}^{3}CH_2-NH_2 \\ \qquad\quad\; | \\ CH_3-{}^{2}C-{}^{1}CH_2-NH_2 \\ \qquad\quad\; | \\ \qquad\quad CH_3 \end{array}$$

2,2-dimethylpropanediamine-1,3

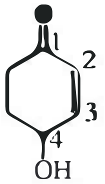
(3) **(a)**



$$\begin{array}{l} CH_3-{}^{2}CH-{}^{1}CH_2-N\equiv C \\ \qquad\quad\; | \\ \qquad {}^{3}CH_2-{}^{4}CH_2-N\equiv C \end{array}$$

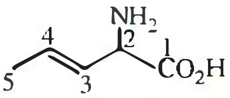
2-methylbutanediisonitrile -1,4

(4) **(a)**



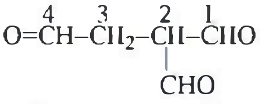
4-Hydroxycyclohex -2-ene-1-one

(5) **(b)**



2-Aminopent-3-en-1-oic acid

(6) **(c)** The IUPAC name of the given compound is 2-formyl-butanedial,

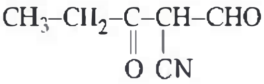


$$\begin{array}{l} \overset{4}{O=CH}-\overset{3}{CH_2}-\overset{2}{CH}-\overset{1}{CHO} \\ \qquad\qquad\qquad\quad\; | \\ \qquad\qquad\qquad\; CHO \end{array}$$

2-Formylbutanedial

The principal functional group is – CHO.

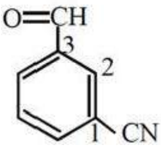
(7) **(b)** The correct I.U.P.A.C. name of



$$\begin{array}{l} CH_3-CH_2-C-CH-CHO \\ \qquad\qquad\;\; \| \quad\; | \\ \qquad\qquad\;\; O \;\; CN \end{array}$$

is 2-formyl-3-oxopentanenitrile. Here the main functional group is -CN, which has nitrile suffix and CHO and CO are the side functional groups which are used as prefixes.

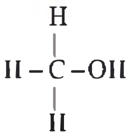
(8) **(a)**



3-Formyl benzene carbonitrile

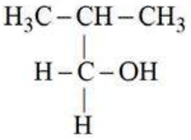
(9) **(c)** 3C + (=) → Acryl group suffix of – CN group is onitrile.

(10) **(c)** In derived name system



$$\begin{array}{c} H \\ | \\ H-C-OH \\ | \\ H \end{array}$$

Carbinol



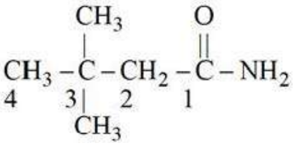
$$\begin{array}{c} H_3C-CH-CH_3 \\ | \\ H-C-OH \\ | \\ H \end{array}$$

Isopropyl carbinol

(11) **(c)** Select the longest chain having more substituents.

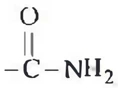
(12) **(d)** Between double bond & triple bond, double bond is preferred. The IUPAC name of the compound is oct-6-yn-2, 4-diene.

(13) **(c)**

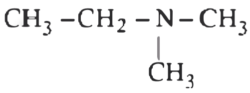


$$\begin{array}{l} \qquad\;\; CH_3 \qquad\quad\;\; O \\ \qquad\quad | \qquad\qquad\;\; \| \\ CH_3-C-CH_2-C-NH_2 \\ 4 \qquad 3| \quad\; 2 \qquad 1 \\ \qquad\;\; CH_3 \end{array}$$

3, 3-dimethylbutanamide

The principal functional group is  $-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$

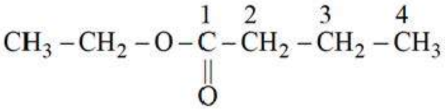
(14) **(b)** IUPAC name of the four-carbon 3° amine is N, N-dimethylethaneamine.



$$\begin{array}{l} CH_3-CH_2-N-CH_3 \\ \qquad\qquad\quad | \\ \qquad\qquad\; CH_3 \end{array}$$

(N, N - dimethylethaneamine)

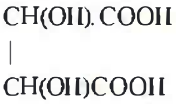
(15) **(b)** The IUPAC name of $CH_3CH_2OCOCH_2CH_2CH_3$ is ethyl butanoate.



$$\begin{array}{l} \qquad\qquad\qquad\quad 1 \quad\; 2 \qquad\;\; 3 \qquad\;\; 4 \\ CH_3-CH_2-O-C-CH_2-CH_2-CH_3 \\ \qquad\qquad\qquad\quad \| \\ \qquad\qquad\qquad\quad O \end{array}$$

Ethyl butanoate

(16) **(b)** Trivial name of 2,3-dihydroxybutandioic acid is tartaric acid.



$$\begin{array}{l} CH(OH).COOH \\ | \\ CH(OH)COOH \end{array}$$

Tartaric acid

The principal functional group is – COOH group.

(17) **(b)** IUPAC name of carbonyl chloride is chloromethanoyl chloride.

(18) **(c)**

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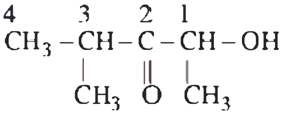
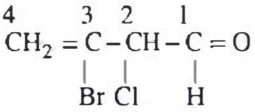
(19) **(d)** The principal group is $-\underset{\underset{O}{\|}}{C}-$ & the alphabate H of hydroxy group comes first than M of methyl group. So numbering is done in the following way.


$$\overset{4}{CH_3}-\overset{3}{\underset{\underset{CH_3}{|}}{CH}}-\overset{2}{\underset{\underset{O}{\|}}{C}}-\overset{1}{\underset{\underset{CH_3}{|}}{CH}}-OH$$

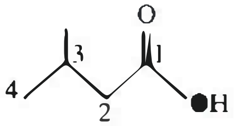
It should be 1-hydroxy-1, 3-dimethylbutan-2-one.

(20) **(c)**


$$\overset{4}{CH_2}=\overset{3}{\underset{\underset{Br}{|}}{C}}-\overset{2}{\underset{\underset{Cl}{|}}{CH}}-\overset{1}{\underset{\underset{H}{|}}{C}}=O$$

3-bromo-2-chloro-3-butenal

(21) **(a)**

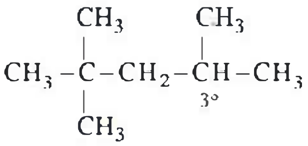


3-methylbutanoic acid

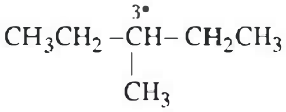
(22) **(b)** For acetylene (an alkyne) & allene, C_nH_{2n-2} formula is applicable completely.

$HC\equiv CH$ (C_2H_2) $CH_2=C=CH_2$ (C_3H_4)

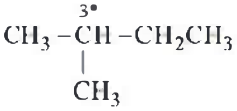
(23) **(a)**


$$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-\underset{3^\circ}{\overset{\overset{CH_3}{|}}{CH}}-CH_3$$

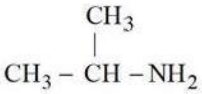
Iso-octane (one 3° C)


$$CH_3CH_2-\underset{\underset{CH_3}{|}}{\overset{3^\circ}{CH}}-CH_2CH_3$$

3-Methylpentane (one 3° C)


$$CH_3-\underset{\underset{CH_3}{|}}{\overset{3^\circ}{CH}}-CH_2CH_3$$

Isopentane (one 3° C)


$$CH_3-\overset{\overset{CH_3}{|}}{CH}-NH_2$$

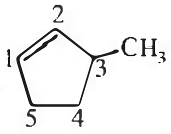
Isopropyl amine (no 3°C)

(24) **(a)** An aromatic species will have :

$(4n+2)$ π electrons	(by Huckel's Rule)
planar structure	(due to resonance)
cyclic structure	(due to presence of sp^2-hybrid carbon atoms).

25. **(c)**
26. **(a)**
27. **(b)**
28. **(d)**

29. **(a)** In naming cycloalkenes, number the ring to give the doubly bonded carbons 1 and 2 and choose the direction of numbering so that the substituents get the lowest numbers. The position of the double bond is not indicated because it is known to be present between C-1 and C-2.

So,  is 3-methylcyclopentene

30. **(b)** Less reactivity of saturated hydrocarbons is due to peresence of single bonds between carbon atoms.

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DAILY PRACTICE PROBLEMS

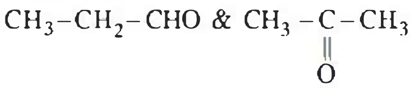
CHEMISTRY SOLUTIONS

22

(1) **(b)**

(2) **(d)**

(3) **(c)** Aldehydes possess — CHO functional group while ketones have — CO — group, so these are functional isomers, eg.



