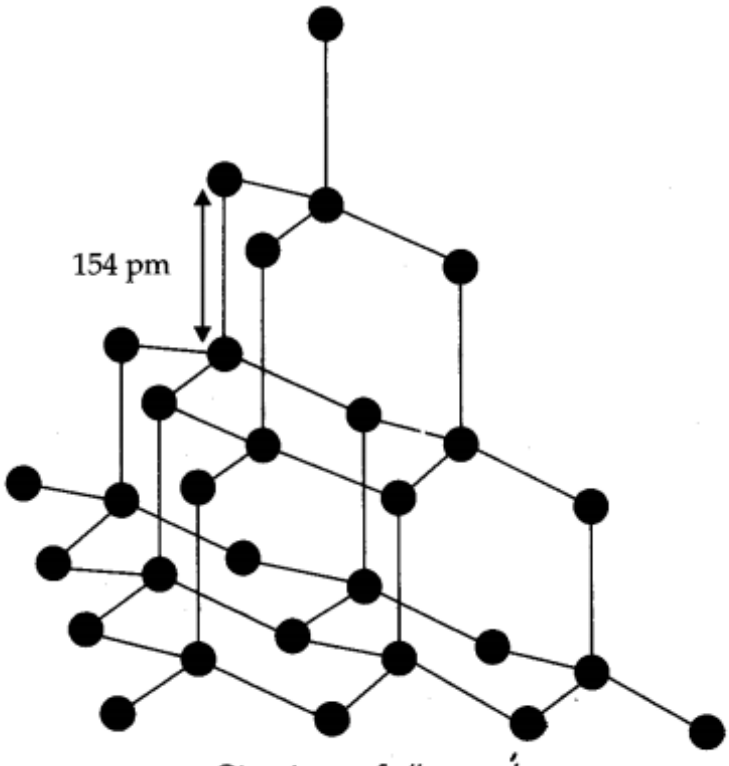
Question 22. Give reasons:
(i) Cone. HNO_3 can be transported in aluminium container.
(ii) A mixture of dilute NaOH and aluminium pieces is used to open drain.
(iii) Graphite is used as lubricant.
(iv) Diamond is used as an abrasive.
(v) Aluminium alloys are used to make aircraft body.
(vi) Aluminium utensils should not be kept in water overnight.
(vii) Aluminium wire is used to make transmission cables.
Answer:
(i) Al reacts with cone. HNO_3 to form a very thin film of aluminium oxide on its surface which protects it from further reaction.
$2Al(s) + 6HNO_3$ (conc.) $\rightarrow Al_2O_3(s) + 6NO_2(g) + 3H_2O(l)$
(ii) NaOH reacts with Al to evolve H_2 gas. Thus the pressure of the gas produced can be used for clogged drains.
$2Al(s) + 2NaOH(aq) + 2H_2O(l) \rightarrow 2NaAlO_2(aq) + 3H_2(g)$
(iii) Graphite has layered structure which are held by weak van der Waals forces. Thus, graphite cleaves easily between the layers, therefore it is very soft and slippery. That's why it is used as lubricant.
(iv) Diamond is used as an-abrasive because it is an extremely hard substance.
(v) Alloys of aluminium, like duralumin, is used to make aircraft body due to some of its property like toughness, lightness and resistant to corrosion.
(vi) Generally, aluminium metal does not react with water quickly but, when it is kept overnight, it reacts slowly with water in presence of air.
$2Al(s) + O_2(g) + H_2O(l) \rightarrow Al2O_3(S) + H_2(g)$
a very small amount of (in ppm) Al^{3+} produced in the solution is injurious to health if the water is used for drinking purposes.
(vii) Aluminium is generally unaffected by air and moisture and it is also good conductor of electricity. That's why it is used in transmission cables.

