

ANSWERS TO THE SHORT QUESTIONS

GENERAL FEATURES OF BORON FAMILY

Q.1 How the elements of group III-A show the valency of three?

Ans: The elements of group III-A have three electrons in the outermost principal quantum number. One of the electrons is promoted from s-orbital to one of the p-orbitals and three unpaired electrons make the valency three.

Q.2 Why the heat of sublimation in III-A group elements decrease down the group?

Ans: It is due to the reason that the atoms of elements with greater atomic number are less tightly packed due to their bigger sizes.

Q.3 B^{+3} ion does not exist but Al^{+3} ion does. Why? (Multan 2011, Bahawalpur 2011)

Ans: The size of B^{+3} ion is very small. It has high charged density and immediately forms the covalent bonding due to greater polarizing power.

Al^{+3} ion gives the ionic bonding and its compounds are dissociated in water to give Al^{+3} ions.

Q.4 How the nature of the oxides of the group III-A change from upper to the downward direction? (Bahawalpur 2011)

Ans: B_2O_3 is acidic in nature. Al_2O_3 and Ga_2O_3 are amphoteric. In_2O_3 and Tl_2O_3 are basic in character.

BORON AND BORAX

Q.5 The hydrides of boron have different structures from the hydrides of other family members. How? (Multan 2011)

Ans: Boron gives polymeric hydrides having bridge structures. B_2H_6 and B_4H_{10} have bridge structures and they are electron deficient molecules. The hydrides of other family members are not bridged molecules.

Q.6 Give the names and the formulas of different acids of boron. (Faisalabad 2010, Bahawalpur 2011, F. Abad 2012)

Ans: Boron gives four important acids. These acids are as follows:

(i) Orthoboric Acid, H_3BO_3 or $B_2O_3 \cdot 3H_2O$ also called boric acid

(ii) Metaboric Acid, HBO_2 or $B_2O_3 \cdot H_2O$

(iii) Tetraboric Acid, $H_2B_4O_7$ or $2B_2O_3 \cdot H_2O$

(iv) Pyroboric Acid, $H_6B_4O_9$ or $2B_2O_3 \cdot 3H_2O$

Orthoboric acid is the most important and is also called boric acid. It is a stable compound while the other acids are stable in solid state and change to orthoboric acid in solution.

Q.7 How will you convert boric acid into borax and vice versa? (D. G. Khan 2011, Rwp. 2011, Guj. 2012, Lahore 2013, Guj. 2013)

Ans: When orthoboric acid H_3BO_3 is neutralized by caustic soda, we get borax



When borax is treated with concentrated H_2SO_4 then boric acid is produced.

SEMICONDUCTOR

Q.47 Which elements and compounds act as semiconductor?

(Sargodha 2008, Multan 2012)

Ans: Silicon, germanium and selenium are good semiconductors. The important semiconductors among the compounds are PbS, SiC, CdS, etc.

Q.48 What is the effect of temperature on semiconductor.

Ans: When a semiconductor is heated, its resistance decreases and conductivity increases. Similarly when a semiconductor absorbs light, the electrons become more mobilized and conductivity increases.

Q.49 Define semiconductor. Give one example. (Gujranwala 2010, Multan 2012)

Ans: *A semiconductor is a substance which has different resistances for the passage of electrical current under different circumstances.*

Examples:

Both elements and compounds can act as semiconductors.

Elements as semiconductors:

- (i) Germanium
- (ii) Selenium
- (iii) Silicon

Compounds as semiconductors:

- (i) Lead sulphide (PbS)
- (ii) Silicon carbide (SiC)
- (iii) Cadmium sulphide (CdS)
- (iv) Lead telluride (PbTe)
- (v) Gallium arsenide (GaAs)
- (vi) Indium antimonide (InSb)

LEAD PIGMENTS

Q.50 What are lead pigments? Give their common names as well.

(Sargodha 2006)

Ans: The important lead pigments are

- (a) Pb_2O (b) PbO (c) Pb_3O_4 (d) PbO_2 (e) White lead

Q.51 How litharge changes its colour?

Ans: Litharge varies in colours from pale yellow to reddish yellow. Actually, it has two forms:

- (a) Rhombic (yellow) (b) Tetragonal (red)

Q.52 What is the formula of white lead? Give its properties and uses:

(Sarg. 2011)

Ans: Formula of white lead is $2 \text{PbCO}_3 \cdot \text{Pb(OH)}_2$. It is white amorphous powder, insoluble in water and highly poisonous. It is mixed with linseed oil and has a good covering power.

Q.8 How the solubility of borax changes with the change of temperature?