CH_3-CH_2-CHO & $CH_3-\underset{\underset{O}{\|}}{C}-CH_3$

(4) **(d)**

(a) Metamers:

$CH_3-CH_2-O-CH_2-CH_3$

&

$CH_3-O-CH_2-CH_2-CH_3$

(b) Functional isomers :

$CH_3-CH_2-CH_2-CH_2-OH$

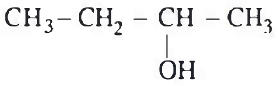
&

$CH_3-O-CH_2-CH_2-CH_3$

(c) Positional isomers :

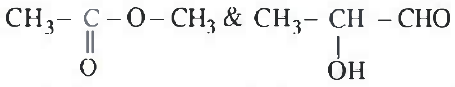
$CH_3-CH_2-CH_2-CH_2-OH$

&



$CH_3-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3$

(5) **(a)** Esters are functional isomers of hydroxyaldehydes.



$CH_3-\underset{\underset{O}{\|}}{C}-O-CH_3$ & $CH_3-\underset{\underset{OH}{|}}{CH}-CHO$

methyl ethanoate 2- hydroxypropanal

(6) **(a)** In the (a) option the compounds are 2-methylbutane and 2,2- dimethylpropane respectively. In (b) & (c) options, all the compounds are same i.e. 2-methylbutane. In (d) both are *n*-pentane.

(7) **(b)** $(CH)_2(COOH)_2$ in fact represents

$HOOC-CH=CH-COOH$

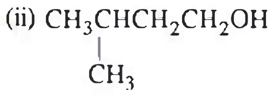
and hence shows geometrical isomerism.

(8) **(d)** Since both the carbon atoms of each of the three double bonds are differently substituted.

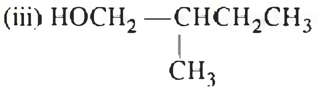
Therefore, $2^3 = 8$ geometrical isomers are possible.

(9) **(a)** Diethyl ether has 4 carbon atoms, among different alternative alochols, only $(CH_3)_3COH$ has 4 carbon atoms.

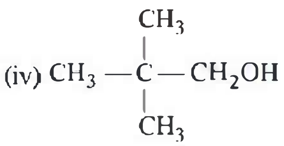
(10) **(c)** (i) $CH_3CH_2CH_2CH_2CH_2OH$



(ii) $CH_3\underset{\underset{CH_3}{|}}{C}HCH_2CH_2OH$

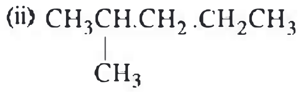


(iii) $HOCH_2-\underset{\underset{CH_3}{|}}{C}HCH_2CH_3$

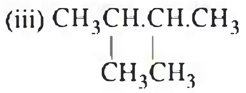


(iv) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2OH$

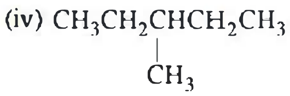
(11) **(b)** (i) $CH_3CH_2CH_2CH_2CH_2CH_3$



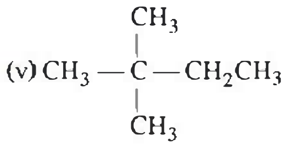
(ii) $CH_3\underset{\underset{CH_3}{|}}{C}H.CH_2.CH_2CH_3$



(iii) $CH_3\underset{\underset{CH_3}{|}}{C}H.\underset{\underset{CH_3}{|}}{C}H.CH_3$



(iv) $CH_3CH_2\underset{\underset{CH_3}{|}}{C}HCH_2CH_3$



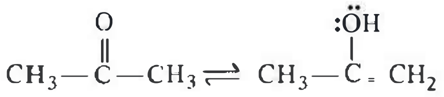
(v) $CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2CH_3$

(12) **(c)** The two isomers have same functional group, but at different positions.

(13) **(d)** As the name indicates α -naphthol and β -naphthol differ in the position of the alcoholic group.

(14) **(b)** The compound must contain α -hydrogen atom w.r.t. the $-CHO$ or $>C=O$ group for showing keto-enol tautomerism.

(15) **(a)**



$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 \rightleftharpoons CH_3-\overset{\overset{:\ddot{O}H}{|}}{C}=CH_2$

keto form enolic form

No. of σ bonds in enolic form :

$3+1+1+1+1+2=9$

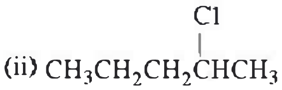
No. of π bonds in enolic form= 1

No. of lone pairs of electrons in enolic form = 2

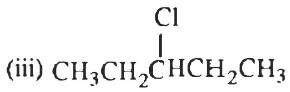
(16) **(d)** The molecular formulas are different so they do not exhibit isomerism.

(17) **(d)** CH_4, CH_3CH_3, $CH_3CH_2CH_3$ exist only in one structural form, while $CH_3CH_2CH_2CH_3$ can exist in more than one structural forms.

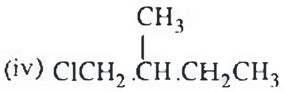
(18) **(b)** (i) $CH_3CH_2CH_2CH_2CH_2Cl$



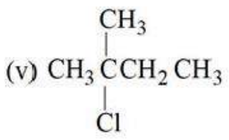
(ii) $CH_3CH_2CH_2\overset{\overset{Cl}{|}}{C}HCH_3$



(iii) $CH_3CH_2\overset{\overset{Cl}{|}}{C}HCH_2CH_3$



(iv) $ClCH_2.\overset{\overset{CH_3}{|}}{C}H.CH_2CH_3$



(v) $CH_3\overset{\overset{CH_3}{|}}{\underset{\underset{Cl}{|}}{C}}CH_2CH_3$

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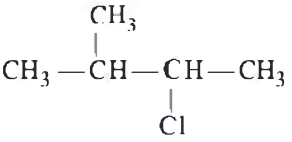
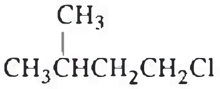
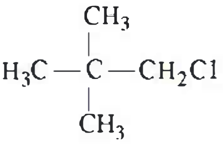
(vi) 

$$\mathrm{CH_3-\overset{\displaystyle CH_3}{\overset{|}{C}H}-\underset{\underset{\displaystyle Cl}{|}}{C}H-CH_3}$$

(vii) 

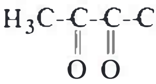
$$\mathrm{CH_3\overset{\displaystyle CH_3}{\overset{|}{C}}HCH_2CH_2Cl}$$

(viii) 

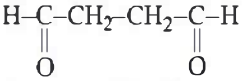
$$\mathrm{H_3C-\overset{\displaystyle CH_3}{\overset{|}{C}}\underset{\underset{\displaystyle CH_3}{|}}{}-CH_2Cl}$$

(19) **(b)** Remember that cis-tans geometrical isomerism is possible only in alkenes and further only in those alkenes in which each of the doubly bonded carbon atoms individually has different atoms/groups.

(20) **(d)** $C_4H_6O_2$ represents

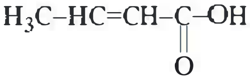


$$\mathrm{H_3C-\underset{\underset{\displaystyle O}{||}}{C}-\underset{\underset{\displaystyle O}{||}}{C}-CH_3}$$ A diketone

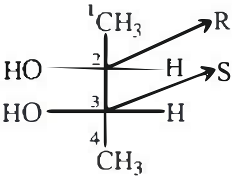


$$\mathrm{H-\underset{\underset{\displaystyle O}{||}}{C}-CH_2-CH_2-\underset{\underset{\displaystyle O}{||}}{C}-H}$$

Compound having two aldehydes

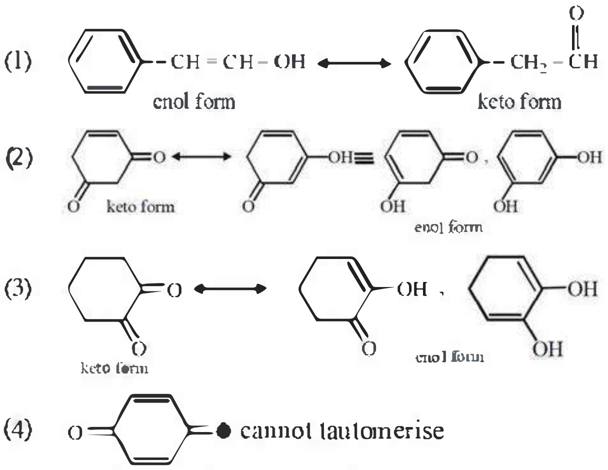


$$\mathrm{H_3C-HC=CH-\underset{\underset{\displaystyle O}{||}}{C}-OH}$$ Alkenoic acid

(21) **(a)** 

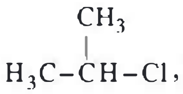
(22) **(a)** A meso compound has minimum two chiral centres and it has a plane of symmetry and it is optically inactive.

(23) **(a)**



(24) **(a)** In (4) two similar groups (CH_3) are present on one of the doubly bonded carbon atom: while in others the two doubly bonded carbon atoms have different atoms (groups).

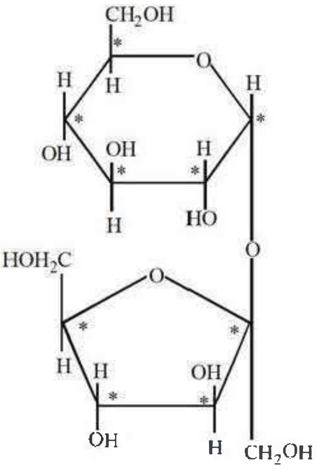
(25) **(a)** In option (a)

Both are identical species  $\mathrm{H_3C-\overset{\displaystyle CH_3}{\overset{|}{C}H}-Cl}$, there is no asymmetric 'C' atom present.

