CHEMISTRY

PHYSICAL, INORGANIC, AND ORGANIC CHEMISTRY

P-BLOCK ELEMENT (BORON AND CARBON FAMILY)

Example

1. Thermodynamically graphite is more stable than diamond but diamond does not transform into graphite on its own. Why?

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2. Complete the following reactionas and identify the products formed.

(i) $BCl_3 + NH_4Cl \xrightarrow[C_6H_5Cl]{140^\circ C} (A) \xrightarrow{NaBH_4} (B)$

(b) $BCl_3 + H_2 + C_{\text{fibre}} \xrightarrow{1700-1800^\circ C} \text{product(s)}$

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3. It has been observed that BF_3 does not hydrolyses completely whereas BCl_3 or BBr_3 get easily hydrolysed to form $B(OH)_3$ and HX? Explain.

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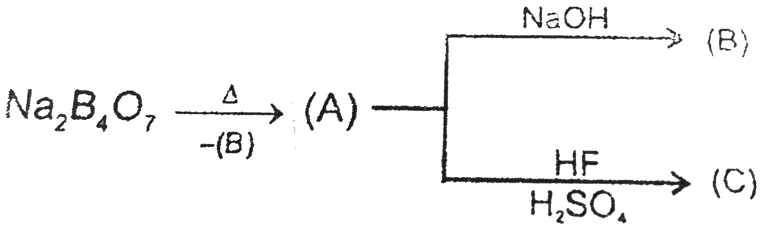
4. (a) $Na_2B_4O_7 +$ concentrated $H_2SO_4 + H_2O \rightarrow \xrightarrow[(ii)\text{ ignite}]{(i)\, C_2H_5OH} (B)$

(B) is identify by the characteristic colour of the flame. Identify (A) and (B). (b) Complete the following reaction and identify the products formed.

`Na_(2)B_(4)O_(7)



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5. What will happen if aluminium is heated with coke in an atmosphere of nitrogen?

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6. $H_2C_2O_4 \xrightarrow{\Delta}$ gas (A)+gas(B)+liquid(C) oxalic acid Gas (A) burns with blue flame and is oxidised to gas (B). Gas (B) turns lime water milky Gas (A)+$Cl_2 \rightarrow (D) \xrightarrow{NH_3.\,\Delta} (E) \overset{NH_3.\,\Delta}{B}$

Identify (A) to (E) and explain reactions involved.

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7. What happens when: (write chemical equations only) (a) Anhydrous $AlCl_3$ is exposed to atmosphere. (b) $AlCl_3$ dissolves in aqueous sodium hydroxide (excess)

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8. Anhydrous $AlCl_3$ cannot be prepared by heating hydrated salt. Why?

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9. List the cations which are capable of replacing aluminium in alums?

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10. Complete the following reactions

(a) $CO + H_2 \xrightarrow[420\text{-}670\text{k},300\text{atm}]{\text{ZnO+Cu}}$ .....

(b) $R_3SiOH + OHSiR_3 \rightarrow$ ....+....

(c) $Na_2CO_3 + Si \rightarrow$ ...+....

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11. Draw the structure of cyclic silicate containing $Si_6O_{18}^{12-}$ ion.

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12. Write the chemical equations involved in the preparation of elemental boron from mineral colemanite.

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Problem

1. Al and Ga are trivalent in their compounds but monovalent compounds are the most stable down the $13th$ group. Why?

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2. If you have a mixture of CO and CO_2, how would you know about the relative proportions of the two gases in the given mixture ?

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3. What will happen if borontrifluoride is kept in moist air?

A. it will strongly fume

B. It will partially hydrolyse.

C. It will completely hydrolyse

D. None of these

Answer: A

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4. What happens when : (write only chemical reactions)

(a) iodine is treated with $SnCl_2$.

(b) carbondioxide is passed through a concertrated aqueous solution of sodium chloride saturated with ammonia.

(c) red lead is treated with nitric acid.

(d) dilute nitric acid is slowly reacted with tin.

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5. True / False

(a) BCl_3 in aqueous solution exists as B^{3+} and Cl^-

(b) Pure crystalline boron is very unreactive and it is attacked only at high temperatures by strong oxidising agents such as a mixture of hot concentrated H_2SO_4 and HNO_3

(c) $AIX_3(X = Cl, Br)$ exists as dimer and retains dimar formula in non-polar solvents like ether, benzene etc.

(d) Be_2C is called acetylide because it reacts with water yielding ethyne.

(e) Pb_3O_4 a double oxide, is obtained by heating lead (II) oxide in air.

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6. Statement-1 : PbO_2 is an oxidising agent and reduced to PbO.

Statement-2 : Stability of $Pb(II) < Pb(IV)$ on account of inert pair effect.

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 True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: A

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7. Write the chemical equations to represent the following reactions.

(a) The oxidation of $HCI(aq)$ to $Cl_2(g)$ by PbO_2.

(b) The disproportionation of SnO to Sn and SnO_2.

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8. What will happen if we take $Si(CH_3)Cl_3$ as a starting material for the preparation of commercial silicon polymer?

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9. Give three properties of diamond.

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10. The silicate anion in the mineral Kionite is a chain of three SiO_4 tetrahedra that share corners with adjacent tetrahedra. The mineral also contains Ca^{2+} ions, Cu^{2+} ions, and water molecules in a $1:1:1$ ration.

(a) Give the formula and charge of the silicate anion.

(b) GIve the complete formula for the mineral.

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11. In what respect the reaction of N_2 with (i)CaC_2 (calcium carbide) & (ii) BaC_2 (barium carbide) differ from each other.

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12. Statement-1 :The thermal stability of hydrides of carbon family is in order:

$CH_4 > SiH_4 > GeH_4 > SnH_4 > PbH_4$

Statement-2: $E - H$ bond dissociation enthalpies of the hydrides of carbon family decrease down the group with increasing atomic size.

A. Statement-1 is Ture, Statement-2 is True,Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture, Statement-2 is True,Statement-2 is NOT a correct explalanation for Statement-1

C. Statement-1 is Ture, Statement-2 is False

D. Statement-1 is False, Statement-2 is Ture

Answer: A

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13. Which one of the following elemen does not dissolve in fused or aqueous alkalies?

A. Boron

B. Silicon

C. Aluminium

D. None of these

Answer: D

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14. What happens when $CO_2(g)$ is passed through sodium meta borate solution?

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15. Which of the following Statement (s) is/are correct?

A. B_2O_3 and SiO_2 are acidic in nature and are important constituents of glass.

B. Borides and Silicid are hydrolysed by water forming boranes and Silanes respectively.

C. Diborane on reaction with chlorine (g) forms B_2H_5Cl

D. SiO_4^{4-} gets hydrolysed by acid or water and form $Si_2O_7^{6-}$

Answer: A,B and D

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Bord Level Exercise Type 1 Very Short Answer Type Questions

1. Which element of group 13 forms the most stable $+1$ oxidation state.

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2. Name the element of group 13 which forms only covalent compounds.

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3. Out of CCl_4 and $SiCl_4$ which one reacts with water?

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4. What is insert pair effect?

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5. Which is the basic building unit of all sillicates?

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6. What is catenation?

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Bord Level Exercise Type 2 Short Answer Type Questions

1. Why boron forms electron deficient compounds?

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2. Why boron halides do not exidising as dimers while $AlCl_3$ exists as Al_2Cl_6 ?

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3. PbO_2 is a stronger oxidising agent than SnO_2.

Or PbO_2 can act an oxidiside agent.

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4. Anhydrous aluminium chloride is used as a catalyst.

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Bord Level Exercise Type 3 Long Answer Type Questions

1. Draw the structures of BCl_3. NH_3 and $AlCl_3$ (dimer).

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2. BCl_3 is trigonal planr while $AlCl_3$ is tetrahedral in dimeric state. Explain.

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3. The $+1$ oxidation state is more stable than $+3$ oxidation state for thallium. Give reason.

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4. Why does not sillicon form an analogue of graphite?

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5. CO_2 is a gas while SiO_2 is a solid. Explain.

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Bord Level Exercise Type 4 Very Long Answer Type Questions

1. (i) What happens when:

(a) Borax is heated strongly

(b) Boric acid is added to water

(c) Aluminium is treated with dilute $NaOH$.

(d) BF_3 is reacted with ammonia.

(ii) Explain the following reaction.

CO is heated with ZnO.

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2. State with equations what happens when borax is heated on a platinum wire loop and to the resulting transparent mass, a minute amount of CuO is added and the mixture is again heated first in the oxidising flame and then in the reducing flame of a Bunsen burner?

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Exercise 1 Part I Subjective Questions Section A Occurance Physical Properties Allotropy

1. What do you understand by (a) inert pair effect (b) allotropy and (c) catenation?

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2. Give reasons:

(i) Graphite is used as a lubricant.

(ii) Diamond is used as an abrasive.

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3. Why does silicon not form an analogue of graphite?

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4. Boron does not form B^{3+} ions because

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Exercise 1 Part I Subjective Questions Section B Isolation Of Elemts B Al C Si

1. How amorapure boron of law purity is obtained from borax?

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2. How ultrapure boron can be prepared from Bl_3 or BCl_3 ?

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3. What is the importance of ultra pure elemental silicon? How is it obtained?

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Exercise 1 Part I Subjective Questions Section C Chemical Properties Of Elemts B C Si

1. Classify sollowing oxides sa neutral, acidic, basic or amphoteric.

$CO, SiO_2, CO_2, Al_2O_3, TI_2O_3$

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2. Complete the following reaction :

C(graphite) + HNO_3 (conc.) $\rightarrow$

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3. CO is stable , but analogous SiO is not stable . Why ?

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4. Why carbon froms covalent compounds whereas lead forms ionic compounds ?