Ans: Borax is sparingly soluble in cold water. 3 grams is dissolved in 100 grams of water at 10°C. At 100°C, 99.3 grams of H_3BO_3 becomes soluble in 100 grams of water.

Q.9 How does the temperature influence the water of crystallization of borax?

Ans: Below 62°C decahydrated crystals are formed. Above 62°C octahedral crystals of pentahydrated borax are obtained.

Q.10 Justify that the aqueous solution of borax turns red litmus blue.

(Multan 2011)

Ans: $\text{Na}_2\text{B}_4\text{O}_7$ is hydrolyzed by water to give H_3BO_3 and NaOH . Since the base is strong, so the solution turns red litmus blue.

Q.11 How borax can be converted to orthoboric acid?

(Multan 2008, Faisalabad 2011)

Ans: When borax is treated with HCl or H_2SO_4 in the presence of water, then orthoboric acid is produced



Q.12 Outline the four use of borax. (Sarg. 2010, Mirpur 2011, Lahore 2012, Multan 2012)

Ans: Borax is used:

- (i) To prepare borate glass, which is heat resistant.
- (ii) In the softening of water.
- (iii) In borax bead test for the detection of metallic cations.
- (iv) In metallurgical operations.
- (v) As a flux in welding.
- (vi) In making washing powders.
- (vii) In leather industry for tanning and dyeing.
- (viii) In cosmetics, soaps, textiles, paints, medicines, match industry and as a preservative.

BORAX BEAD TEST

Q.13 How the glassy mass is produced from borax?

(Lahore 2008, Sargodha 2008, Guj. 2008, Sargodha 2009, Rwp. 2010, Faisalabad 2011, Lahore 2013)

Ans: When borax is heated, it swells up. When it is heated further, it melts into a clear transparent glass



glassy mass

Q.14 Which basic radicals give the response to borax bead test?

(Sargodha 2008, Guj. 2008, Rwp. 2010, Lahore 2013)

Ans: There are seven basic radicals in salt analysis scheme which give coloured beads when borax bead test is performed. These radicals are Cu^{+2} , Fe^{+2} , Fe^{+3} , Mn^{+2} , Co^{+2} , Ni^{+2} , Cr^{+3} . They have different colours in the cold and hot states in the oxidizing and reducing flames.

Q.15 What is the nature of compounds which give coloured beads in borax bead test?

(Rawalpindi 2010)

Ans: Those metals which give the borax bead test are converted into their metaborates. These metaborates appear in the form of beads. They show different colours in the cold and hot states in the oxidizing and reducing flames.

OXYACIDS OF BORON

Q.16 Give the names and formulas for oxyacids of boron:

Ans: Orthoboric acid H_3BO_3
 Metaboric acid HBO_2
 Tetraboric acid $\text{H}_2\text{B}_4\text{O}_7$
 Pyroboric acid $\text{H}_6\text{B}_4\text{O}_9$

Q.17 How H_3BO_3 can be prepared from colemanite?

Ans: Colemanite is suspended in boiling water and SO_2 gas is passed through it. H_3BO_3 crystallizes out from the solution



Q.18 How H_3BO_3 can be prepared from $\text{Na}_2\text{B}_4\text{O}_7$?

Ans: Borax is treated with calculated quantity of conc. H_2SO_4 . When the solution is cooled, H_3BO_3 settles down in the form of precipitate.



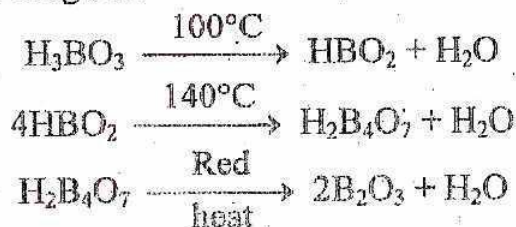
Q.19 How does H_3BO_3 act as an acid? (Mirpur 2011, Lahore 2011, D.G. Khan 2013)

Ans: H_3BO_3 reacts with water and releases H^+ ions from water. It accepts OH^- ion and acts as a monobasic acid.



Q.20 What is the effect of heat on H_3BO_3 ?

Ans: When H_3BO_3 is heated, it releases water molecules in three stages and B_2O_3 is produced in the long run.



Q.20A Give uses of boric acid.

(Rawalpindi 2010)

Ans: Orthoboric acid is used:

- (i) In medicines as antiseptic as dusting powder in boric ointment and as eye-wash.
- (ii) In pottery as a glaze. The reason is that borate glazes are more fusible than silicate glazes. They have high co-efficient of expansion.
- (iii) In candle industry for stiffening of wicks.