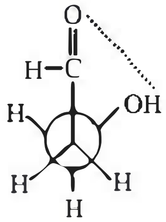
B, C, D have pairs of compounds which have chiral carbon and are non-superimposable on each other.

(26) **(d)** R'R and R'S are diastereomers and have different physical properties like water solubility, B.P., M.P. etc.

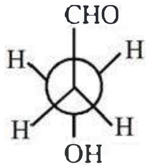
Mixture of diastereomers is optically active hence the product mixture in step 1 is optically active.

(27) **(c)** 

The star shown indicates chiral centre.

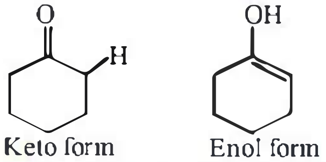
(28) **(c)** 

In some cases, gauche is more stable due to H-bonding.



Staggered has minimun steric crowding

(29) **(a)** In cyclohexanone keto enol tautomerism is as follows.



(30) **(b)** Trans isomer is more stable than cis isomer because in cis isomer, the bulky groups are on the same sides of the double bod. The steric repulsion of the groups makes the cis isomer less stable than the trans isomer in which the bulky groups are far apart because they are on the opposite sides of the double bond.

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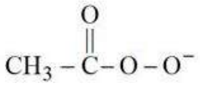
(1) (b) Anions of peracids do not exhibit resonance, hence not stabilized.



$CH_3-\overset{\overset{O}{\parallel}}{C}-O-O^-$

(2) (c) On increase branching, surface area decreases, thus boiling point decreases.

(3) (c) + I group increases the basicity of amine.

(4) (a) O atom is more electronegative

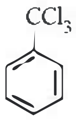
(5) (c) C_2-C_3 are at conjugated position.

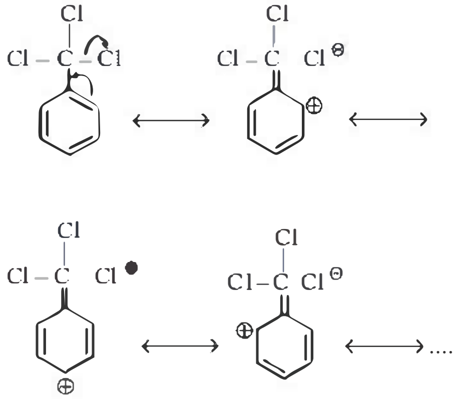
(6) (a) Lone pair of electrons on N-atom does not take part in resonance.

(7) (c) + I nature of CH_3 group increases electrons density on NH_2 group.

(8) (a) Due to ortho effect.

(9) (a) Electromeric effect comes into play at the demand of attacking reagent

(10) (c) There is a negative hyperconjugation in  as -



(11) (a) 2-chloropentanoic acid, due to more effective – I effect.

(12) (a) Partial displacement of electron takes place.

(13) (d) ter. alkyl group has highest + I effect.

(14) (d) NO_2

(15) (a) F has greater – I effect.

(16) (a)

(17) (a) – COOH exerts – M effect.

(18) (c)

(19) (a) Presence of – I group (–Cl) increases acidity of phenol.

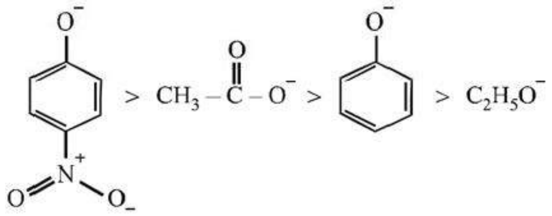
(20) (d) Presence of – NO_2 decreases electron density on N hence decreases basic character. Aryl substituted aliphatic amines ($C_6H_5CH_2NH_2$) are stronger bases than aniline because here lone pair of electrons is localised while in aniline it is delocalised.

(21) (b) Acidic strength ∝ –I power of the group.

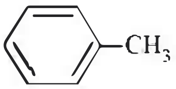
(22) (a) In 2-butene, no conjugation present.

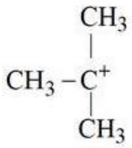
(23) (a) Resonating structures differ in bonding pattern.

(24) (a) Higher the stability of the corresponding anion, more will be the acidic character of the parent compound.



Higher stability of acetate ions than phenoxide ion is due to equivalent resonating structures in the former.

25. (b) 

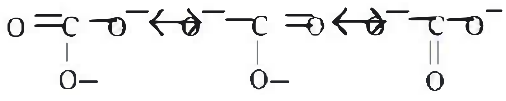
26. (c) 

$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C^+}}$

27. (a)

28. (c) Resonance structures contain the same number of unpaired electrons.

29. (b) CO_3^{2-} shows resonance and thus all the three bonds are of identical bond length.



30. (d) The anion left after the removal of α hydrogen is stabilized by resonance effect.

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(1) **(a)** Strongly electron-attracting group ($-NO_2$) present in *o*-position disperses negative charge of carbanion most effectively, thus, it increases stability.

(2) **(c)** Carbocations consist of 3 bond pairs in outermost orbit.

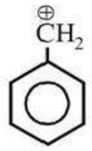
(3) **(b)** Presence of odd electrons.

(4) **(a)** + I group stabilises carbocation.

(5) **(c)** It is not affected by changes in polarity of solvent.

(6) **(a)** Allyl carbocation is resonance stabilised.

(7) **(a)**



$CH_2=CH-\overset{+}{C}H_2$

4-RS 2-RS

3° is more stable than 2°

(8) **(d)** +ve charge containing carbon joined with two other carbons.

(9) **(c)** Cyanide ion is an ambident nucleophile.

(10) **(a)** A nucleophile is electron-rich species.

(11) **(c)** BF_3 is electron deficient.

(12) **(d)** Weak bases are always better leaving groups.

(13) **(a)** $Cl-CH_2-COOH < Cl-CH_2CH_2COOH$
$< Cl-CH_2-CH_2-CH_2-COOH$

(14) **(c)** Ter. carbocation is most stable.

(15) **(a)** + I group decreases the stability of carbanion.

(16) **(d)** Order of stability of carbonium ions and free radicals is 3°>2°> 1°

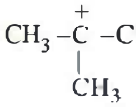
(17) **(a)** Order of stability of carbonium ions and free radicals is 3°>2°> 1°

(18) **(a)**

(19) **(a)** More resonance in (a).

(20) **(b)** + M effect of OH is highest, which decreases magnitude of charge, thus stability increases.

(21) **(c)** Because



$CH_3-\overset{+}{\underset{CH_3}{\underset{|}{C}}}-CH_3$ has '9' α– H atoms which is maximum in all four examples.

(22) **(a)** **(23)** **(a)** **(24)** **(c)**

(25) **(b)** Since the leaving group (Br) is departing before the attack of the nucleophile, the intermediate formed must be carbocation which is sp^2 hybridised.

(26) **(d)** When the nucleophile attacks the completely dissociated carbocation (IV), there is no steric hindrance on either side of the carbocation with the result a 50 : 50 racemic mixture is obtained.

(27) **(d)** When the nucleophile attacks the carbocation of either the intimate ion pair (II) or the solvent-separated ion pair (III), the leaving group will partially block the approach of the nucleophile to that side of the carbocation; with the result a non-50: 50 racemic mixture is obtained in which inverted configuration is in greater amount.

(28) **(c)** Statement -1 is false because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon–chlorine bond acquires partial double bond character, hence it becomes shorter and stronger and thus cannot be replaced by nucleophiles.

(29) **(a)** Due to +M effect of $-\ddot{O}H$, its intermediate carbocation is more stable than the one in benzene.

(30) **(b)** Heterolytic fission occurs when the two atoms differ considerably in their electronegativities and shared pair of electrons is carried by more electronegative atom.

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(1) **(b)** $(CH_3-CH_2)_3B \xrightarrow{H^+} \underset{(A)}{CH_3-CH_3}$, Mol. wt. = 30

$(CH_3-CH_2)_3B \xrightarrow[NaOH]{AgNO_3} \underset{(B)}{CH_3-CH_2-CH_2-CH_3}$,

Mol. wt. = 58

(2) **(c)** Due to symmetrical crystal structure, C_6H_{14} has maximum melting point.

(3) **(c)** $$\frac{\text{Volume of hydrocarbon}}{\text{Volume of } O_2} = \frac{2}{(3n+1)}$$

$\Rightarrow \frac{10}{x} = \frac{2}{7}$

$\Rightarrow x = 35 =$ Volume of O_2

$\therefore$ Volume of air $= 35 \times 5 = 175$ lit.

(4) **(c)** Above reaction is Reed reaction and product is sulphonyl chloride.

(5) **(d)** In the presence of $AlCl_3/HCl$ if any alkane having more than four carbon is heated, then isomerisation takes place.