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Exercise 1 Part I Subjective Questions Section D Chemical Properties Of Elements Ai Sn Pb

1. Give balance equation for the reaction of aluminium with aqueous sodium hydroxide.

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2. Aluminium metal is frequently used as a reducing agent for the extraction of metals like Cr,Mn,Fe etc. Explain.

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3. Write balanced equations for the sollowing reactions:

Tin is treated with an excess of chlorine gas.

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4. What happens when :

Aluminium reacts with HNO_3.

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Exercise 1 Part I Subjective Questions Section E Hydrides

1. Complete the following reaction and write the structure of the product formed.

$$B_2H_6 \xrightarrow[\text{High temp.}]{\text{Excess NH\_(3))}}$$

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2. What is inorganic benzene ? Why is it so called ? How will you get it from diborame ?

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3. How will you obtain?

Borazole from sodium borohydride (in three steps only)

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4. Write balanced equations for the sfollowing reactions:

Lead sulphide is heating in air.

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Exercise 1 Part I Subjective Questions Section F Oxides Oxyacids Hydroxides Borax

1. Boric acid is weak monobasic acid and acts as Lewis acid

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2. Complete the following reaction and identify compounds (A) and (B).

$$B(OH)_3 \xrightarrow[\text{Fusion}]{NH_4HF_2} (A) \xrightarrow[\Delta]{B_2O_3} (B)$$

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3. A certain salt (X) gives the following tests :

(a) Its aqueous solution is alkaline to litmus.

(b) On strong heating. It sweels to give a glassy bead.

(c) When conc H_2SO_4 is added to a hot concentrated solution of (X), white crystals of a weak acid separates out. Identify (X) and write down the chemical equations for reaction at steps a, b and c.

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4. A white precipitate (X) is formed when a mineral (A) is boiled with Na_2CO_3 solution. The precipitate is filtered and filtrate contains two compound (Y) and (Z). The compound (Y) is removed by crystallization and when CO_2 is passed through the filtrate obtained after crystallization, then (Z) changed to (Y). When compound (Y) is heated, it gives two compounds (Z) and (T). Compound (T) on heating with cobalt oxide produces blue coloured substance (S)

The mineral (A) is

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Exercise 1 Part I Subjective Questions Section G Halides Alums Other Metal Salts

1. Why does $AlCl_3$ fumes in air?

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2. When BCl_3 is treated with water, it hydrolyses and forms $\left[B(OH)_4\right]^-$ only whereas $AlCl_3$ in acidified aqueous solution forms $\left[Al(H_2O)_6\right]^{3+}$ ion, Explain what is the hybridisation of boron and aluminium in these species?

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3. Complete the following reaction:

$SnCl_4 + C_2H_5Cl + Na \rightarrow$

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4. Define an alum. What are some of its important uses?

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Exercise 1 Part I

1. If the starting material for the manufacture of silicone is $RSiCl_3$, write the structure of the product formed.

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2. Write down hydrolysis of:

(i) alkyl substituted chlorosilane , (ii) trialkyl chlorosilane

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Exercise 1 Part I Subjective Questions Section H

1. What are silicates ? How are they classified?

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Exercise 1 Part Ii Only One Option Correct Type Section A Occurance Physical Properties Allotropy

1. The decrease in stability of higher oxidation state in p-block with increasing atomic number is due to:

A. increase in bond energy as going down the group.

B. the reluctance of s-sub shell electrons to participate in the chemical bonding.

C. both are correct.

D. Noble gas configuration achieved by lower oxidation state.

Answer: B

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2. Diamond and Graphite are

A. isomers

B. isotopes

C. allotropes

D. none of the above

Answer: C

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3. Which of the following is a good conductor of electricity?

A. Diamond

B. Graphite

C. Coal

D. None

Answer: B

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4. Inert form of carbon is

A. Diamond

B. Graphite

C. Coal

D. charcoal

Answer: A

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5. Thermodynamically the most stable form of carbon is

A. Diamond

B. Graphite

C. fullerenes

D. Coal

Answer: B

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6. 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+} ions

D. form M^{2+} and M^{4+} ions

Answer: B

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7. The liquified metal expanding on solidification is :

A. Ga

B. Al

C. Zn

D. Cu

Answer: A

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8. Coal gas is a mixture of:

A. CO and H_2

B. $H(2)$, saturated and unsaturated hydrocarbons, CO, CO_2, N_2 and O_2

C. saturated and unsaturated hydrocabons

D. CO, CO_2 and CH_4

Answer: B

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9. Metalloid among the following is

A. Si

B. C

C. Pb

D. Ge

Answer: D

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10. Formation of in-numberable compounds of carbon is due to its:

A. High reactivity

B. Catenation tendency

C. Covalent and ionic tendency

D. Different valency

Answer: B

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Exercise 1 Part Ii Only One Option Correct Type Section B Isolation Of Elements B Ai C Si

1. Amorphous boron of $95\ \%$ to $98\ \%$ purity is obtained by:

A. heating B_2O_3 with H_2

B. heating B_2O_3 with Mg or Na at high temperature.

C. heating KBF_4 with Na or K.

D. heating BBr_3 with H_2 in presence of a catalyst.

Answer: B

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2. Crystalline boron in small amounts may be obtained by:

A. reducing BCl_3 with H_2

B. pyrolysis of Bl_3

C. thermal decomposition of diborane

D. all of these

Answer: D

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3. Boron of highest purity $(\sim 99.9\,\%)$ is obtained by

A. reduction of B_2O_2 by Mg.

B. electrolysis of fused tetrafluoroborates (KBF_4) in molten KF.

C. reduction of BCl_3 with H_2 at $1270K$.

D. thermal decomposition of boranes at $1173K$.

Answer: C

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4. $Ca_2B_6O_{11} + 2Na_2CO_3 \rightarrow X + 2CaCO_3 + 2NaBO_2$ The compound X in the above reaction is

A. $Na_2B_4O_7$

B. HBO_2

C. H_3BO_3

D. $H_2B_4O_7$

Answer: A

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5. Which is not the property of diamond?

A. It is insoluble in all solvents

B. it is oxidised with a mixture of $K_2Cr_2O_7$ and H_2SO_4 at $200^\circ C$

C. Being harfest, it is used as an abrasive for sharpening hard tools.

D. $\Delta_f H^\odot$ value of diamound is $1.90 kJ mol^{-1}$

Answer: B

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6. In the elactrolytic extraction of aluminium, cryolite is used.

A. To obtain more aluminium

B. As solvent to dissolve bauxite

C. To protect the anode

D. As reducing agent

Answer: B

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7. In laboratory silicon can be prepared by the reaction

A. Silica with magnesium

B. By heating carbon in electric furnace

C. By heating potassium fluosilicate with potassium

D. None of these

Answer: C

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Exercise 1 Part Ii Only One Option Correct Type Section C Chemical Properties Of Elements B C Si

1. Producer gas is a mixture of

A. CO and N_2

B. CO and H_2

C. N_2 and NH_3

D. CO, H_2 and N_2

Answer: A

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2. Silicon react with hot solution of $NaOH$ forming:

A. $Si(OH)_4$

B. $Si(OH)_2$

C. SiO_2

D. Na_2SiO_3

Answer: D

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3. Concentrated HNO_3 turns yellow in sun light Explain ?

A. graphite oxide

B. benzene hexacarboxylic acid

C. both (A) and (B)

D. none of the above

Answer: B

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4. When steam is passed through red hot coke:

A. CO_2 and H_2 are obtained

B. CO and N_2 are formed

C. CO and H_2 are obtained

D. petrol gas is obtained

Answer: C

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5. Amorphous boron on burning in air forms

A. $B(OH)_3$

B. Mixture of B_2O_3 and BN

C. Only B_2O_3

D. Only BN

Answer: B

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6. Carbon and silicon belong to group IV. The maximum coordination number of carbon in commonly occuring compounds is four whereas that of silicon is six. This is due to

A. Large size of silicon

B. More electropositive nature of silicon

C. Availability of low lying d-orbitals in silicon

D. Both (A) and (B)

Answer: C

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7. Boron form covalent compound due to

A. Higher ionization energy

B. Lower ionization energy

C. Small size

D. Both (A) and (C)

Answer: D

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Exercise 1 Part Ii Only One Option Correct Type Section D Chemical Properties Of Elements Ai Sn Pb

1. When Al is added to sodium hydroxide solution:

A. no reaction takes place

B. oxygen is evolved

C. water is produced

D. hydrogen is evolved

Answer: D

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2. Aluminium is a noble metal

A. aluminium is a nobel metal

B. oxygen forms a protective oxide layer on aluminium surface

C. iron unergoes reaction easily with water

D. iron forms both mono and divalent ions

Answer: B

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3. Aluminium does not react with:

A. $NaOH$

B. conc. HCI

C. N_2

D. conc.HNO_3

Answer: D

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4. On passing CO_2 into aqueous solution containing $NaAlO_2$:

A. $Al_2(CO_3)_3$ is formed

B. $Al(OH)_3$ is precipitated

C. Al_2O_3 is formed

D. collodial $Al(OH)_3$ is formed

Answer: B

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5. Red lead is:

A. PbO

B. PbO_2

C. Pb_3O_4

D. Pb_2O_3

Answer: C

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6. Tin reacts with concentrated HNO_3 and gives:

A. stannic nitrate

B. stannous nitrate

C. metastannic acid

D. none of sigma bond

Answer: C

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7. Which of the following is the correct statement for red lead?