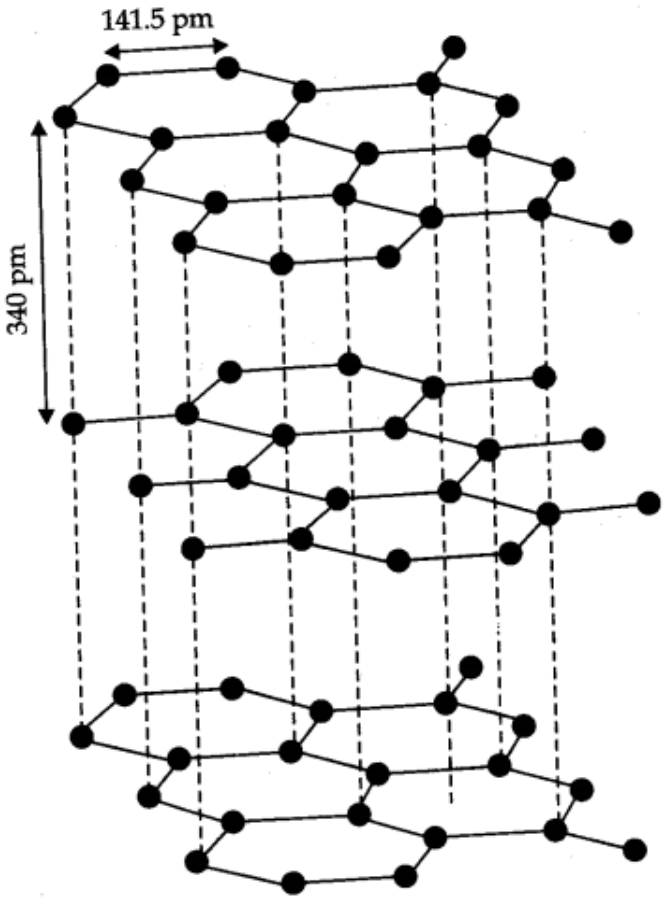
Question 23. Explain why is there a phenomenal decrease in ionization enthalpy from carbon to silicon.
Answer: Because there is increase in atomic size on moving from carbon to silicon, the screening effect increases. Thus the force of attraction of nucleus for the valence electron decreases as compared to carbon. Thus the ionization enthapy decreases from carbon to silicon.

Question 24. How would you explain the lower atomic radius of Ga as compared to Al?
Answer: Due to poor shielding effect of d-electrons in Ga, the electrons in gallium experience great force of attraction by nucleus as compared to Al.

Question 25. What are allotropes? Sketch the structure of two allotropes of carbon namely diamond and graphite. What is the impact of structure on physical properties of two allotropes?
Answer: Allotropes: Allotropes are the different forms of an element which are having same chemical properties but different physical properties due to their structures.



Structure of diamond



Structure of Graphite

In diamond, carbon is SP^3 -hybridized. Since, diamond is three dimensional network solid, it is hardest substance with high density whereas graphite has a layered structure. The various layers are formed by van der Waals forces of attraction that's why graphite is soft and slippery.

Question 26. (a) Classify following oxides as neutral, acidic, basic or amphoteric
CO, B_2O_2, SiO_2, CO_2, Al_2O_3, PbO_2, Tl_2O_3

(b) Write suitable equations to show their nature.
Answer: (a) Neutral — CO
Acidic — B_2O_2, SiO_2, CO_2 Basic — Tl_2O_3 Amphoteric — Tl_2O_3, PbO_2
(b) CO does not react with acid as well as base at room temperature.
Being acidic B_2O_3, SiO_2 and CO_2 reacts with alkalis to form salts.

$$B_2O_3 + 2NaOH \longrightarrow 2NaBO_2 + H_2O$$
Boric anhydride — Sod. metaborate

$$SiO_2 + 2NaOH \xrightarrow{\Delta} Na_2SiO_3 + H_2O$$
Sod. silicate

$$CO_2 + 2NaOH \longrightarrow Na_2CO_3 + H_2O$$
Sod. carbonate

Being amphoteric, Al_2O_3, and PbO_2 react with acids and bases.