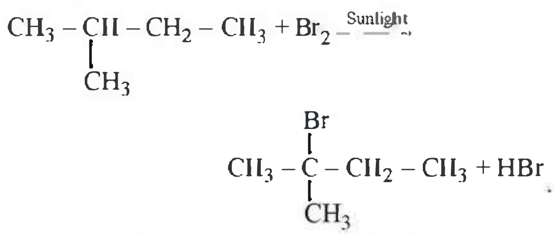
(6) **(c)** In the Wolff-Kishner reduction, carbonyl compound is converted into alkane by intermediate hydrazone.

(7) **(c)** $CH_3CH_2CH_3$

(8) **(a)** The end product (B) is $CH_3CH_2CH_3$

(9) **(c)** n-Propyl bromide

(10) **(c)**



$$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3+Br_2 \xrightarrow{\text{Sunlight}} CH_3-\overset{\overset{Br}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3+HBr$$

Ease of substitution of H atoms is 3°> 2°> 1°.

(11) **(b)** $R_2CuLi + R'X \dashrightarrow R-R' + RCu + LiX$

This is Corey-House reaction.

(12) **(b)** $RCO_2K \overset{\text{electrolysis}}{\dashrightarrow} R-R$

(13) **(b)** Isopropyl bromide.

(14) **(d)** An infinite conformers of ethane are possible including staggered, skew and eclipsed forms.

(15) **(a)** The Kolbe synthesis of alkane using a sodium salt of butanoic acid gives n-hexane.

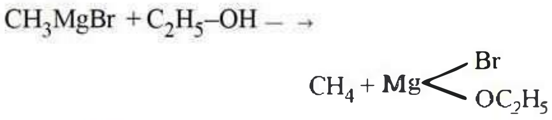
(16) **(b)** $CH_3-Br + 2Zn + Br-CH_3 \dashrightarrow CH_3-Zn-CH_3 + ZnBr_2$

$CH_3-Zn-CH_3 + CH_3-Br \dashrightarrow \underset{\text{Ethane}}{CH_3-CH_3} + CH_3ZnBr$

(17) **(d)** $2R-CH_2-X + 2Na \xrightarrow{\text{dry ether}} R-CH_2-CH_2-R + 2NaX$

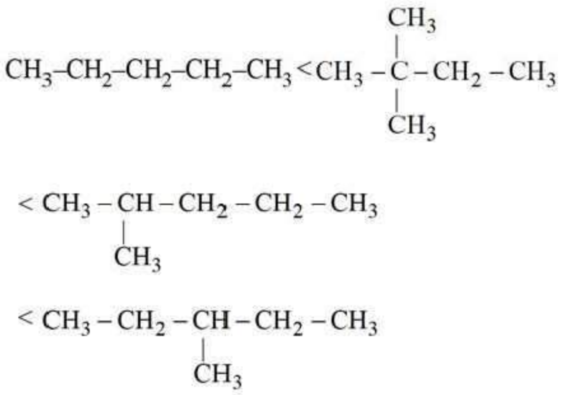
(18) **(d)** $2C_2H_5-I + 2Na \xrightarrow{\text{dry ether}} \underset{\text{(butane)}}{C_4H_{10}} + 2NaI$

(19) **(a)**



$$CH_3MgBr + C_2H_5-OH \dashrightarrow CH_4 + Mg\begin{matrix} Br \\ OC_2H_5 \end{matrix}$$

(20) **(a)** As the branching in isomeric alkane increases the boiling point decreases. So the boiling point order is–

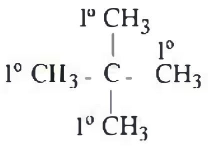


$$CH_3-CH_2-CH_2-CH_2-CH_3 < CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3$$

$$< CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_2-CH_3$$

$$< CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$$

(21) **(c)**



$$1^\circ CH_3-\overset{\overset{1^\circ CH_3}{|}}{\underset{\underset{1^\circ CH_3}{|}}{C}}-\overset{1^\circ}{CH_3}$$

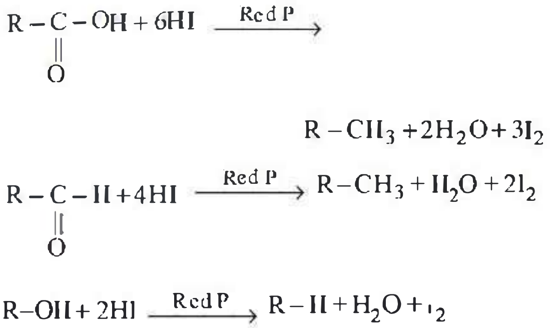
Note that all the methyl groups are equivalent.

(22) **(d)** The Wurtz reaction is generally used to form symmetrical alkanes because different alkyl halides such as RX & R'X forms a mixture of RR, R'R' & RR'.

(23) **(d)** $CH_3I + H_2 \xrightarrow{Na/C_2H_5OH} CH_4 + HI$

$CH_3I + 2H \xrightarrow[\text{couple}]{\text{Zn-Cu}} CH_4 + HI$

(24) **(a)**



$$R-\underset{\underset{O}{\|}}{C}-OH + 6HI \xrightarrow{\text{Red P}} R-CH_3 + 2H_2O + 3I_2$$

$$R-\underset{\underset{O}{\|}}{C}-H + 4HI \xrightarrow{\text{Red P}} R-CH_3 + H_2O + 2I_2$$

$$R-OH + 2HI \xrightarrow{\text{Red P}} R-H + H_2O + I_2$$

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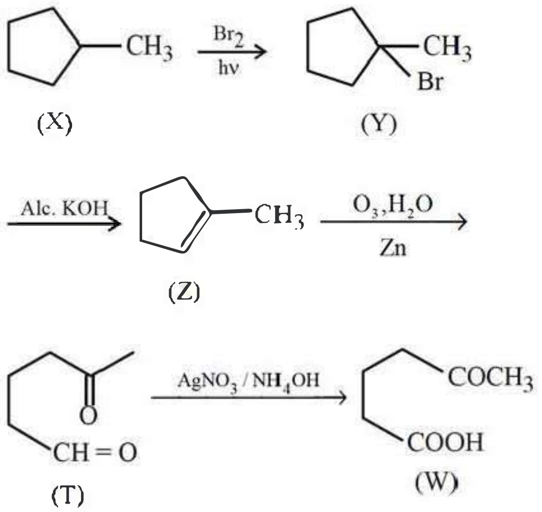
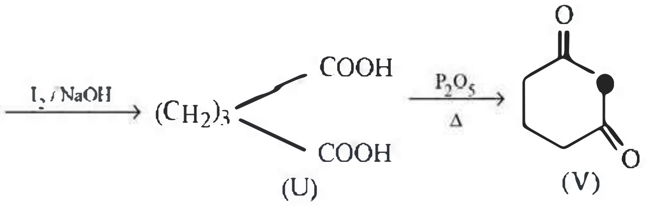
(25) (b), **(26)** (c), **(27)** (a)





(28) **(d)**

(29) **(b)** The statement-1 that chlorination of CH_4 does not takeplace in dark is correct because it is a free radical reaction and free radicals are obtained in presence of sunlight.

(30) **(b)** Alkanes with odd carbon atoms have the end carbon atoms on the same side of the molecule and in even carbon atom alkane, the end carbon atoms on opposite sides. Thus alkanes with even carbon atoms are packed closely in crystal lattice to permit greater intermolecular attraction and hence higher melting point.

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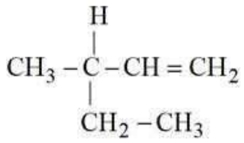
(1) (b)

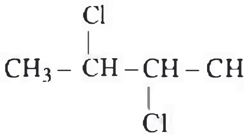


$$CH_3-\underset{CH_2-CH_3}{\overset{H}{C}}-CH=CH_2$$

Here the central carbon atom is an asymmetric carbon atom.

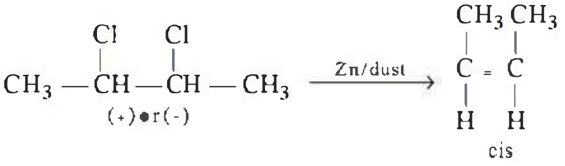
(2) (b) 1° halide generally gives E 2 mechanism.

(3) (c)



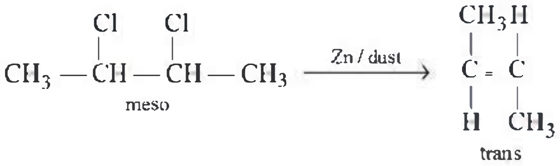
$$CH_3-\overset{Cl}{CH}-\underset{Cl}{CH}-CH_3$$ may be of two types.