A. It is an active form of lead

B. Its molecular formula is Pb_2O_3

C. It decompose into PbO and CO_2

D. It decompose into PbO and O_2

Answer: D

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8. The strongest oxidising agent among the following is

A. $Pb(IV)$ oxide

B. $Si(II)$ oxide

C. $Sn(II)$ oxide

D. $Ge(II)$ oxide

Answer: A

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Exercise 1 Part Ii Only One Option Correct Type Section E Hydrides

1. From B_2H_6, all the following can be prepared except

A. $H_3BO(3)$

B. $\left[BH_2(NH_3)_2\right]^+[BH_4]^-$

C. $B_2(CH_3)_6$

D. $NaBH_4$

Answer: C

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2. The product obtained in the reaction of diborane with excess of ammonia at low temperature is:

A. $B_2H_6.\ NH_3$

B. $B_2H_6.2NH_3$

C. $(BN)_x$

D. Borazine

Answer: B

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3. Diborane reacts with water to form:

A. HBO_2

B. H_3BO_3

C. $H_3BO_3 + H_2$

D. H_2

Answer: C

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4. In diborane, the two $H - B - H$ angles are nearly

A. $60^\circ, 120^\circ$

B. $97^\circ, 120^\circ$

C. $95^\circ, 150^\circ$

D. $120^\circ, 180^\circ$

Answer: B

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5. In the reaction: $BF_3 + 3LiBH_4 \rightarrow 3LiF + X$, X is

A. B_4H_{10}

B. B_2H_6

C. BH_3

D. B_3H_8

Answer: B

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6. Diborane upon hydrolysis gives

A. boric anhydride and polymetaborate

B. metaboric acid and hydrogen

C. orthoboric acid and hydrogen

D. boron oxide and metaboric acid

Answer: C

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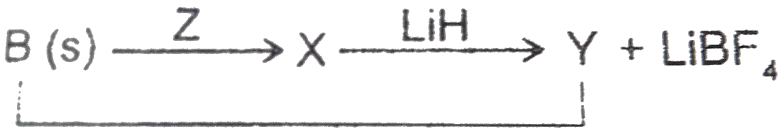
7.



Which of the statement is true for the above sequence of reactions?

A. Z is hydrogen

B. Y is $LiBH_4$

C. Z and Y and F_2 and B_2H_6 respectively

D. Z is potassium hydroxide

Answer: C

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8. Which of the following is known as inorganic benzene

A. Borazine

B. Boron nitride

C. p-dichlorobenzene

D. Phosphonitrilic acid

Answer: A

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Exercise 1 Part Ii Only One Option Correct Type Section F Oxides Oxyacids Hydroxides Borax

1. Boric acid is polymeric due to

A. Its acidic nature

B. the presence of hydrogen bonds

C. its monobasic nature

D. its geometry

Answer: B

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2. In the following reaction : $B(OH)_3 + H_2O \rightarrow \left[B(OH)_4\right] + H^+$:

A. $B(OH)_3$ is lewis acid.

B. $B(OH)_3$ is lewis base.

C. $B(OH)_3$ is amphoteric.

D. none is correct.

Answer: A

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3. When orthoboric acid (H_3BO_3) is heated, the residue is

A. boron

B. metaboric acid and hydrogen

C. boric anhydride

D. borax

Answer: C

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4. Borax is:

A. $Na_2B_4O_7$

B. $Na_2B_4O_7.4H_2O$

C. $Na_2B_4O_7.7H_2O$

D. $Na_2B_4O_7.10H_2O$

Answer: D

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5. When borax is dissolved in water:

A. $B(OH)_3$ is formed only

B. $\left[BH_2(NH_3)_2\right]^+[BH_4]^-$ is formed only

C. both $B(OH)_3$ and $\left[B(OH)_4\right]^-$ are formed

D. $\left[B_3O_3(OH)_4\right]^-$ is formed only

Answer: C

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6. Borax bead test is not given by

A. B_2O_3

B. H_3BO_3

C. Na_3BO_3

D. $B_2O_3 + NaBO_2$

Answer: D

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7. Borax bead test is not given by

A. divalent metals

B. heavy metals

C. light metals

D. metal which forms coloured metaborates

Answer: D

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8. On the addition of mineral acid to an aqueous solution of borax, the compound formed is:

A. borodihydride

B. orthoboric acid

C. metaboric acid

D. pyroboric acid

Answer: B

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9. Borax on heating with cobalt oxide forms a blue bead of

A. $Co(BO_2)_2$

B. $CoBO_2$

C. $Co_3(IBO_3)_2$

D. $Na_3Co(BO_3)_2$

Answer: A

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10. Borax is prepared by treating coleminate with

A. $NaNO_3$

B. $NaCl$

C. Na_2CO_3

D. $NaHCO_3$

Answer: C

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Exercise 1 Part Ii Only One Option Correct Type Section G Halides Alums Other Metal Salts

1. H_2S gas can be obtained by the action of water on:

A. CuS

B. FeS

C. Flower of sulphur

D. Al_2S_3

Answer: D

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2. Which one of the following compound is a gas (at $0^{\circ}C$):

A. BF_3

B. BCl_3

C. BBr_3

D. Bl_3

Answer: A

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3. Alum is found to contain hydrated monovalent cation $\left[M(H_2O)_6\right]^+$ trivalent cation $\left[M'(H_2O)_6\right]^+$ and SO_4^{3-} in the ratio of:

A. $1:1:1$

B. $1:2:3$

C. $1:3:2$

D. $1:1:2$

Answer: D

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4. Aqueous solution of potash alum is:

A. alkaline

B. acidic

C. neutral

D. soapy

Answer: B

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5. Which mixed sulphate is not an alum:

A. $K_2SO_4.\ Al_2(SO_4)_3.24H_2O$

B. $K_2SO_4.\ Cr_2(SO_4)_3.24H_2O$

C. $Na_2SO_4.\ Fe_2(SO_4)_3.24H_2O$

D. $CuSO_4.\ Al_2(SO_4)_3.24H_2O$

Answer: D

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6. Alum is used by dyer:

A. for fire-proofing fabrics

B. as first aid for cuts

C. for softening hard water

D. as mordant

Answer: D

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7. Al_2O_3 can be converted to anhydrous $AlCl_3$ by heating

A. hydrated Al_2O_3 with Cl_2 gas

B. Al_2O_3 with aqueous HCI

C. Al_2O_3 with $NaCI$ in solid state

D. a mixture of Al_2O_3 and carbon in dry Cl_2 gas

Answer: D

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8. CCl_4 is inert towards hydrolysis but $SiCl_4$ is readily hydrolysed because

A. carbon cannot expand its octet but silicon can expand its octet

B. ionisation potential of carbon is higher than silicon

C. carbon forms double and triple bonds

D. electronegativity of carbon is higher than of silicon

Answer: A

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9. Which of the following anions is present in the simple single chain structure of silicate?

A. SiO_4^{4-}

B. $Si_2O_7^{6-}$

C. $\left(Si_2O_5^{2-}\right)_n$

D. $\left(SiO_3^{2-}\right)_n$

Answer: D

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10. Silicone resins are made by:

A. dissolving a mixture of $PhSiCl_3$ and $(Ph)_2SiCl_2$ in toluene and then hydrolysis with water.

B. hydolysing a mixture of $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$

C. hydrolysis of $(CH_3)_2SiCl_2$

D. none

Answer: A

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11. Which silicon compound is used in machinary (with moving parts) in a manner similar to the use of an allotrops a covalent network solid and a molecular solid?

A. Silica gel

B. Zeolite

C. Silicone

D. Silane

Answer: C

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12. Select the incorrect statement.

A. Silicones are hydrophobic in nature.

B. $Si - O - Si$ linkages are moisture sensitive.

C. SnI_4 is an orange solid on account of charger transfer.

D. Silicones are resistant to most chemicals due to high strength of the $Si - C$ bond stable silica like structure of $Si - O - Si - O - Si.$

Answer: B

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13. Pyrosilicate ion is:

A. SiO_2^{2-}

B. SiO_4^{2-}

C. $Si_2O_6^{7-}$

D. $Si_2O_7^{6-}$

Answer: D

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14. Select incorrect statement:

A. Red lead is Pb_3O_4

B. $(Me)_2SiCl_2$ on hydrolysis and then on subsequent intermolecular condensation gives cross linked silicones.

C. SiO_4^{4-} on hydrolysis with water or acid produces $Si_2O_7^{6-}$

D. None

Answer: B

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15. The structural unit present in pyrosilicates is:

A. $Si_3O_9^{6-}$

B. SiO_4^{4-}

C. $Si_2O_7^{6-}$

D. $\left(Si_2O_5^{2-}\right)_n$

Answer: C

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Exercise 2 Part I Only One Option Correct Type

1. Catenation tendency in group 14 is:

A. $C > > Si > Ge = Pb$ due to bond energies

$C - H > Si - H > Ge - H > Sn - H$

B. $C > > Si > Ge = Sn > Pb$ due to bond energies

$C - C > Si - C > Ge - C > Sn - C$

C. $C = Si = Ge = Sn = Pb$ due to bond energies

$C - H > Si - H > Ge - H > Sn - H$

D. $C > > Si > Ge = Sn > Pb$ due to bond energies

$C - C > Si - Si > Ge - Ge > Sn - Sn$

Answer: D

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2. Given the order of density:

Diamond $>$ Graphite $>$ Fullerence C_{60}, choose thye correct order for $C - C$ bond length (Consider large bond length if there are two different bondlengths)

A. Diamond $<$ graphite $<$ fullerene (C_{60})

B. Diamond $>$ graphite $>$ fullerene (C_{60})

C. Diamond $>$ fullerene $(C_{90^\circ}) >$ graphite

D. Diamond $<$ fullerene $(C_{90^\circ}) <$ graphite

Answer: C

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3. Bauxite $(Al_2O_3.2H_2O)$ and Aluminosilicate both are ores of aluminium. Bauxite is found on earth but not on Mars whereas Aluminosilicate is found on earth as well as Mars. Possible reason is:

A. No human colony on Mars.

B. No tropical rain forests on Mars.

C. No need of bauxite on Mars

D. Closeness of earth to sun.

Answer: B

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4. Isolation of boron in very high purity is extremely difficult because of:

A. Strong tendency of boron to acquire electron rich atoms such as C, N or O

B. High melting point of boron $(2180^\circ C)$

C. Tremendous affinity of liquid Boron towards oxygen.

D. All of these

Answer: D

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5. Reaction I : $3C$ (natural graphite) + $SoO_2 \xrightarrow{\text{heat}} \underset{+2CO}{SiC} \xrightarrow{2500^\circ C} C$ (graphite) +Si

Reaction II : $SiO_2 + 2C \rightarrow Si + 2CO$

Reaction I is used in production of synthetic graphite, whereas Reaction II is used in extraction od silicon.