CHEMISTRY OF ALUMINIUM

Q.21 What are the important ores and minerals of Al?

(Lahore 2013)

Ans: Some important minerals of aluminium are as follows:

Feldspar	KAlSi_3O_8
Mica (muscovite)	$\text{KH}_2\text{Al}_3(\text{SiO}_4)_3$
Kaolin (china clay)	$\text{H}_2\text{Al}_2(\text{SiO}_4)_2 \cdot \text{H}_2\text{O}$
Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
Cryolite	Na_3AlF_6

Q.22 What is anodizing?

(D.G. Khan 2013)

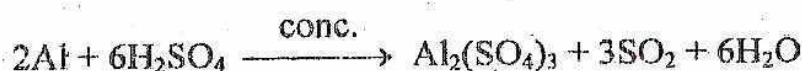
Ans: The layer of Al_2O_3 on the surface of aluminium is very useful. Its thickness

Q.23 Why Al is not found free in nature? (Multan 2008, Faisalabad 2011)

Ans: Aluminium reacts with oxygen vigorously and this reaction is highly exothermic. This heat can be used for the melting of those metals whose oxides are reduced by aluminium powder. This strong affinity of Al for O₂ does not allow Al to be free in nature.

Q.24 How does Al react with dil. and conc. H₂SO₄? (Sarg. 2011, F. Abad 2012)

Ans: Aluminium reacts with dilute and conc. H₂SO₄ as follows:

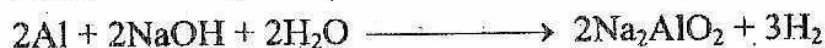


Q.25 How does Al react with conc. HNO₃? (Multan 2013)

Ans: Conc. HNO₃ has no action on aluminium. A protective layer of Al₂O₃ is developed which does not allow aluminium to react with HNO₃ further.

Q.26 How does Al become water soluble by using NaOH. (Multan 2008)

Ans: Aluminium dissolves in alkalis with the evolution of hydrogen gas, and soluble aluminates are produced. The reaction is as follows:



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Q.27 How inert pair effect controls the oxidation state of Sn and Pb?

Ans: Sn and Pb can hardly promote their electrons from s-orbitals to vacant p-orbitals. So they show the valency of two rather than four. Well C, Si, Ge do not show the inert pair effect.

Q.28 How carbon on behaves differently from other members of its own group. (Lahore 2010)

- Ans:**
- (i) It is the hardest substance in its family.
 - (ii) It shows allotropy.
 - (iii) It shows catenation.
 - (iv) It is fundamental element in organic chemistry.

Q.29 Mention various allotropic modifications of elements of group IV-A:

Ans: The property of allotropy is associated with all the elements of group IV-A except Pb. Carbon shows two, Si two, Ge two and Sn has three allotropic forms.

CO₂ AND SiO₂

Q.30 What are the important ores of SiO₂?

Ans: Important ores of silicon are as follows

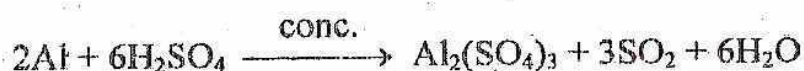
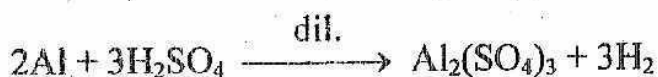
Analcite (a zeolite)	= NaAl(SiO ₃) ₂ · H ₂ O
Asbestos	= Ca Mg ₃ (SiO ₃) ₄
Kaolin (china clay)	= H ₂ Al ₂ (SiO ₄) ₂ · H ₂ O
Zircort	= ZrSiO ₄

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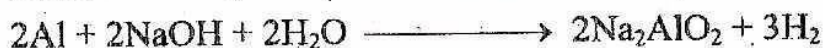


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Q.31 What are the different forms in which SiO_2 exists in the earth's crust?

Ans: (i) Rock crystal (ii) Amethyst quartz (iii) Smoky quartz
(iv) Rose quartz (v) Milky quartz

Q.32 Why diamond is non-conductor of electricity? (Faisalabad 2010)

Ans: Graphite has layered structure. Free electrons are present in them which are responsible for conduction of current. In diamond there are no free electrons.

Q.33 What is quartz and what are its properties?

Ans: Quartz is one of the common crystalline form of SiO_2 . It is hard, brittle, refractor and a colourless solid.

Q.34 Why is CO_2 a gas at room temperature while SiO_2 is a solid?