It may be asymmetrical or meso and they can give different compounds.



$$CH_3-\overset{Cl}{CH}-\overset{Cl}{CH}-CH_3 \xrightarrow{Zn/dust} \overset{CH_3}{\underset{H}{C}} = \overset{CH_3}{\underset{H}{C}}$$

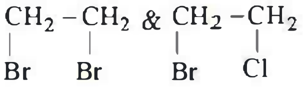
(+) or (-) cis



$$CH_3-\overset{Cl}{CH}-\overset{Cl}{CH}-CH_3 \xrightarrow{Zn/dust} \overset{CH_3}{\underset{H}{C}} = \overset{H}{\underset{CH_3}{C}}$$

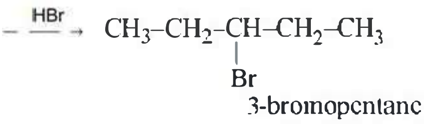
meso trans

(4) (b) In the presence of NaCl solution, the products are



$$\underset{Br}{CH_2}-\underset{Br}{CH_2} \;\&\; \underset{Br}{CH_2}-\underset{Cl}{CH_2}$$

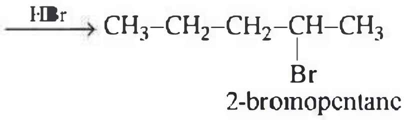
(5) (c) $CH_3 \rightarrow -CH_2 \rightarrow -\overset{+\delta}{CH}=\overset{-\delta}{CH}-CH_3$



$$\xrightarrow{HBr} CH_3-CH_2-\underset{Br}{CH}-CH_2-CH_3$$

3-bromopentane

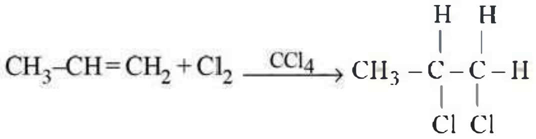
$CH_3-CH_2-\overset{-\delta}{CH}=\overset{+\delta}{CH} \leftarrow CH_3$



$$\xrightarrow{HBr} CH_3-CH_2-CH_2-\underset{Br}{CH}-CH_3$$

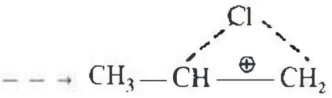
2-bromopentane

(6) (a)



$$CH_3-CH=CH_2+Cl_2 \xrightarrow{CCl_4} CH_3-\underset{Cl}{\overset{H}{C}}-\underset{Cl}{\overset{H}{C}}-H$$

(7) (d) $CH_3-CH=CH_2+H\bar{O}-\overset{+}{Cl}$



$$\dashrightarrow CH_3-CH\overset{\oplus}{-}CH_2$$

(8) (b) In hydroboration it is evident that in the overall reaction a molecule of water has been added to propene and the addition is contrary to Markownikoff's rule

$$3CH_3CH=CH_2+BH_3 \xrightarrow{0°C} (CH_3CH_2CH_2)_3B$$

Tripropylborane

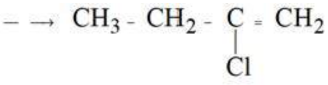
$$(CH_3CH_2CH_2)_3B+3H_2O_2+3NaOH \rightarrow 3CH_3CH_2CH_2OH$$

n – propyl alcohol

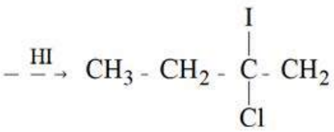
(9) (d) Ethene reacts with acidic $KMnO_4$ to form CO_2 and H_2O.

(10) (c) This reaction occurs according to Markownikoff's rule which states that when an unsymmetrical alkene undergo hydrohalogenation, the negative part goes to that C-atom which contain lesser no. of H-atom.

$CH_3-CH_2-C\equiv CH+HCl$



$$\dashrightarrow CH_3-CH_2-\underset{Cl}{C}=CH_2$$



$$\xrightarrow{HI} CH_3-CH_2-\underset{Cl}{\overset{I}{C}}-CH_2$$

(11) (c) Reaction is known as Priles Chaiev reaction.

(12) (c) Reaction is named as oxo and carboxylation. If $CO+H_2$ is taken then the reaction is named as a hydroformylation.

(13) (a) NBS is used for the bromo substitution of allylic hydrogen.

(14) (d)

(15) (b) $R-CH_2-CH_2-OH$

(16) (c) Reaction of HBr with propene in the presence of peroxide gives n-propyl bromide.

(17) (a) $CH_3CH_2CH_2Cl \xrightarrow{KOH(alc.)} CH_3CH=CH_2$

$CH_3CHClCH_3 \xrightarrow{KOH(alc.)} CH_3CH=CH_2$

(18) (d) The synthesis of ethene from electrolysis of an aqueous solution of potassium succinate is known as Kolbe's electrolysis synthesis.

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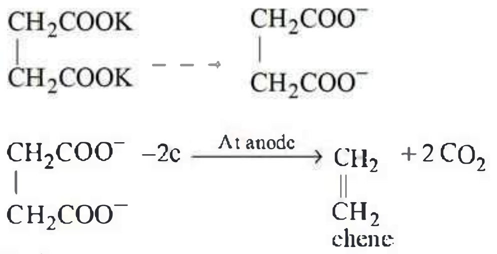
The reaction takes place as follows :



$$\begin{array}{l}CH_2COOK\\ |\\ CH_2COOK\end{array} \dashrightarrow \begin{array}{l}CH_2COO^-\\ |\\ CH_2COO^-\end{array}$$

$$\begin{array}{l}CH_2COO^-\\ |\\ CH_2COO^-\end{array} -2e \xrightarrow{\text{At anode}} \begin{array}{l}CH_2\\ \|\\ CH_2\\ \text{ethene}\end{array} +2\,CO_2$$

$2K^+ + 2e \dashrightarrow 2K$ (at cathode)

$2K + 2H_2O \dashrightarrow 2KOH + H_2$

(19) **(c)** The greater the no. of alkyl groups attached to the doubly bonded C atoms, the more stable the alkene is $R_2C=CH_2$.

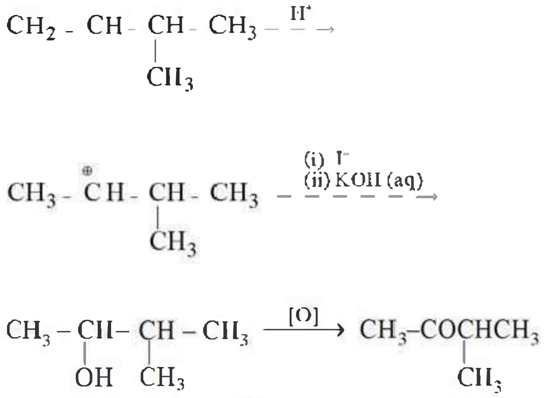
(20) **(c)** Propene on treatment with chlorine at 500-600°C produces allyl chloride. The reaction takes place as follows :

$$CH_3-CH=CH_2 \xrightarrow[500-600°C]{Cl_2} CH_2Cl-CH=CH_2$$

Allyl chloride

(80%) yield

(21) **(b)**

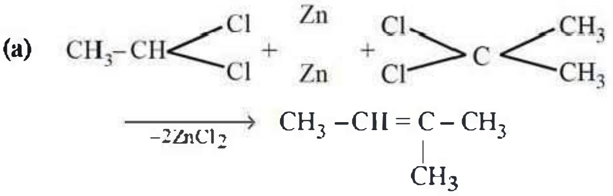


$$\begin{array}{l}CH_2-CH-CH-CH_3\\ \qquad\quad\;\, |\\ \qquad\quad CH_3\end{array} \overset{H^+}{\dashrightarrow}$$

$$\begin{array}{l}CH_3-\overset{\oplus}{C}H-CH-CH_3\\ \qquad\qquad\;\; |\\ \qquad\qquad CH_3\end{array} \xrightarrow{\text{(i) } I^- \text{ (ii) KOH (aq)}}$$

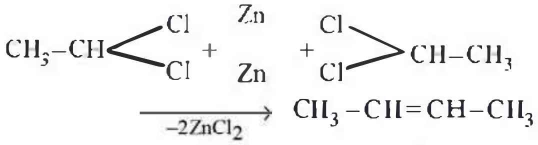
$$\begin{array}{l}CH_3-CH-CH-CH_3\\ \qquad\;\;\, |\qquad |\\ \qquad OH\;\; CH_3\end{array} \xrightarrow{[O]} \begin{array}{l}CH_3-COCHCH_3\\ \qquad\qquad\;\; |\\ \qquad\qquad CH_3\end{array}$$

(22) **(a)**



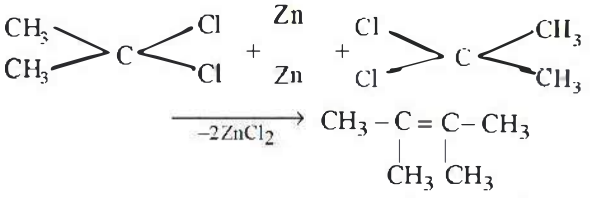
$$CH_3-CH{<}^{Cl}_{Cl} + {}^{Zn}_{Zn} + {}^{Cl}_{Cl}{>}C{<}^{CH_3}_{CH_3} \xrightarrow{-2ZnCl_2} \begin{array}{l}CH_3-CH=C-CH_3\\ \qquad\qquad\quad\;\; |\\ \qquad\qquad\quad CH_3\end{array}$$