A. Reaction I - SiO_2 in excess , Reaction II - SiO_2 in excess

B. Reaction I - C in excess , Reaction II - SiO_2 in excess

C. Reaction I - SiO_2 in excess , Reaction II - C in excess

D. It does not matter.

Answer: B

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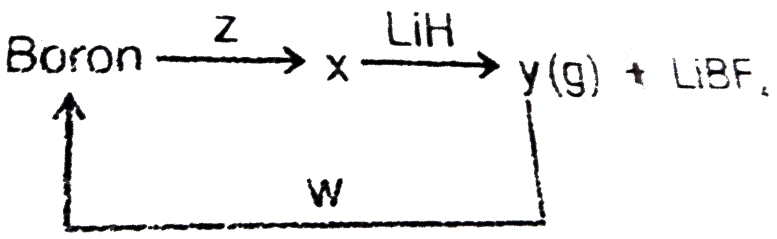
6.



True statement is:

A. z is least reactive non-metal

B. w is cooling

C. y is electron deficient

D. All of these

Answer: C

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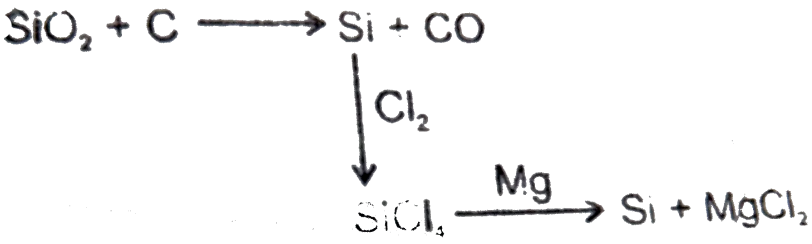
7.



Identify true statement:

A. Excess of SiO_2 should not be used in above process

B. Producted Si is highly pure

C. Cl_2 & Mg are oxidising agents.

D. Zone refining is not used for ultrapure Si.

Answer: B

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8. An element $E = (B, C, Si, Ge)$, predict E on the basic of given conditions:

I : Powdered E reacts with O_2 to form an oxide.

II : Oxide formed in I reacts with $NaOH$

III : E reacts with steam on red heat forming two gaseous products, which can be used as a fuel. E can be :

A. B

B. C

C. Si

D. Ge

Answer: B

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9. In limited supply of oxygen C & Si are allowed to teacted at sufficiently high temperatures in separate vesseles, favourable products are:

A. CO_2 & SiO_2

B. CO, CO_2SiO & SiO_2

C. CO, CO_2 & SiO_2

D. CO & SiO_2

Answer: D

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10. $2E + N_2 \rightarrow 2EN$ (very hard substance)

$EN + H_2O \rightarrow$ Acid + pungent smelling gas Acid is:

A. HNO_3

B. H_3BO_3

C. HNO_2

D. can be A & B

Answer: B

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11. Aluminium vessels should not be washed with materials containing washing soda because:

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

Answer: C

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12. Select the incorrect statement of the following.

A. Aluminium is often used as reducing agent for libration of other metals from their oxides.

B. Anthydrous $AlCl_3$ can be prepared by treating Al_2O_3 with coke and chlorine gas.

C. Aluminium readily dissolves in both dilute as well as in concentrated nitric acid.

D. Aluminium hydroxide is soluble in both aqueous alkali and acids indicating its amphoteric nature.

Answer: C

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13. Which of the following statements is correct for diborane?

A. Small amines like NH_3, CH_3NH_2 give unsymmetrical cleavage of diborane.

B. Large amines such as $(CH_3)_3N$ and pyridine gives symmetrical cleavage of diborane.

C. Small as well as large amines both gives symmetrical cleavage of diborane.

D. (A) and (B) both

Answer: D

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14. $B_2H_6 + NH_3 \rightarrow$ Addition compound $(X) \xrightarrow{450\ \mathrm{K}} Y + Z(g)$

in the above sequence Y and Z are respectively:

A. borazine, H_2

B. boron, H_2

C. boron nitride, H_2

D. borazine and hydrogen

Answer: D

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15. Borazine and benzene show striking similarities in their properties. This led to a labelling of borazine as 'inorganic benzene'. However, in contrast to benzene, borazine readily undergoes addition reactions. The appropriate reason for this difference is:

A. Alternate arraangement of B and N atoms in the hexagonal ring.

B. Due to the difference in electronegativity between boron and nitrogen, the cloud (electron density) is more localised on the nitrogen atoms.

C. Aromatic ϕ clouds of electron density are delocalised over all of the ring atoms.

D. Net dipole moment of borazine molecule is non-zero.

Answer: B

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16. Aqueous ammonia is used as a precipitating reagent for Al^{3+} ions as $Al(OH)_3$ rather than aqueous $NaOH$, because:

A. NH_4^+ is a week base

B. $NaOH$ is a very strong base

C. $NaOH$ forms soluble $\left[Al(OH)_4\right]^-$ ions

D. $NaOH$ forms $\left[Al(OH)_2\right]^+$ ions

Answer: C

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17. Borax is used as buffer since :

A. Its aqueous solution contains both the week acid and its salt

B. Its aqueous solution contains H_3BO_3, which is a week acid

C. Its aqueous solution contains equal amount of strong acid and its salt

D. statement that borax is a buffer, is wrong

Answer: A

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18. Which of the following sompound is obtained on heating potassium ferrocyanide with concentrated H_2SO_4?

A. CO_2

B. CO

C. C_2H_2

D. $(CN)_2$

Answer: B

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19. $B(OH)_3 + NaOH \rightarrow Na[B(OH)_4](aq).$

Then addition of which of the following shifts the reaction in the backward direction.

A. Glycerol

B. Mannitol

C. Catechol

D. Ethanol

Answer: D

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20. $H_3BO_3(s) + aq.\ NaOH \xrightarrow{\Delta} (X)$,

$H_3BO_3(s) + \text{molten} NaOH \xrightarrow{\Delta} (Y)$

Compound (X) & (Y) are respectively,

A. Na_3BO_3, Na_3B

B. Na_3BO_3, $NaBO_2$

C. $Na\left[B(OH)_4\right]$, Na_3BO_3

D. Na_3BO_3, $Na\left[B(OH)_4\right.$

Answer: C

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21. $SnCl_4$ stannic chloride hydrolyses in dilute solution as per given reaction $SnCl_4 + 4H_2O \rightarrow \left[Sn(OH)_4\right] + 4HCl$. Hydrolysis can be repressed by adding compound A.$SnCl_4 + A \rightarrow B$, B can be:

A. $Sn(OH)_4$

B. $SnCl_2$

C. H_2SnCl_6

D. $Sn(OH)Cl$

Answer: C

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22. Amphoteric oxide $(X) + 3C + Cl_2 \rightarrow$ Poisonous gas + anhydrous chloride (Y) Hydrated chloride $\xrightarrow{\Delta} Z$

Element forming 'Y' other than 'CI' reacts with concentrated HCI but leads to passivation with conc. HNO_3.

Select the correct option.

A. $X = Z$ and Y on reacting with LiH forms strong oxidising agent

B. $X = Z$ and Y on reacting with LiH forms strong reducing agent

C. $X \neq Z$and Y is used as a catalyst in Friedel crafts reaction

D. $X \neq Z$ and Y on reacting with LiH forms strong oxidising agent

Answer: B

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23. Which of a solution of sodium hydroxide is addeed in excess to the solution of potash alum, we obtain

A. a white precipitate

B. bluish white precipitate

C. a clear solution

D. a crystalline mass

Answer: C

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24. BF_3 on hydrolysis forms

A. $H_3BO(3)$

B. HBF_4

C. both (A) and (B)

D. none of these

Answer: C

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25. Preparation of organosilicones from $SiCl_4$ involves substituion in first step:

$SiCl_4 + xRMgCl \rightarrow (R)_xSiCl_{4-x} + xMgCl_2$

Values of 'x' to obtain chain terminating & chain multiplication parts of chain silicone produced are respectively:

A. 1&2

B. 2&1

C. 2&3

D. 3&2

Answer: D

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26. To get the silicone $R_3Si-(OSiR_2)_n-SiR_3$ having $4Si-O-Si$ linkage, the unit taken is:

A. 4 unit of R_2SiCl_2 and 2 unit of R_3SiCl

B. 2 unit of R_2SiCl_2 and 2 unit of R_3SiCl

C. 3 unit of R_2SiCl_2 and 2 unit of R_3SiCl

D. 3 unit of R_2SiCl and 2 unit of R_2SiCl_2

Answer: C

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Exercise 2 Part Ii Single And Double Value Integer Type

1. How many of the following statements are correct regarding allotropes of carbon:

(a) Graphite is not a good conductor of electicity in perpendicular direction of layers at ordinary temperatures.

(b) Coke is the impure form of carbon.

(c) Anthracite is the purest form of carbon.