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$
$$Al_2O_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2O$$
$$PbO_2 + 2NaOH \longrightarrow Na_2PbO_3 + H_2O$$
$$2PbO_2 + 2H_2SO_4 \longrightarrow 2PbSO_4 + 2H_2O + O_2$$

Being Basic Tl_2O_3 dissolves in acids.

$$Tl_2O_3 + 6HCl \longrightarrow 2TlCl_3 + 3H_2O$$

Question 27. In some of the reactions thallium resembles aluminium, whereas in others it resembles with group 1 metals. Support this statement by giving some evidences.
Answer: Tl shows both the oxidation state +1 and +3 due to inert pair effect. Tl forms basic oxide like group I elements. TlO_2 is strongly basic.

Question 28. When metal X is treated with sodium hydroxide, a white precipitate (A) is obtained, which is soluble in excess of NaOH to give soluble complex (B). Compound (A) is soluble in dilute HCl to form compound (C). The compound (A) when heated strongly gives (D), which is used to extract metal. Identify (X), (A), (B), (C) and (D). Write suitable equations to support their identities.
Answer:

$$\underset{(X)}{Al} + 3NaOH \longrightarrow \underset{(A)}{Al(OH)_3}\downarrow + 3Na$$

$$\underset{(A)}{Al(OH)_3} + NaOH \longrightarrow \underset{\text{Soluble 'B'}}{Na^+[Al(OH)_4]^-}$$
Sod. tetrahydroxoaluminate (III)

Since *A* is amphoteric in nature.

$$\underset{(A)}{Al(OH)_3} + \text{dil. } HCl \longrightarrow \underset{(C)}{AlCl_3} + 3H_2O$$

$$\underset{(A)}{2Al(OH)_3} \xrightarrow{\Delta} \underset{(D)}{Al_2O_3} + 3H_2O$$

Question 29. What do you understand by (a) inert pair effect (b) allotropy and (c) catenation?
Answer:
(a) Inert pair effect: The pair of electron in the valence shell does not take part in bond formation is called inert pair effect.
(b) Allotropy: It is the property of the element by which an element can exist in two or more forms which have same chemical properties but different physical properties due to their structures.

(c) Catenation: The property to form chains or rings not only with single bonds but also with multiple bonds with itself is called catenation.
For example, carbon forms chains with (C-C) single bonds and also with multiple bonds (C = C or C = C).

Question 30. A certain salt X, gives the following results.
(i) Its aqueous solution is alkaline to litmus.
(ii) It swells up to a glassy material Y on strong heating.
(iii) When cone.H_2SO_4 is added to a hot solution of X, white crystal of an acid Z separates out.
Answer:

(i) $Na_2B_4O_7 + 10H_2O \xrightarrow{\text{water}} 2NaOH + H_2B_4O_7 + 8H_2O$

(ii) $Na_2B_4O_7 \xrightarrow{\text{heat}} 2NaBO_2 + B_2O_3$

(iii) $Na_2B_4O_7 \cdot 10H_2O + H_2SO_4 \longrightarrow 4H_3BO_3 + Na_2SO_4 + 5H_2O$

Question 31. Write balanced equations for:
(i) $BF_3 + LiH \longrightarrow$ (ii) $B_2H_6 + H_2O \longrightarrow$ (iii) $NaH + B_2H_6 \longrightarrow$
(iv) $H_3BO_3 \xrightarrow{\Delta}$ (v) $Al + NaOH \longrightarrow$ (vi) $B_2H_6 + NH_3 \longrightarrow$

Answer:

(i) $2BF_3 + 6LiH \longrightarrow \underset{\text{Diborane}}{B_2H_6} + 6LiF$

(ii) $\underset{\text{Diborane}}{B_2H_6} + 6H_2O \longrightarrow \underset{\text{Orthoboric acid}}{2H_3BO_3} + 6H_2$

(iii) $2NaH + B_2H_6 \longrightarrow \underset{\text{Sod. borohydride}}{2Na^+[BH_4]^-}$