2-methyl-2-butene



$$CH_3-CH{<}^{Cl}_{Cl} + {}^{Zn}_{Zn} + {}^{Cl}_{Cl}{>}CH-CH_3 \xrightarrow{-2ZnCl_2} CH_3-CH=CH-CH_3$$

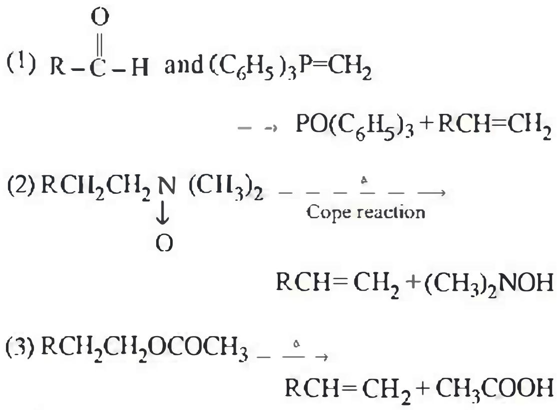
2-butene



$$^{CH_3}_{CH_3}{>}C{<}^{Cl}_{Cl} + {}^{Zn}_{Zn} + {}^{Cl}_{Cl}{>}C{<}^{CH_3}_{CH_3} \xrightarrow{-2ZnCl_2} \begin{array}{l}CH_3-C=C-CH_3\\ \qquad\quad\; |\quad\; |\\ \qquad\; CH_3\; CH_3\end{array}$$

2,3-dimethyl-2-butene

(23) **(a)** $RCH=CH_2$ can be obtained by all above reagents as follows :



(1) $R-\overset{\overset{\displaystyle O}{\|}}{C}-H$ and $(C_6H_5)_3P=CH_2$

$\dashrightarrow PO(C_6H_5)_3 + RCH=CH_2$

(2) $RCH_2CH_2\underset{\underset{\displaystyle O}{\downarrow}}{N}(CH_3)_2 \xrightarrow[\text{Cope reaction}]{\Delta}$

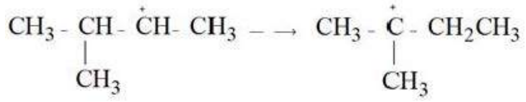
$RCH=CH_2 + (CH_3)_2NOH$

(3) $RCH_2CH_2OCOCH_3 \xrightarrow{\Delta}$

$RCH=CH_2 + CH_3COOH$

(24) **(d)** It is the test for unsaturation in molecule.

(25) **(c)** The intermediate 2° carbocation

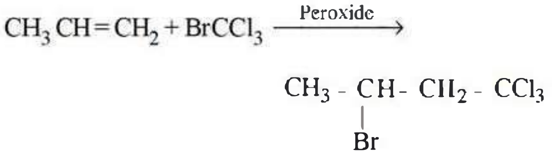


$$\begin{array}{l}CH_3-CH-\overset{+}{C}H-CH_3\\ \qquad\;\; |\\ \qquad CH_3\end{array} \longrightarrow \begin{array}{l}CH_3-\overset{+}{C}-CH_2CH_3\\ \qquad\quad |\\ \qquad CH_3\end{array}$$

undergoes rearrangement to form 3° carbocation.

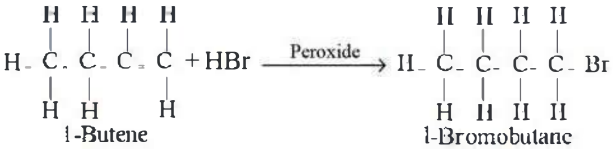
(26) **(b)** Peroxide effect is noticed only in case of HBr. Addition of HCl follows Markownikoff's rule.

(27) **(a)** Compounds like CCl_4, $CHCl_3$, $BrCCl_3$ etc also show peroxide effect, hence they will show anti-Markownikoff's addition in the presence of peroxides. The reaction with $BrCCl_3$ takes place as



$$CH_3CH=CH_2 + BrCCl_3 \xrightarrow{\text{Peroxide}} \begin{array}{l}CH_3-CH-CH_2-CCl_3\\ \qquad\quad\; |\\ \qquad\quad Br\end{array}$$

(28) **(a)**



$$\begin{array}{c}H\;\;H\;\;H\;\;H\\ |\;\;\;|\;\;\;|\;\;\;|\\ H-C-C-C=C\\ |\;\;\;|\;\;\;\;\;\;\;|\\ H\;\;H\;\;\;\;\;\;\;H\\ \text{1-Butene}\end{array} + HBr \xrightarrow{\text{Peroxide}} \begin{array}{c}H\;\;H\;\;H\;\;H\\ |\;\;\;|\;\;\;|\;\;\;|\\ H-C-C-C-C-Br\\ |\;\;\;|\;\;\;|\;\;\;|\\ H\;\;H\;\;H\;\;H\\ \text{1-Bromobutane}\end{array}$$

In this reaction anti Markownikoff's addition is explained on the basis of the fact that in the presence of peroxide the addition takes place via a free radical mechanism.

(29) **(a)**

(30) **(b)** With *trans*-2-butene, the product of Br_2 addition is meso (optically inactive).

Even though, both assertion and reason are correct. the correct reason for the formation of *meso*-2, 3-dibromobutane from *trans*-2-butene is *anti*-addition of Br_2.

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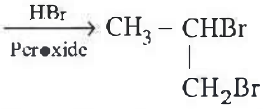
(1) **(c)** The product formed by the addition of HBr to propyne in the presence of H_2O_2 is $CH_3CH(Br)CH_2Br$, contrary to Markownikoff's rule.

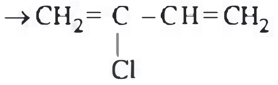
$$CH_3-C\equiv CH \xrightarrow[\text{Peroxide}]{HBr} CH_3-CH=CHBr$$



$$\xrightarrow[\text{Peroxide}]{HBr} \begin{matrix} CH_3-CHBr \\ | \\ CH_2Br \end{matrix}$$

(2) **(c)** On passing vinyl acetylene into conc. HCl in the presence of cuprous and ammonium chlorides, chloroprene is formed and the reaction proceeds by 1, 4-addition followed by rearrangement under the influence of the catalyst.

$$CH_2=CH-C\equiv CH+HCl\rightarrow [CH_2Cl-CH=C=CH_2]$$



$$\rightarrow CH_2=\underset{\underset{Cl}{|}}{C}-CH=CH_2$$

Chloroprene (2-chlorobuta-1, 3-diene)

(3) **(a)** $HCCl_3+6Ag+Cl_3HC \xrightarrow[-6AgCl]{} HC\equiv CH$

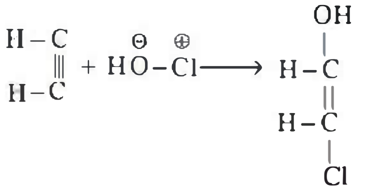
acetylene

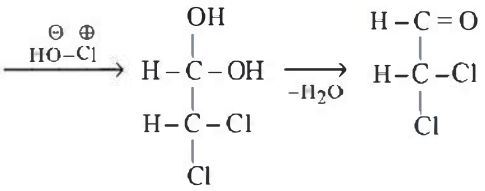
(4) **(b)** 2-Butyne mainly forms trans-2-butene on hydrogenation with $LiAlH_4$.

(5) **(b)** Reaction is called as 'Birch reduction'.

(6) **(a)** 2-Butyne forms cis-2-butene with Lindlar's catalyst.

(7) **(b)** Chlorine water $(HO^{\ominus}-Cl^{\oplus})$ reacts with acetylene and gives dichloroethanal





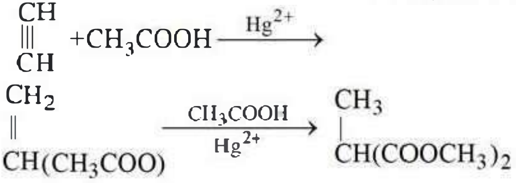
(8) **(b)** In dil H_2SO_4 alkyne is hydrolysed to form ketone, here acetone will be the main product.

(9) **(d)** This is the exceptional case of oxidation in which triple bonded carbon is not separated. The product is oxalic acid.

(10) **(d)** In the presence of hot iron pyrite, thiophene is formed as a product, when NH_3 is taken in place of sulphur, pyrrole is formed.

(11) **(a)** $CH_2=O+H-C\equiv C-H+CH_2=O \xrightarrow{Cu}$
$HOCH_2-C\equiv C-CH_2OH$
2-butyne-1,4 diol.

(12) **(a)**



$$\begin{matrix} CH \\ ||| \\ CH \end{matrix} + CH_3COOH \xrightarrow{Hg^{2+}} \begin{matrix} CH_2 \\ || \\ CH(CH_3COO) \end{matrix} \xrightarrow[Hg^{2+}]{CH_3COOH} \begin{matrix} CH_3 \\ | \\ CH(COOCH_3)_2 \end{matrix}$$

(13) **(c)** 2-Butyne is the chief product according to Saytzeff's rule.