(d) Buckminister fullerence contains 12 five membered rings and 20 six-membered rings.

(e) Diamond is a good conductor of heat.

(f) Graphite is diamagnetic in nature.

(g) Graphite is thermodynamically more stable than diamond

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2. For boron family (B,Al,Ga,In and Tl)

x : Number of elements which are solid at 40°

y : period number of element which has greater ionization energy than element just above and below it in periodic table.

Z: Period number of most abundant element of group 13.

Report your answer $x + 2y + 3z$

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3. Consider a prototypical fullerene, C_{60}

Let,a = Number of 5-membered rings: b = Number of 6-membered rings

c = Number of π bonds in C_{60}

Find the value of $(3a - 2b + c)$

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4. Central atom may exhibit sp^3 hybridisation in how many of the following species:

(a)CO_2 , (b)Graphite , (c)Diamond , (d)CO

(e)$H_3BO_3(aq)$, (f)Zeolites $(Si$-central) , (g)Silicones (Si)

(h)Chlorosilane (Si)

(i)Borax (Boron) , (j) Al_2Cl_6 , (k)B_2H_6 , (l)SiO_2

(m)H_2CO_3 , (n)$COCl_2$, (o)CH_4 , (p)CCl_4

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5. $Mg + B \rightarrow Mg_xB_y \xrightarrow{HCl}$ Diborane

Report your answer as $(x + y)$.

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6. $B + \underset{conc.}{HNO_3} \rightarrow \underset{\text{white solid}}{A} + \underset{\text{brown gas}}{B}$

How many of the following statements are correct regarding products (A) & (B) ?

(1) (A) can be prepared by reacting borax with dilute acids.

(2) (A) is a weak monobasic lewis acid.

(3) (A) behaves like an electrolyte when dissolved in water.

(4) (A) can be prepared by reacting colemanite, SO_2 & H_2O

(5) (B) is paramagnetic in nature.

(6) (B) is a mixed anhydride.

(7) (B) does not forms a dimer

(8) (B) reacts with $NaOH(aq)$ undergoing disproportionation.

(9) Bond angle about central atom is greater in (A) than in (B). (Assume atom forming maximum number of bonds as central atom)

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7. How many of the following order of bond energies are correct.

(i)$C-C>Si-Si$, (ii) $C-O>Si-O$, (iii) $C-F>Si-F$, (iv) $C-F>Si-F$, (v) $C-H>Si-H$, (vi) $Si-Cl>C-Cl$ (vii) $Si-Si>C-Si$, (viii) $C-Br>Si-Br$

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8. Which of the following Salts are amphoteric in anture.

PbO, PbO_2, SnO, SnO_2, Al_2O_3, ZnO, BeO, Ca_2O_3, B_2O_3

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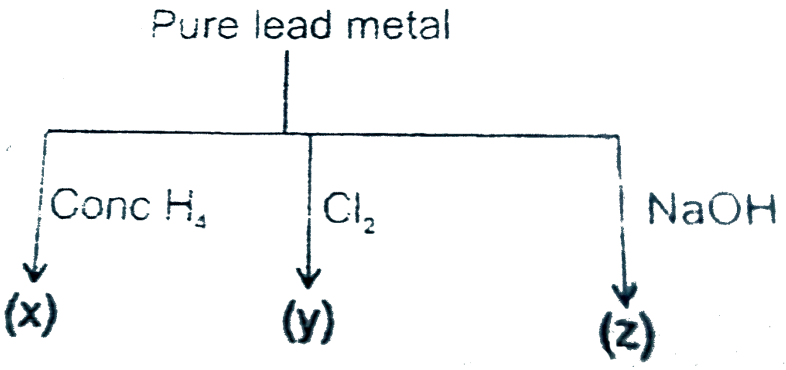
9.



the summation of atomicity of compounds in x, y and z is?

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10. Reduction of $117.5gBCl_3$ by H_2 in silent electric discharge produces HCl, which required $500mL$ of $xMNaOH$ for neutralization. Report x.

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11. 4 moles of $NaBH_4$ react completely with I_2.

calculate volume of gaseous products at STP from above process.

(Give you answer by dividing 4.48)

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12. The number of oxygen atoms in borax which do not from $p\pi - p\pi$ back bond is:

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13. How many compounds show amphoteric nature amongst following

B_2O_3, TI_2O_3, $Al(OH)_3$, $Ga(OH)_3$, Al_2O_3, Ga_2O_3, $NaAlO_2$, $Sr(OH)_2$, Cr

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14. How many compounds form acidic solution when dissolved in water

H_3PO_4, H_3BO_3, $Na_2B_4O_7.10H_2O$, $H_3P_3O_9$, $Ba(OH)_2Ca(OH)_2$, PbO, C

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15. $B_{10}C_2H_{12}$ is isostructural & isoelectronic with borate ion of formula $B_xH_y^{2-}$ give $x+y+z$.

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16. No of compounds producing gas on hydrolysis (with H_2O) is

$Al_4C_3, BaC_2, Mg_2C_3, SiC, B_2H_6, Fe_3C$

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17. How many of the given statements are true for potash alum.

(1) it is a white crystalline solid

(2) it swells up on heating

(3) it imparts a golden yellow colour to the bunsen flame

(4) An aqueous solution of the above given a white gelatinous precipitate with $BaCl_2$ solution soluble only in concentrated sulphuric acid.

(5) An aqueous solution of the above given a white gelatinous precipitate on treatment with NH_4OH. Which dissolves in aqueous $NaOH$ in

excess and reappears, On boiling with concentrated NH_4Cl solution.

(6) It gives a yellow precipitate with Cobalt nitrile solution.

(7) White precipitate in 5^{th} state can also be obtained by passing H_2S gas in aqueous solution of the above.

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18. Sum of the number of oxygen shared in between two silicon atoms in $Si_3O_9^{6-}$ and $Si_3O_{10}^{8-}$ is:

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19. In benitonite $(BaTiSi_3O_9)$ number of O atoms shared persilicate tetrahedron is ...

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20. the overall charge present on the cyclic silicate anion $[Si_6O_{18}]^{n-}$ is:

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21. The silicate ion in the mineral kinoite is a chain of three SiO_4^{4-} tetrahedral that share corners with adjacent tetrahedral. The mineral also contains Ca^{2+} ions, Cu^{2+} ions and water molecules in $1:1:1$ ratio. The mineral is represented as

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22. Straight chain polymer is formed by hydrolysis of $[x]$ which is tetrasubstituted chloromethylsilane then followed by condensation polymerization. Atomicity of $[x]$ is:

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23. Zeolites are minerals of the composition $M_{\left(\frac{x}{n}\right)}\left[[AlO_2]_x(SiO_2)_y\right].ZH_2O$

Where 'n' is the charge on the metal cation. These structure contain

various ring which results in formation of a fairly open structure containing channels and cavities at molecular level (2 to 11A) in diameter). They may be used to trap molecules of various sizes, this makes them very useful as "Selective absorbants" or as "molecular sieves". In the structure of zeolites:

(A) Each Al atom is attached to 'p' oxygen atoms directly

(B) Each Si atom is attached to 'q' oxygen atoms directly

(C) Each Al atom is attached to 'r' Si atoms directly

(D) Each O atom is # hydridized.

Find (p+q+r+t)

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Exercise 2 Part Iii One Or More Than One Options Correct Type

1. Select the correct statement(s).

A. The graphite is diamagnetic and diamond is paramagnetic in nature.

B. Graphite acts as a metallic conductor along the layers of carbon atoms

C. Graphite is less denser than diamond

D. C_{60} is called as Buckminster fullerene

Answer: B::C::D

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2. One of the most fascinating developments in Modern chemistry has been the synthesis of Buckminister fullerence, C_{60} Identify the correct options about C_{60}

A. It cosists of fused 5 and 6 membered carbon rings.

B. All atoms are not-equivalent

C. All bonds are not-equivalent

D. $C-C$ bond lengths at the fusion of two 6-membered rings are shorter with the $C-C$ bond length at the fusion of 5-and 6-

membered rings.

Answer: A::B::C::D

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3. What products are expected from the reaction between colemanite powder and sodium carbonate solution, when they are heated?

A. $CaCO_3$

B. $Na_2B_4O_7$

C. $NaBO_2$

D. CaO

Answer: A::B::C

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4. Boron can be obtained by:

A. reduction of B_2O_3 by C.

B. reduction of BCl_3 with H_2 at $1270k$.

C. thermal decomposition of boron halides at $1173k$.

D. electrolytic reduction of KBF_4 in KF at $1073k$.

Answer: B::C::D

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5. Aluminium can be prepared by:

A. Electrolytic reduction of aluminia in presence of Cryolite & fluorspar.

B. Reduction of $AlCl_3(s)$ by potassium amalgam.

C. Reduction of aqueous solution of $Al_2(SO_4)_3(aq)$ by zinc metal

D. Thermal decomposition of aluminium oxide.

Answer: A::B

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6. Which of the following can produce silicon.

A. Reduction of SiO_2 by carbon

B. Readuction of SiO_2 by silicon carbide

C. Thermal decomposition of SiH_4

D. Thermal decomposition of SiC

Answer: A::B::C

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7. Which of the following facts regarding boron and silicon in true?

A. Boron is used to make boron steel or boron carbide control rods for nuclear reactor.

B. Boron and silicon form halides which are not hydrolysed.

C. Boron and silicon react with magnesium to form magnesium boride and magnesium silicide which are decomposed by acids to give volatile borane and silane, respectively.

D. Both boron and silicon react with alkali to form borates and silicates containing BO_3^{3-} and SIO_4^{4-} tetrahedral units, respectively.

Answer: A::B::D

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8. Graphite and diamond will behave differently in which of the following reactions?

