Boron Family Chemistry Questions with Solutions

Q1. What is the atomic number of thallium?
(a) 81
(b) 77
(c) 66
(d) None of the above
Answer: (a) The atomic number of thallium is 81.

Q2. Which of the following element primarily shows +1 oxidation state?
(a) Boron
(b) Aluminium
(c) Thallium
(d) None of the above
Answer: (c) Thallium primarily shows a +1 oxidation state.

Q3. Which of the following electrolyte is used to extract aluminium?
(a) Pure alumina with bauxite and molten cryolite
(b) Fused cryolite with fluorspar
(c) Pure alumina in molten cryolite
(d) Fused cryolite with felspar
Answer: (c) Pure alumina in molten cryolite is used to extract aluminium.

Q4. The electrolytic refining of aluminium is known as
(a) Hoop's process
(b) Baeyer's process
(c) Serpeck's process
(d) None of the above
Answer: (a) The electrolytic refining of aluminium is known as Hoop's process.

Q5. Which of the following is the hardest compound of boron?
(a) Boron carbide
(b) Boron fluoride
(c) Boron nitride
(d) None of the above
Answer: (c) Boron nitride is the hardest compound of boron.

Q6. How does oxidation state varies when we move from boron to thallium?

Answer: When we move from boron to thallium, the stability of +3 oxidation state decreases while that of +1 oxidation state increases.

Q7. Why is BCl_3 more than stable $TICL_{3?}$
Answer: BCl_3 is more than stable $TICL_3$ because in boron ($2\ s^{2,}\ 2\ p_x^1$) all three valence electrons are available for bonding with chlorine. While, in $TICl_3$ ($6\ s^{2,}\ 6\ p_x^1$), the 6s orbital experience maximum screening effect. Thus, only 6 p^1 electron is available for bonding with chlorine making BCl_3 more than stable $TICL_{3.}$

Q8. What happens when we heat boric acid?
Answer: Boric acid (H_3BO_3) forms metaboric acid (HBO_2) when heated above 370K, while on further heating it oxidise to boric oxide (B_2O_3)
H_3BO_3 + Heat → HBO_2 + Heat → B_2O_3

Q9. How can you prove amphoteric nature of aluminium?
Answer: We can justify the amphoteric nature of aluminium by reacting it with an acid and a base.
Reaction with an Acid: Aluminium reacts with an acid to yield salt and hydrogen gas.
$2\ Al + 6\ HCl \rightarrow 2\ AlCl_3 + 3\ H_2\uparrow$
Reaction with a base: Aluminium reacts with a base to yield salt and hydrogen gas.
$2\ Al + 2\ NaOH + 6\ H_2O \rightarrow 2\ Na^+[Al(OH)_4]^- + 3\ H_2\uparrow$

Q10. Why is bondlength of B-F bond is longer in BF_4^- while shorter in $BF_{3?}$
Answer: The bondlength of B-F bond is longer in BF_4^- while shorter in BF_3 because the BF_4^- is sp^3 hybridised while BF_3 is sp^2 hybridised. A sp^3 hybridised orbital is longer than the sp^2 hybridised orbital. Thus, the bondlength of B-F bond is longer in BF_4^- while shorter in $BF_{3.}$

Q11. Why do boron halides form addition compounds with ammonia and amines?
Answer: Boron halides are electron deficient in nature so they form addition compound with electron rich species like ammonia and amines.

Q12. Why gallium has large ionisation enthalpy than aluminium?
Answer: Gallium has larger ionisation enthapy than aluminium because gallium has a poor screening effect due to which the effective nuclear charge in gallium increases.
Thus, gallium has higher ionisation enthaplhy than the aluminium.

Q13. Mention any two similarities and differences between aluminium and boron.
Answer:

Similarities between Aluinium and Boron		
S. No.	**Aluminium**	**Boron**

1.	It has three valence electrons.	It has three valence electrons.
2.	Its electronic configuration is [Ar] $3s^2\ 3p_x^{1.}$	Its electronic configuration is [He] $2s^2\ 2p_x^{1.}$

Differences between Aluinium and Boron		
S. No.	Aluminium	Boron
1.	It is a metal.	It is a non-metal.
2.	It forms basic oxide.	It forms acidic oxide.

Q14. How does boron differ from other members of group 13?
Answer: Boron is different from other members of group 13.
1. Boron is a metalloid while the other members of group 13 are post transition metals.
2. Boron oxides and hydroxides are acidic in nature while the other members of group 13 forms amphoteric oxides.
3. Boron forms covalent compounds while the other members of group 13 forms ionic and covalent bond.
4. Boron has a high melting point and boiling point while the other members of group 13 has relatively lesser melting and boiling points.
5. Boron is hard while the other members of group 13 are comparatively softer.

Q15. Why does boron shows anomalous behaviour?
Answer: Boron shows a few anomalous properties from other members of the group. It is because of
1. Small size.
2. High Ionisation energy
3. High charge/size ratio.

Practise Questions on Boron Family

Q1. What is the order of acidity of boron halides?
(a) $BI_3 > BF_3 > BBr_3 > BCl_3$
(b) $BF_3 > BCl_3 > BBr_3 > BI_3$
(c) $BI_3 > BBr_3 > BCl_3 > BF_3$
(d) $BBr_3 > BCl_3 > BI_3 > BF_3$
Answer: (c) The order of acidity of boron halides is as follows

$BI_3 > BBr_3 > BCl_3 > BF_3$

Explanation: (i) Based on back bonding, the smaller the halide atom, the more influential the back bonding is and shows less tendency to accept a pair of electrons.

(ii) Size of halides increases down the group. Hence the ability of back bonding decreases, making the molecule more acidic.

Hence, the correct order of Lewis acid for boron-halides is $BI_3 > BBr_3 > BCl_3 > BF_3$.

Q2. Why gallium has less atomic radius than aluminium?

Answer: Gallium has less atomic radius than aluminium because gallium offers a poor screening effect for the outer electrons, which increases the force of attraction between the outermost electrons and nuclear charge—decreasing the atomic radius of gallium.

Hence, gallium has less atomic radius than aluminium.

Q3. Why $[BF_6]^{3-}$ doesn't exist?

Answer: $[BF_6]^{3-}$ doesn't exist because boron doesn't has an empty d orbital due to which it couldn't expand its octet. Thus, $[BF_6]^{3-}$ doesn't exist.

Q4. Why can't we store nitric acid in aluminium container?

Answer: We can't store nitric acid in aluminium container because aluminium reacts with nitric acid to form aluminium oxide.

$Al + HNO_3 \rightarrow Al_2O_3$

Q5. Why B^{3+} ion doesn't exist?

Answer: B^{3+} ion doesn't exist because the total sum of all three ionisation energies of boron is so high that lattice energy liberated by the interaction of B^{3+} and anions is not enough. Thus, B^{3+} ion doesn't exist.