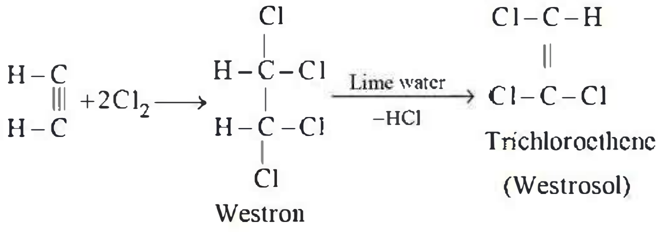
$$CH_3CH(Cl)CH(Cl)CH_3 \longrightarrow CH_3C\equiv CCH_3$$

(14) **(a)** $HC\equiv C-MgCl+C_2H_5Br \longrightarrow$
$HC\equiv C-C_2H_5+Mg(Cl)Br$

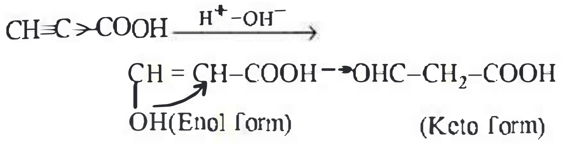
(15) **(c)** In Kolbe's synthesis, sodium or potassium salt of maleic acid or fumaric acid on electrolysis gives acetylene or ethyne at anode.

(16) **(c)** The order of acidity of H_2O, NH_3 and acetylene depends upon the relative basicity of OH^-, NH_2^- and $HC\equiv C^-$. The decreasing nature of basic character is $NH_2^- > HC\equiv C^- > OH^-$, hence the decreasing order of acidity is $H_2O > HC\equiv CH > NH_3$.

(17) **(d)** Acetylene adds up two molecules of chlorine to give tertachloroethane, known as westron industrially. This on dehydrochlorination with lime water gives trichloroethene, commerically called westrosol



(18) **(c)**



$$CH\equiv C-COOH \xrightarrow{H^{+}-OH^{-}} \underset{\text{OH(Enol form)}}{CH=CH-COOH} \dashrightarrow \underset{\text{(Keto form)}}{OHC-CH_2-COOH}$$

(19) **(d)** When acetylene is passed into methanol at 160-200°C in the presence of a small amount (1-2%) of potassium methoxide and under pressure just high enough to prevent boiling, methyl vinyl ether is formed.
The mechanism is believed to involve nucleophilic attack in the first step.

$$HC\equiv CH+CH_3O^-\rightarrow C^-H=CHOCH_3$$

$$\xrightarrow{CH_3OH} CH_2=CHO\,CH_3+CH_3O^-$$

Methyl vinyl ether

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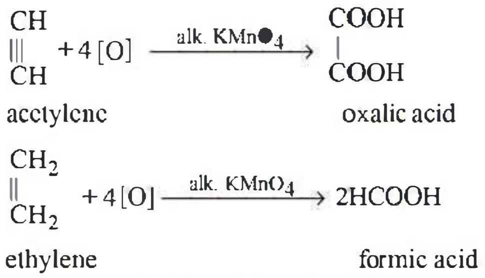
(20) **(a)** Acetylene and ethylene react with alk. $KMnO_4$ to give oxalic acid and formic acid respectively.



$$\begin{matrix}CH\\ |||\\ CH\end{matrix} + 4[O] \xrightarrow{\text{alk. }KMnO_4} \begin{matrix}COOH\\ |\\ COOH\end{matrix}$$

acetylene — oxalic acid

$$\begin{matrix}CH_2\\ ||\\ CH_2\end{matrix} + 4[O] \xrightarrow{\text{alk. }KMnO_4} 2HCOOH$$

ethylene — formic acid

(21) **(d)** Terminal alkynes ($\equiv C-H$) give white precipitate with Tollen's reagent (ammoniacal $AgNO_3$)

(22) **(d)** Each triply bonded carbon is *sp* hybridised & has 2π & 1σ bonds.

(23) **(a)** Potassium fumarate on electrolysis, CaC_2 on hydrolysis and ethylene bromide on elimination give acetylene. Aluminium carbide on hydrolysis produces methane.

(24) **(b)** $CH{\equiv}CH \xrightarrow[60°C]{H_2SO_4.HgSO_4} \underset{A}{CH_3CHO} \xrightarrow{[O]} \underset{B}{CH_3COOH}$

(25) **(d)** Acetylene contains two acidic hydrogen atoms.

(26) **(a)**

(27) **(a)** $AgC\equiv CAg$ is white and $CuC\equiv CCu$ is red.

(28) **(d)**

(29) **(a)** The low reactivity of alkynes towards electrophilic addition reactions is believed to be due to following two factors.

(1) The bridged intermediate cation formed by the initial attack of electrophile on the triple bond is less stable because it is a highly strained system.

(2) In acetylenic carbon atoms, the π electrons are more tightly held by the carbon nuclei and hence they are less easily available for reaction with electrophiles.

Thus both the above factors, steric and elctronic, play their part in diminishing the reactivity of alkynes towards electrophiles.

(30) **(a)**

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CHEMISTRY SOLUTIONS

(28)

(1) **(a)** Sewage is a biodegradable pollutant as it can be decomposed by micro-organisms either by nature or by suitable treatment. The other options are non-biodegradable pollutants.

(2) **(c)**

(3) **(a)** By measuring BOD the quantity of organic pollutants in water can be determined. The total amount of oxygen consumed by micro-organisms (bacteria) in decomposing the organic matter present in a certain volume of a sample of water is called BOD of water.

(4) **(a)** Fluorine upto 1 ppm, F^- protects teeth against decay. However, concentrations above 2 ppm causes brown mottling of teeth.

(5) **(a)** Chlorine treatment of water disinfects by killing genus.

(6) **(a)**

(7) **(c)** Sudden mass death of fishes from oxygen depletion is more likely in case of eutrophic lake. An eutrophic lake has an excess of phosphate ions in it (due to inflow of nutrients from fertilizers) which results in dense plant population which consumes oxygen and causes oxygen depletion in water. As a result, the fishes start perishing.

(8) **(d)** Continuous sewage flow into a stream would lead to depletion of oxygen. Discharge of sewage into water results in excessive phytoplankton growth and the micro-organisms which decompose this organic matter need oxygen. This results in depletion of oxygen in water.

(9) **(a)** Water.

(10) **(b)** The pollutants chlorofluorocarbons contributed by aerosols are major source of air pollution. Once CFC's are released in the atmosphere, they mix with atmospheric gases, reach stratosphere where they are broken by UV radiations into $\dot{Cl}$ free radical which damages the ozone layer.

(11) **(d)** Acid rains are produced by excess NO_2 and SO_2 from burning of fossil fuels. SO_2 and NO_2 after oxidation and reaction with water are major contributors to acid rain :

$$2SO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 2\,H_2SO_4\,(aq)$$

$$4NO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 4HNO_3\,(aq)$$

(12) **(a)** The common components of photochemical smog are ozone (O_3), nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN).

(13) **(a)** Water pollution causes increased deoxygenation and turbidity.

(14) **(b)** Most harmful types of environment pollutants are non-biodegradable chemicals. This is because they are not degraded and their presence even in small amounts in the atmosphere is harmful. They can react with other compounds to produce even more toxic compounds.

The other options are all biodegradable pollutants which can degrade by themselves or by micro-organisms.

(15) **(d)** Freons are chlorofluorocarbons (CFC's). In stratosphere, they are broken by UV radiations to produce $\dot{Cl}$ free radical which destroys ozone layer.

(16) **(c)**

(17) **(c)** With the depletion of ozone layer, more UV radiations filter into troposphere which leads to ageing of skin, sunburns, skin cancer etc.

(18) **(c)**

(19) **(a)** CO binds with Hb to form carboxy–Hb, which is much more stable than O_2–Hb complex. As a result, oxygen carrying capacity of blood is greatly reduced resulting in respiratory problems.

(20) **(d)**

(21) **(c)** **(22)** **(a)** **(23)** **(a)**

(24) **(c)** The air around Taj Mahal has fairly high levels of SO_x and NO_x. The resulting acid rain reacts with marble, $CaCO_3$ of Taj Mahal ($CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$) causing damage to the monument.

(25) **(b)** **(26)** **(c)** **(27)** **(c)**

(28) **(b)** **(29)** **(b)** **(30)** **(c)**

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CHEMISTRY SOLUTIONS

29

(1) **(b)** Gases and liquids possess fluidity and hence they have viscosity as a common property. Molecules in the solid state do not have translational motion. Thus, statement (b) is the only true statement.

(2) **(a)** The existence of a substance in more than one crystalline form is known as polymorphism.

(3) **(d)** Dulong and Petit's law is valid for all solids except Be, C and Si.

(4) **(a)**

(5) **(a)**

(6) **(b)** LiF is an example of ionic crystal solid, in which constituent particles are positive (Li^+) and negative (F^-) ions.

(7) **(d)** They are comparatively soft and not very rigid.

(8) **(a)** Ice has the lowest melting point out of the given solids, hence it has the weakest intermolecular forces.

(9) **(b)** Tetragonal system has the unit cell dimension

$a = b \neq c$ and $\alpha = \beta \neq \gamma \neq 90°$

(10) **(c)** It is the definition of unit cell.