A. Burning in sufficient air

B. Reaction with hot conc. HNO_3

C. Reaction with F_2

D. Reaction with $NaOH(aq.)$

Answer: B::C

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9. Which statement(s) is/are correct?

A. Al acts as a reducing agent

B. Al does not react with steam even at higher temperature

C. Al forms a number of alloy with other metals

D. Al is ionic in all its compounds

Answer: A::B::C

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10. Which of the following statement are true.

A. Red lead (Pb_3O_4) is diamagnetic and contains both Pb^{+2} and Pb^{+4} ions.

B. Both PbO and PbO_2 are amphoteric in nature.

C. Stannate and plumbate ions result in SnO_2 and PbO_2 with acidic solution.

D. Concentrated Nitric acid oxidises red lead into lead dioxide.

Answer: A::B::C

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11. Which of the following statements is true?

A. Small amines such as NH_3, CH_3NH_2 and $(CH_3)_2NH$ give unsymmetrical cleavage of diborane.

B. Boron hydrides can't be used as high energy fuels.

C. Boron hydrides are readilysed.

D. Borazine hydrolyses to NH_3 and boric at elevated temperature, if heated with water.

Answer: A::C::D

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12. Diborane undergoes unsymmetrical cleavage reactions with:

A. dimethylamine

B. ammonia at low temperature

C. methylamine

D. carbon dioxide

Answer: A::B::C

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13. Select correct statements:

A. B_2H_6 is stronger lewis acid than BF_3

B. BF_3 is weaker lewis acid than BCl_3

C. B_2H_6 is not a lewis acid

D. In B_2H_6 all $'H'$ atoms are not in the same plane

Answer: B::D

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14. Which of the following form tetrahydridoborates

A. (Li)

B. Na

C. NH_4^+

D. Ag^+

Answer: A::B

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15. Borax bead test is given by:

A. An aluminium salt

B. A cobalt salt

C. A copper (II) salt

D. A nickel salt

Answer: B::C::D

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16. Boric acid can be used:

A. as an antiseptic

B. as a flux in soldering

C. in making optical glasses

D. in making enamels and pottery glazes

Answer: A::B::C::D

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17. Carbon monoxide is prepared by

A. heating formic and with conc. H_2SO_4

B. heating potassium ferrocyanide with conc H_2SO_4

C. heating malonic acid with : P_2O_{10}

D. hydrolysis of Mg_2C_3

Answer: A::B

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18. The hydroxide of which metal ion is soluble in excess of sodium hydroxide solution:

A. Fe^{3+}

B. Cr^{3+}

C. Sn^{2+}

D. Cu^{2+}

Answer: B::C

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19. Which of the following species exists:

A. $[BF_6]^{3-}$

B. $[AIF_6]^{3-}$

C. $[GaF_6]^{3-}$

D. $[InF_6]^{3-}$

Answer: B::C::D

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20. Which of the following statement(s) is/are correct?

A. The oxide, B_2O_3 and $B(OH)_3$ are acidic

B. The halides of B(except BF_3) and Si are hydrolysed.

C. The hydrides of B and Si are volatile, spontaneously flammable and readily hydrolysed.

D. Aluminium hydride is a polymer, $(AIH_3)_n$.

Answer: A::B::C::D

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21. Which is/are true in case of BF_3 ?

A. It is volatile liquid even at room temperature

B. It is Lewis acid

C. It has planer geometry

D. It forms adduct with NH_3

Answer: B::C::D

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22. Which of the following statements about anhydrous aluminium chloride is/are incorrect ?

A. It exists as $AlCl_3$ molecule in gaseous phase

B. It is a strong Lewis base

C. It sublimes at $100^{\circ} C$ under vacuum

D. It is not easily hydrolysed

Answer: A::B::D

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23. Which of following are correct.

A. B_2H_6 in non-planar.

B. B_2H_6 undergo symmetrical cleavage with PF_3, CO and $(C_2H_5)_3N$

C. B_2H_6 undergo unsymmetrical cleavage with NH_3, CH_3NH_2, $(CH_3)_2NH$

D. $BeH_2(s)$, Ga_2Me_5, Al_2Me_6 have two type of bonds ($2C-2e$ bond as well as $3C-2e$ bond)

Answer: A::B::C::D

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24. A complex cross-linked polymer (silicone) is formed by

A. hydrolysis of $(CH_3)_3SiCl$

B. hydrolysis of a mixture of $(CH_3)_3$ and $(CH_3)_2SiCl_2$

C. hydrolysis of CH_3SiCl_3

D. hydrolysis of $SiCl_4$

Answer: C

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25. Select the correct statement(s)

A. CH_3SiCl_3 undergoes hydrolysis followed by inter molecular elimination of water to form a complex cross linked polymer (i.e silicone)

B. Silicone fluids are thermally stable.

C. In sheet silicone, three oxygen atoms of each tetrahedral are shared with adjacent SiO_4^{4-} tetrahedrals.

D. Silica is attacked by HF and $NaOH$.

Answer: A::B::C::D

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26. Which is incorrect about permutit or zeolite:

A. By it both temporary and permanent hardness of water can not be removed.

B. if formula is $Na_2Al_2Si_3O_8.\ xH_2O$

C. it softens hard water by exchanging its Na^+ ions with Ca^{2+} and Mg^{2+} present in hard water.

D. Exhausted zeolite can be regenerated by passing conc. Solution of NaCI through it.

Answer: A::B

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Exercise 2 Part Iv Comprehensions

1. Compound (A) on reaction with iodine in the solvent diglyme gives a hydride (B) and hydrogen gas. The product (B) is instantly hydrolysed by water or aqueous alkali forming compound (C) and liberating hydrogen gas. The compound (C) in aqueous solution behaves as a week mono basic acid. But in presence of certain organic polyhydroxy compound behaves as a strong monobasic acid. The hydride (B) in air catches fire spontaneously forming oxide which gives coloured beads with transition metal compounds.

Which of the following statement is correct for the product (C)?

A. It is an odd electron molecule.

B. It in water acts as proton donor.

C. It in solid state have hydrogen bonding.

D. It is a useful primary standard for titrating against acids.

Answer: C

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2. Compound (A) on reaction with iodine in the solvent diglyme gives a hydride (B) and hydrogen gas. The product (B) is instantly hydrolysed by water or aqueous alkali forming compound (C) and liberating hydrogen gas. The compound (C) in aqueous solution behaves as a week mono basic acid. But in presence of certain organic polyhydroxy compound behaves as a strong monobasic acid. The hydride (B) in air catches fire spontaneously forming oxide which gives coloured beads with transition metal compounds.

Aqueous solution of product (C) can be titrated against sodium hydroxide using phenolphthalein indicator only in presence of:

A. $cis-1,2diol$

B. trans-1, 2 diol

C. borax

D. Na_2HPO_4

Answer: A

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3. Compound (A) on reaction with iodine in the solvent diglyme gives a hydride (B) and hydrogen gas. The product (B) is instantly hydrolysed by water or aqueous alkali forming compound (C) and liberating hydrogen gas. The compound (C) in aqueous solution behaves as a week mono basic acid. But in presence of certain organic polyhydroxy compound behaves as a strong monobasic acid. The hydride (B) in air catches fire spontaneously forming oxide which gives coloured beads

with transition metal compounds.

Which of the following statement is correct for the hydride (B)?

A. One mole of it react with two moles of HCI.

B. It reacts with excess of ammonia at low temperature to form an ionic compound.

C. One mole of it reacts with one mole of trimethylamine.

D. It reacts with methyl alcohol to form a trimethyl compound liberating oxygen gas.

Answer: B

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4. All the boron trihalides except BI_3 may be prepared by direction between the elements. Boron trihalides consist of trigonal-planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases,

BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form simple Lewis complexes with suitable bases, as in the reaction:

$BF_3(g) + NH_3(g) \rightarrow F_3B - NH_3(s)$

However, boron chlorides, bromides and iodides are susceptible (sensitive) to protolysis by mild proton sources such as water, alcohols and even amines, for example BCl_3 undergoes rapid hydrolysis:

$BCl_3(g) + 3H_2O(l) \rightarrow B(OH)_3(aq) + 3HCl(aq)$

It is supposed that the first step in the above reaction is the formation of the complex $Cl_3B \leftarrow OH_2$ which then eliminates HCl and reacts with water.

Which of the follwoing is the best order of Lewis acid strength of BF_3, BCl_3 and BBr_3 ?

A. $BF > BCl_3 > BBr_3$

B. $BF = BCl_3 = BBr_3$

C. $BF < BCl_3 < BBr_3$

D. $BBr_3 < BF_3 < BCl_3$

Answer: C

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5. All the boron trihalides except BI_3 may be prepared by direction between the elements. Boron trihalides consist of trigonal-planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases, BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form simple Lewis complexes with suitable bases, as in the reaction:

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Which of the following is the correct prediction about observed $B-X$ bond length, in BX_3 molecules?

A. $B-F$ bonf length in BF_3 is found to be less than theoretical value because the electronegativity values of $B(2.04)$ and $F(4.0)$ suggest the bond to be ionic and hence the attraction between oppositely charged ions must decrease the bond length

B. BF_3 and $[BF_4]^-$ have equal $B-F$ bond length

C. The decrease in the $B-F$ bond length in BF_3 is due to delocalised $p_\pi - p_\pi$ bonding between vacant $'2p'$ orbital of B and filled $'2p'$ orbital of F.

D. The correct $B-X$ bond length order is $B-F > B-Cl > B-Br > B-I$

Answer: C

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6. All the boron trihalides except BI_3 may be prepared by direction between the elements. Boron trihalides consist of trigonal-planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases, BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form simple Lewis complexes with suitable bases, as in the reaction:

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It is supposed that the first step in the above reaction is the formation of the complex $Cl_3B \leftarrow OH_2$ which then eliminates HCl and reacts with water.