(Bahawalpur 2006, Sargodha 2006, Rawalpindi 2006, Sargodha 2008, Rwp. 2008, Sarg 2010, Mirpur 2011, Lahore 2012, Guj. 2013, Faisalabad, 2013, Multan 2013, D.G. Khan 2013)

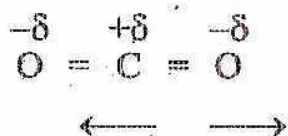
Ans: CO_2 is a gas at room temperature while SiO_2 is a solid. The reason is that CO_2 exists in the form of discrete molecules which exist independently. In case of SiO_2 there is a network structure. It is three dimensional structure giving a giant molecule.

Q.35 Explain: (Bahawalpur 2011)

(a) CO_2 is non-polar in nature.

(b) CO_2 is acidic in character.

Ans: (a) CO_2 is a non-polar in nature. This is due to the linear structure of CO_2 . Both dipoles can cancel the effect of each other and net dipole moment is zero



(b) CO_2 is acidic in nature because it gives carbonic acid after dissolving in water.



SILICATES

Q.36 What is silica glass?

Ans: It is also called fused quartz. It is obtained by heating SiO_2 . It has random structure. When it is cooled, it is not crystallized readily.

Q.37 How sodium silicate is prepared? (Faisalabad 2013)

Ans: When Na_2CO_3 is reacted with pure sand and heated in furnace, Na_2SiO_3 is obtained. It is called water glass or soluble glass.

Q.38 What are the properties of water glass? (Faisalabad 2013)

Ans: It is water soluble and its aqueous solution is strongly alkaline. It is used in the preparation of chemical gardens and is used in soap manufacture.

Q.39 What are the uses of sodium silicate?

Ans: It is used as a filler in the manufacture of soap, as a fire proof in textile, in furniture polish, in calicoprinting and in preservation of eggs.

Q.40 What is chemical garden?

(Faisalabad 2012, Faisalabad 2013)

Ans: When the crystals of various soluble coloured salts like NiCl_2 , FeSO_4 and CuSO_4 etc. are placed in a solution of water glass, there happens a beautiful growth of crystals. This is called silica garden or chemical garden.

Q.41 What are the uses of aluminium silicates or clay?

Ans: It is used to make porcelin and china clay. Impure clay is used to make bricks, tiles and stone wares.

Q.42 How the clay is hardened?

Ans: Clay is soaked in water and it is hydrated with the passage of time. It becomes more and more plastic in nature. On heating, water of hydration is lost and hard rock like mass is obtained.

Q.43 Give the formula of talc or soap stone. Gives its properties and uses:

(Faisalabad 2011)

Ans: $\text{Mg}_3\text{H}_2(\text{SiO}_3)_4$ is the formula of soap stone. It is greasy to touch and is used in making cosmetics and household articles.

Q.44 What is asbestos? Give its uses?

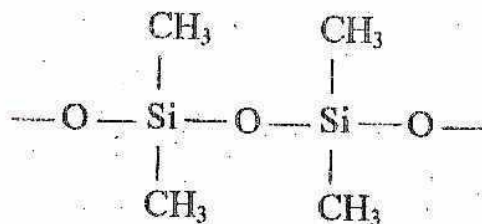
Ans: Asbestos is mixed silicate of Ca and Mg, with formula $\text{CaMg}_3(\text{SiO}_3)_4$. It is used to make incombustible fabrics and hard board.

SILICONES

Q.45 What are silicones? Give their uses.

(Rawalpindi 2008, Lahore 2009, Lahore 2010, Multan 2011, Multan 2012)

Ans: The compounds of silica having long chains through oxygen atoms and suitable number of alkyl groups are called silicones. Methyl silicones are the most important



Silicon oils are used:

- (i) For high temperature oil baths and high vacuum pumps.
- (ii) For low temperature lubrication.
- (v) The methylsilicones of high molar masses resemble rubber. They are used in making rubber like tubing and sheets.
- (vi) As insulating materials for electrical motors.

Q.46 Why are liquid silicones preferred over ordinary organic lubricants?

(Rawalpindi 2006, Guj. 2008, Lahore 2008, B. Pur 2009, Sargodha 2009, Lahore 2010, Sarg. 2011, Mirpur 2011, Fed. 2013)

Ans: There happens a very small change in viscosity with the change in temperature for silicones. When the temperature drops from 100°C to 0°C , then the viscosities of petroleum oils which are used as lubricants increase their viscosity 100 times. Anyhow, viscosities of silicon oils increase less than four times for this change of temperature. Hence, silicones are preferred over ordinary organic lubricants.