(11) **(b)**

(12) **(d)** Radius ratio in TlCl is 0.732 – 1.000 and co-ordination number is 8 and arrangement is body centred cubic.

(13) **(c)** Zinc blende (ZnS) has fcc structure.

(14) **(b)**

(15) **(b)** Number of tetrahedral voids in the unit cell

$= 2 \times$ number of atoms $= 2Z$.

(16) **(d)** It represents ccp arrangement.

(17) **(c)** AB_2 type of structure is present in CaF_2

$$\therefore \; n = 8 \times \frac{1}{8} + \left(6 \times \frac{1}{2}\right) = 4.$$

(18) **(c)** Tetrahedral sites are double comparable to octahedral sites then ratio of X and Z respectively is 2 : 1. Thus the formula of the compound X_2Z.

(19) **(a)** Co-ordination number in HCP and CCP arrangements is 12 while in bcc arrangement it is 8.

(20) **(d)** In NaCl (rock salt) : Number of Na^+ ions = 12 (at edge centers) $\times \frac{1}{4} + 1$ (at body centre) $\times 1 = 4$. Number of Cl^- ions = 8 (at corners) $\times \frac{1}{8} + 6$ (at face centre) $\times \frac{1}{2} =$ 4 . Thus 4 formula units per unit cell.

(21) **(b)** Co-ordination number in HCP = 12

Co-ordination number in Mg is also = 12

(22) **(a)** Rhombohedral crystal system

$a = b = c, \; \alpha = \beta = \gamma \neq 90°$

ex – Na_2CO_3, $CaSO_4$, $CaCO_3$, HgS

Thus (1), (2) and (3) are incorrect.

(23) **(a)** As solids are also non-crystalline in nature, thus statement (1), (2) and (3) are the correct statements.

(24) **(c)** Ionic crystals possess high melting and boiling points and they also exhibit non-directional properties of the bond.

(25) **(d)** The angle of intersection between corresponding faces in crystals "*A*" and "*B*" will be same. Thus it will be constant and it will be equal as both "*A*" and "*B*" represent crystal structure of the same substance.

(26) **(a)** The law is still valid because the external form depends upon rate of deposition of atoms or ions on different faces.

(27) **(c)** There are three types of unit cells that fall in this category (i.e. cubic).

(28) **(c)** Tetrahedral holes are smaller in size than octahedral holes. Cations usually occupy less space than anions. Thus, statement-2 is correct and statement-1 is incorrect.

(29) **(c)** Crystalline solids have regular arrangement of constituent particles and are anisotropic whereas amorphous solids have no regular arrangement and are isotropic. Thus statement-2 is correct and statement-1 is incorrect.

(30) **(a)** Schottky defect is due to missing of equal number of cations and anions.

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(30)

1. **(d)** Density of unit cell

$$= \frac{N \times \text{Mol.wt.}(M)}{a^3 \times \text{Avogadro no.}(N_A)} \text{g cm}^{-3}$$

2. **(b)** Distance between K^+ and F^- = $\frac{1}{2} \times$ length of the edge

3. **(a)** The number of spheres in one body centred cubic and in one face centred cubic unit cell is 2 and 4 respectively.

4. **(b)** $n\lambda = 2d\sin\theta$

5. **(a)** $\frac{1}{58.5} \times 6.023 \times 10^{23} = 1.029 \times 10^{22}$

A unit cell contains 4 Na^+ ion and 4 Cl^- ions

$\therefore$ Unit cell = $\frac{1.029 \times 10^{22}}{4} = 2.57 \times 10^{21}$ unit cell

6. **(b)** Bragg's equation is $n\lambda = 2d\sin\theta$

Where n is an integer i.e. 1, 2, 3, 4 etc.

7. **(c)** $Z = \frac{V \times N_A \times d}{M}$

$$= \frac{4.2 \times 8.6 \times 8.3 \times 10^{-24} \times 6.023 \times 10^{23} \times 3.3}{155} = 3.84 = 4$$

8. **(b)** In a unit cell, atoms (W) at the corner = $\frac{1}{8} \times 8 = 1$

atoms (O) at the centre of edges = $\frac{1}{4} \times 12 = 3$

atoms (Na) at the centre of the cube = 1

W : O : Na = 1 : 3 : 1, hence formula = $NaWO_3$

9. **(a)** Let the units of ferrous oxide in a unit cell = n, molecular weight of ferrous oxide (FeO) = 56 + 16 = 72 g mol^{-1},

Weigth of n units = $\frac{72 \times n}{6.023 \times 10^{23}}$,

Volume of one unit = $(\text{length of edge})^3$

$= (5Å)^3 = 125 \times 10^{-24}\ cm^3$

Density = $\frac{\text{wt. of cell}}{\text{volume}}$,

$$4.0 = \frac{72 \times n}{6.023 \times 10^{23} \times 125 \times 10^{-24}}$$

$$n = \frac{3079.2 \times 10^{-1}}{72} = 42.7 \times 10^{-1} = 4.27 \approx 4$$

10. **(b)** $r_+ / r_- = \frac{180}{187} = 0.962$ which lies in the range of 0.732 – 1.000, hence co-ordination number = 8 i.e. the structure is CsCl type.

11. **(c)** Mg has 6 co-ordination number (fcc structure)

12. **(d)** Crystals show good cleavage because their constituent particles are arranged in planes.

13. **(c)** The phenomenon is called piezoelectricity.

14. **(b)** When radius ratio is between 0.732 – 1, then co-ordination number is 8 and structural arrangement is body-centred cubic.

15. **(d)** All the given statements are correct about F -centres.

16. **(a)** As each Sr^{2+} ion introduces one cation vacancy, therefore concentration of cation vacancies = mol % of $SrCl_2$ added.

17. **(c)** Yellow colour on heating NaCl in presence of Na is due to presence of electrons in anion vacancies (F -centres)

18. **(a)** Impurity present in a crystal does not establish thermal equilibrium.

19. **(c)** AgBr exhibits Frenkel defect due to large difference in the size of Ag^+ and Br^- ions.

20. **(b)** Brass, Cu = 80%, Zn = 20% is substitutional alloy.

Steel is an interstitial alloy because it is an alloy of Fe with C, C atoms occupy the interstitial voids of Fe crystals.

21. **(d)** F -centres are the sites where anions are missing and instead electrons are present which are responsible for colour.

22. **(a)** In NaCl crystal, Na^+ ions have coordination number 6. Statements (1), (2) and (3) are correct statements.

23. **(a)** AgBr exhibits Frenkel defect due to large difference in the size of Ag^+ and Br^- ions. Statements, (1), (2) and (3) are correct choices.

24. **(a)** Point defects are present in ionic solids.

25. **(b)** In 1 unit cell of hcp, the number of atoms can be calculated as follows

Number of atoms in a unit cell of hcp

$$= 12 \times \frac{1}{6} + 2 \times \frac{1}{2} + 3 = 6$$

i.e. the correct answer is option (b)

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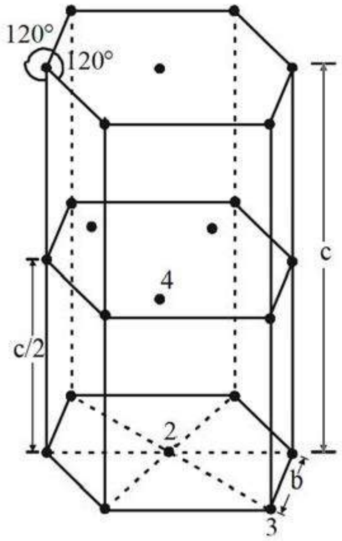
[∵ in a hexagonal close packing (hcp) the spheres in the first and third layers are vertically aligned. (See figure below]



26. **(a)** The volume of hcp unit cell is given by the formula:-

Volume of hexagon = Area of base × height

$$= 6\times\frac{\sqrt{3}}{4}(2r)^2\times 4r\sqrt{\frac{2}{3}} = 24\sqrt{2}\,r^3$$

i.e. the correct answer is option (a)

27. **(d)** In a hcp unit cell the space occupied is 74%, as calculated below

$$\text{Packing fraction} = \frac{\text{Volume of the atoms in a unit cell}}{\text{Volume of a unit cell}}$$

$$= \frac{6\times\frac{4}{3}\pi r^3}{24\sqrt{2}\,r^3} = \frac{\pi}{3\sqrt{2}} = \frac{22}{7}\times\frac{1}{3\sqrt{2}}$$

$$= 0.74 \text{ or } 74\ \%$$

∴ Empty space in hcp unit cell = (100 − 74)% = 26%

i.e. the correct answer is option (d).

28. **(b)** Space or crystal lattice is a regular repeating arrangement of points in space and forms the basis of classification of all structures.

29. **(b)** When an atom or an ion is missing from its normal lattice site, a lattice vacancy or defect is created, which is called Schottkey defect. Due to missing species, density of crystal will be lowered.

30. **(b)** On heating the metal atoms deposit on the surface and finally they diffuse into the crystal and after ionisation the alkali metal ion occupies cationic vacancy whereas electron occupies anionic vacancy.

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