Which is correct about the hydrolysis of BX_3?

A. All BX_3 undergo hydrolysis to produce $B(OH)_3(aq)$ and $HX(aq)$.

B. BF_3 does not undergo complete hydrolysis due to formation of HBF_4

C. BBr_3 does not undergo hydrolysis at all because it cannot form H-bonds with water.

D. All the above are correct

Answer: B

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7. All the boron trihalides except BI_3 may be prepared by direction between the elements. Boron trihalides consist of trigonal-planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases, BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form simple Lewis complexes with suitable bases, as in the reaction:

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It is supposed that the first step in the above reaction is the formation of the complex $Cl_3B \leftarrow OH_2$ which then eliminates HCl and reacts with water.

Which of the following reactions is incorrect ?

A. $BF_3(g) + F^-(aq) \rightarrow [BF_4]^-(aq)$

B. $BCl_3(g) + 3EtOH(l) \rightarrow B(OEt)_3(l) + 3HCl(g)$

C. $BBr_3(l) + F_3BN(CH_3)_3(s) \rightarrow BF_3(g) + Br_3BN(CH_3)_3(s)$

D. $BCl_3(g) + 2C_5H_5N(l) \rightarrow Cl_3B(C_5H_5N)_2(s)$

Answer: D

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8. The small size and high charge of Al^{3+} ion gives it a high charge density which is responsible for its tendency to show (a) covalency in its compounds in the gaseous state (b) high hydration energy which stabilizes its compounds in solution, and (c) high lattice energy of its compounds in the solid state. Thus aluminium can forms both covalent and ionic bond.

Like halides of boron, halides of aluminium do not show back bonding because of increase in size of aluminium. Actually aluminium atoms complete their octets by forming dimers. Thus chloride and bromide of aluminium exist as dimers, both in the vapour state and in polar-solvents like benzene while the corresponding boron halides exists as monomer. In boron trihalides the extent of back bonding decreases with increases with increase in size of halogens and thus lewis acid character increases. All BX_3 are hydrolysed by water but BF_3 shows a different behaviour.

The dimeric structure of aluminium chloride disappears when:

A. it dissolves in water

B. it reacts with donor molecules like R_3N

C. it dissolves in benzene

D. (A) & (B) both

Answer: D

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9. The small size and high charge of Al^{3+} ion gives it a high charge density which is responsible for its tendency to show (a) covalency in its compounds in the gaseous state (b) high hydration energy which stabilizes its compounds in solution, and (c) high lattice energy of its compounds in the solid state. Thus aluminium can forms both covalent and ionic bond.

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with increase in size of halogens and thus lewis acid character increases.

All BX_3 are hydrolysed by water but BF_3 shows a different behaviour.

Which one of the following statements is correct ?

A. All boron trihalides are hydrolysed to boric acid.

B. Anhydrous aluminium chloride is an ionic compound

C. Aluminium halides make up the electron deficiency by bridging with halide or alkyl groups

D. None of these

Answer: C

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10. The small size and high charge of Al^{3+} ion gives it a high charge density which is responsible for its tendency to show (a) covalency in its compounds in the gaseous state (b) high hydration energy which stabilizes its compounds in solution, and (c) high lattice energy of its compounds in the solid state. Thus aluminium can forms both covalent

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Which of the following statements about anhydrous aluminium chloride is correct ?

A. It is an ionic compound.

B. It is not easily hydrolysed.

C. It sublimes at $100^\circ C$ under vacuum.

D. It is a strong lewis base.

Answer: C

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11. The small size and high charge of Al^{3+} ion gives it a high charge density which is responsible for its tendency to show (a) covalency in its compounds in the gaseous state (b) high hydration energy which stabilizes its compounds in solution, and (c) high lattice energy of its compounds in the solid state. Thus aluminium can forms both covalent and ionic bond.

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Which of the following reaction is incorrect ?

A. $BF_3(g) + F^-(aq) \rightarrow BF_4^-$

B. $BF_3(g) + 2H_2O \rightarrow [BF_3OH]^- + H_3O^-$

C. $BCl_3(g) + 3EtOH(l) \rightarrow B(Oet)_3(l) + 3HCl$

D. $BCl_3(g) + 2C_5H_5N(l) \rightarrow Cl_3B(C_5H_5N)_2(s)$

Answer: D

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Exercise 3

1. Write the chemical reactions associated with the 'borax' best 'test' of cobalt (II) oxide.

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2. Compound (X) on reduction with $LiAlH_4$ gives a hydride (Y) containing $21.72\,\%$ hydrogen along with other products. The compound (Y) reacts with air explosively resulting in formation of boron trioxide. Identify (X) and (Y).

Give balanced reactions involved in the formation of (Y) and its reaction with air. Give the structure of (Y).

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3. Write the balanced equations for the reactions of the following compounds with water:

(i) AI_4C_3 (ii) $CaNCN$ (iii) BF_3 (iv) NCI_3 (v) XeF_4

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4. How is boron obtained from borax ? Give the chemical reactions involved. Draw the structure of B_2H_6 and give its reaction with HCl.

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5. H_3BO_3 is :

A. monobasic and weak lewis acid

B. monobasic and weak Bronsted acid

C. monobasic and strong Lewis acid

D. tribasic and weak Bronsted acid

Answer: A

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6. $B(OH)_3 + NaOH \rightarrow Na\left[B(OH)_4\right](aq).$

Then addition of which of the following proceeds the reaction in the forward direction ?

A. Cis-$1, 2$ diol

B. Trans $1, 2$ diol

C. Borax

D. Na_2HPO_4

Answer: A

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7. Statement: In water, orthoboric acid behaves as a weak monobasic acid.

Explanation: In water, orthoboric acid as a proton donor.

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 True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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8. The coordination number of Al in the crystalline state of $AlCl_3$ is _____.

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9. The correct statement (s) for orthoboric acid is/are

A. It behaves as a weak acid in water due to self ionization.

B. Acidity of its aqueous solution increases upon addition of ethylene glycol.

C. It has a three dimensional structure due to hydrogen bonding.

D. It is weak electrolyte in water.

Answer: B::D

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10. Starting from $SiCl_4$ prepare the following in steps not exceeding the number give in parantheses (give reaction only)

a. Silicon (1)

b. Linear silicon containing methyl groups only (4)

c. $Na_2SiO_3(3)$.

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11. $(Me)_2SiCl_2$ on hydrolysis will produce.

A. $(Me)_2Si(OH)_2$

B. $(Me)_2Si=O$

C. $-\left[-O-(Me)_2Si-O-\right]_n-$

D. $Me_2SiCl(OH)$

Answer: C

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12. $[SiO_4]^{4-}$ has tetrahedral structure, the silicate formed by using the three oxygen has

A. Sheet silicate

B. Pyrocilicate

C. Three dimensional silicate

D. linear chain silicate

Answer: A

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13. Assertion (A) :Pb^{+4} compounds are stronger oxidiising agents than Sn^{4+} compounds .

Reason (R): The higher oxidation states for group 14 elements are more stable for the heavier members of the group due to inert pair effect .

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 True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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14. In the following reaction.

$2X + B_2H_6 \rightarrow \left[BH_2(X)_2\right]^{\oplus}\left[BH_4\right]^{\ominus}$

The amine $(s)x$ is /are.

A. NH_3

B. CH_3NH_2

C. $(CH_3)_2NH$

D. $(CH_3)_3N$

Answer: A::B::C

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15. The value of n in the molecular formula $Be_nAl_2Si_6O_{18}$ is:

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16. Three moles of B_2H_6 are completely reacted with methanol. The number of moles of boron containing product formed is.

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17. Under hydrolysis conditions, the compounds used for preparation of linear polymer and for chain termination, respectively are

A. CH_3SiCl_3 and $Si(CH_3)_4$

B. $(CH_3)_2SiCl_2$ and $(CH_3)SiCl$

C. $(CH_3)SiCl_2$ and CH_3SiCl_3

D. $SiCl_4$ and $(CH_3)_3SiCl$

Answer: B

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Exercise 3 Part Ii Jee Main Aiee Problems Previous Years

1. Aluminium is extracted in the electrolysis of :

A. alumina

B. bauxite

C. molten cryolite.

D. alumina mixed with molten cryolite

Answer: D

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2. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite

A. is a non-crystalline substance.

B. is an allotropic form of diamond.

C. has molecules of variable molecular masses like polymers.

D. has carbon atoms arranged in large plates of ring of strongly bound carbon atoms with weak interplate bonds.

Answer: D

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3. The soldiers of Napoleon army while at Alps during freezing winter suffered a serious problem with regard to the tin buttons of their uniform. White metallic tin buttons get converted to grey poweder. This transformation is relate to

A. a change in the crystalline structure of tin.

B. an interaction with nitrogen of the air at very low temperature.

C. a change in the partial pressure of oxygen in the air.

D. an interaction with water vapour contained in the humid air.

Answer: A

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4. Aluminium chloride exists as a 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. $\left[Al(OH)_6\right]^{3-} + 3HCl$

B. $\left[Al(H_2O)_6\right]^{3+} + 3Cl^-$

C. $Al^{3+} + 3Cl^-$

D. $Al_2O_3 + 6HCl$

Answer: B

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5. In silicon dioxide:

A. there are double bonds between silicon and oxygen atoms.

B. silicon atom is bonded to two oxygen atoms.

C. each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded to two silicon atoms.

D. each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms.

Answer: D

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6. Heating an aqueous solution of aluminium chloride to dryness will give

A. $Al(OH)Cl_2$

B. Al_2O_3

C. Al_2Cl_6

D. $AlCl_3$

Answer: B

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7. vii. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence :

A. $GeX_2 < SiX_2 < SnX_2 < PbX_2$

B. $SiX_2 < GeX_2 < PbX_2 < SnX_2$

C. $SiX_2 < GeX_2 < SnX_2 < PbX_2$

D. $PbX_2 < SnX_2 < GeX_2 < SiX_2$

Answer: C

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8. In context with the industrial preparation of hydrogen from water gas $(CO + H_2)$, which of the following is the correct statement ?