(iv) $\underset{\text{Orthoboric acid}}{H_3BO_3} \xrightarrow{\Delta} \underset{\text{Metaboric acid}}{HBO_2} + H_2O$

$\underset{\text{Metaboric acid}}{4HBO_2} \xrightarrow[-H_2O]{\Delta} \underset{\text{Tetraboric acid}}{H_2B_4O_7} \longrightarrow \underset{\text{Boron trioxide}}{2B_2O_3} + H_2O$

(v) $2Al + 2NaOH + 6H_2O \longrightarrow \underset{\text{Sod. tetrahydroxoaluminate (III)}}{2Na^+[Al(OH)_4]^-} + 3H_2$

(vi) $B_2H_6 + 2NH_3 \longrightarrow \underset{\text{Borane-ammonia complex}}{2BH_3 \cdot NH_3}$

Question 32. Give one method for industrial preparation and one for laboratory preparation of CO and $C0_2$ each.
Answer:

Carbon monoxide

Industrial: $2C(s) + O_2(g) \xrightarrow[\text{air}]{\text{Limited}} 2CO(g)$

Laboratory: $\underset{\text{Formic acid}}{HCOOH} \xrightarrow{H_2SO_4} CO + H_2O$

Carbon dioxide

Industrial: $C(s) + O_2(g) \xrightarrow[\text{air}]{\text{Excess}} CO_2(g)$

Laboratory: $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

Question 33. An aqueous solution of borax is
(a) neutral
(b) amphoteric
(c) basic
(d) acidic
Answer: Borax is a salt of a strong base (NaOH) and a weak acid (H_3BO_3), therefore, it is basic in nature, i.e., option (c) is correct.

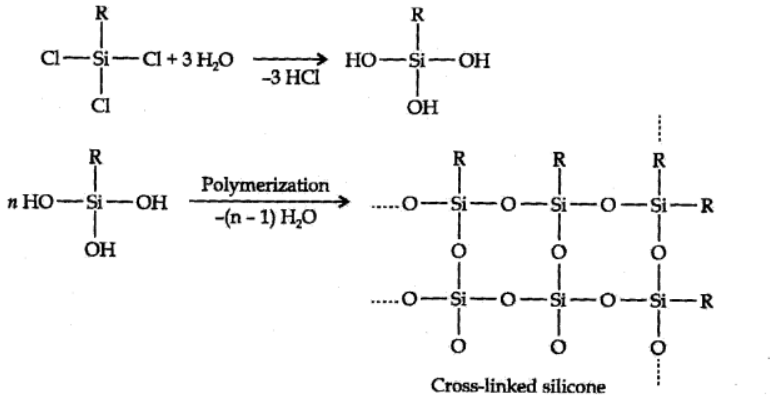
Question 34. Boric acid is polymeric due to
(a) its acidic nature
(b) the presence of hydrogen bonds
(c) its monobasic nature
(d) its geometry
Answer: Boric acid is polymeric due to the presence of H-bonds. Therefore, option (b) is correct.

Question 35. The type of hybridisation of boron in diborane is
(a) sp (b) sp^2 (c) sp^3 (d) dsp^2
Answer: In B_2H_6, B is sp^3-hybridized. Therefore, option (c) is correct.

Question 36. Thermodynamically the most stable form of carbon is
(a) diamond
(b) graphite
(c) fullerenes
(d) coal
Answer: Thermodynamically the most stable form of carbon is graphite, i.e., option (b) is correct.

Question 37. Elements of group 14
(a) exhibit oxidation state of +4 only
(b) exhibit oxidation state of +2 and +4
(c) form $M^{2-}$and M^{4+} ion
(d) form M^{2+} and M^{4+} ions.
Answer: Due to inert pair effect, elements of group 14 exhibit oxidation states of +2 and +4. Thus, option (b) is correct.

Question 38. If the starting material for the manufacture of silicons is $RSiCl_3$ write the structure of the product formed.
Answer: Hydrolysis of aikyltrichlorosilanes gives cross-linked silicons.



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