A. CO is removed by absorption in aqueous Cu_2Cl_2 Solution.

B. H_2 is removed through occlusiion with Pd.

C. CO is oxidized to CO_2 with steam in the presence of a catalyst, followed by absorption of CO_2 in alkali.

D. CO and H_2 are fractionally separated using differences in their densities.

Answer: C

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9. Among the following substituted silanes, the one which will give rise to cross linkes silicons polymer on hydrolysis is

A. $RSiCl_3$

B. R_2SiCl_2

C. R_3SiCl_2

D. R_4Si

Answer: A

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10. Which one of the following is the correct statement ?

A. Beryllium exhibits coordination number of six.

B. Chlorides of both beryllium and aluminium have bridged structures in vapour phase.

C. $B_2H_6.2NH_3$ is known as 'inorganic benzene'.

D. Boric acid is a protonic acid.

Answer: B

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11. Boron cannot from which one of the following anions?

A. BF_6^{3-}

B. BH_4^-

C. $B(OH)_4^-$

D. BO_2^-

Answer: A

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12. Which of the following is the wrong statement ?

A. $ONCI$ and ONO^- are not isoelectronic.

B. O^3 molecule is bent

C. Ozone is violet-black in solid state

D. Ozone is diamagnetic gas.

Answer: A::B::C::D

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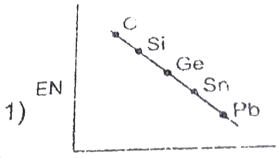
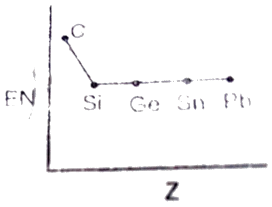
1. Which of the following is the correct graph for EN values of carbon family :

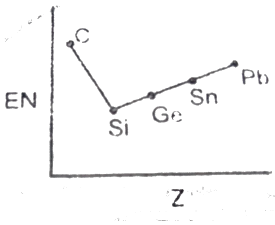
A.



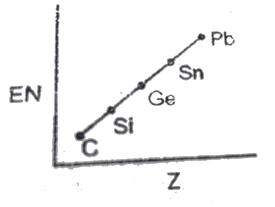
B.



C.



D.



Answer: B

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2. Select the incorrect statement :

A. Silicon does not form an allotrope like graphite because of its no tendency of multiple bond formation.

B. Catenation tendency is greater in C than in Si.

C. CO is stable in nature but SiO does not

D. None of these

Answer: D

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3. Which of the following statement about Si is correct.

A. Si predominantly forms covalent componds with oxidation number as $+4$.

B. Ionisation enthalpy of Si is more than that of carbon.

C. Electron affinity of Si is less than that of carbon.

D. Si can't show coordination number more than 4.

Answer: A

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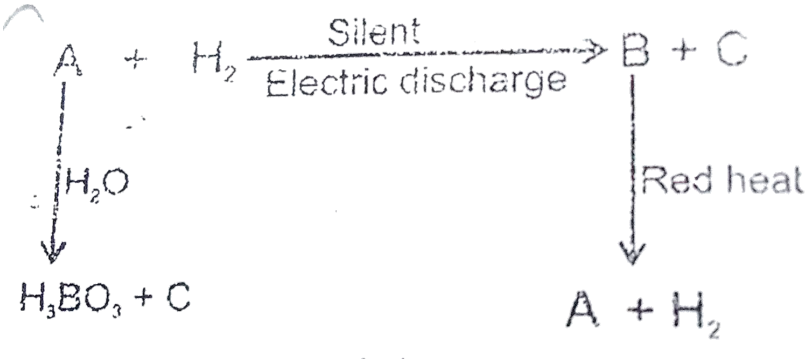

4.

Identify correct statement.

A. C is a weak lewis acid

B. B is a weak lewis base

C. C is a strong acid

D. D reacts with $NaOH$ to produce C

Answer: C

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5. $4BCl_3 + 3LiAIH_4 \rightarrow A + 3AlCl_3 + 3LiCl$

When A reacts with $NaOH$ it produces a colourless combustible gas and another compound 'B'. Select incorrect statement about 'B'

A. (1) It aqueous solution turns red litmus blue

B. It shows anionic hydrolysis

C. It shows cationic hydrolysis

D. It can also produce by reaction of boron with NaOH

Answer: C

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6. When heating white lead then find out released gas (A) and (B)

$$\underset{\text{white lead}}{2PbCO_3 . Pb(OH)_2} \overset{\Delta}{\rightarrow} Pb_3O_4 + (A) + (B) + H_2O$$

A. CO, O_2

B. CO_2, O_2

C. CO_2, CH_4

D. CO, CO_2

Answer: D

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7. Amorphous boron is extracted from borax by the following steps :

$$\text{Borax} \xrightarrow{(A)} H_3BO_3 \xrightarrow{\text{Heat}} B_2O_3 \xrightarrow{(B)} \text{Boron}(A) \text{ and } (B) are$$

(a) H_2SO_4, Al

(b) HCl, Carbon

(c) H_2SO_4, Mg

(d) $HCl, Fe.$

A. H_2SO_4, Al

B. HCl,carbon

C. H_2SO_4, Mg

D. HCl, Fe

Answer: C

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8. The role of addition of Me_3SiCl during the hydrolysis followed by conduction of Me_3SiCl_2 is.

A. To catalyte the reaction.

B. To terminate the chain and hence controlling the molecular weight.

C. For obtaiming a proper cross linking.

D. All of the above

Answer: B

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9. Given type of silicones are called $[P]$

$$-O-\overset{\overset{R}{|}}{\underset{\underset{R}{|}}{Si}}-O-\overset{\overset{R}{|}}{\underset{\underset{R}{|}}{Si}}-O-\overset{\overset{R}{|}}{\underset{\underset{R}{|}}{Si}}-$$

$[P]$ is prepared by hydrolysis of $[Q]$

$[P]$ & $[Q]$ are respectively.

A. Linear silicone, CH_3SiCl_3

B. branched silicone, $(CH_3)_3SiCl$

C. Cyclic silicone, $(CH_3)_2SiCl_2$

D. Cyclic silicone, CH_3SiCl_3

Answer: C

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10. Which of the following is not a property of silicones ?

A. They are combustible

B. They are water-repellant

C. They are polymeric liquids or solids

D. Their viscosity does not change significaltly with rise in tamperature.

Answer: A

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11. Tourmalene is a class of cyclosilicates with general formula.

$(Ca, K, Na)(Al, Fe, Li, Mg, Mn)_3(Al, Cr, Fe, V)_6(BO_3)_3(Si, Al, B)_6O_1$

Which of the following is not a correct example of tourmalene ?

A. $CaAl_3Fe_6(BO_3)_3S_6O_{18}F_4$

B. $Ca_2Li_3V_6(BO_3)_3Si_6O_{18}(OH)_4$

C. $KMg_3Cr_6(BO_3)_3Si_6O_{18}F_4$

D. $CaAl_9(BO_3 \_ (3)Si_6O_{18}(OH)_4$

Answer: A

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12. The silicate anion in the mineral kinoite is a chain of three SiO_4 tetrahedra, that share corners with adjacent tetrahedra. The charge pof silicate anion is

A. -4

B. -8

C. -6

D. -2

Answer: B

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13. The dehydration of malonic acid $CH_2(COOH)_2$ with P_4O_{10} and heat give

A. carbon monoxide

B. carbon suboxide

C. carbon dioxide

D. all three

Answer: B

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14. Borax on heating with cobalt oxide forms a blue bead of

A. $Co(BO_2)_2$

B. $Co(BO_2)$

C. $Co_3(BO_3)_2$

D. $Na_3CO(BO_3)_2$

Answer: A

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15. The dissolution of $Al(OH)_3$ by a solution of $NaOH$ results in the formation of

A. $\left[Al(H_2O)_4(OH)\right]^{2+}$

B. $\left[Al(H_2O)_2(OH)_4\right]^{-}$

C. $\left[Al(H_2O)_3(OH)_3\right]$

D. $\left[Al(H_2O)_6(OH)_3\right]$

Answer: B

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16. Select the incorrect statement about the boron.

A. Pure form of the elements are obtained by the reduction of BCl_3 with zinc at $900^\circ C$.

B. Crystalline boron is attacked only by hot concentrated oxidising agents.

C. Amorphous boron and ammonia at white gives $(BN)_x$, a slippery white solid with a layer structure resembling that of graphite.

D. Boron does form B^{3+} cation easily.

Answer: D

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17. Aqueous solution containing 1 mol of borax raects with 2 mol of acids. Thic is because of:

A. formation of 2 mol of $B(OH)_3$ only

B. formation of 2 mol of $\left[B(OH)_4\right]^-$ only

C. formation of 1 mol each of $B(OH)_3$ and $\left[B(OH)_4\right]^-$

D. formation of 2 mol each of $\left[B(OH)_4\right]^-$ and $B(OH)_3$, of which only $\left[B(OH)_4\right]^-$ reacts with acid

Answer: D

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18. Water transpoted through Lead pipes becomes poisonous due to the formation of :

A. PbO

B. PbO_2

C. $Pb(OH)_2$

D. Pb_3O_4

Answer: C

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19. When a mixture of air and steam is passed over red hot coke, the outgoing gas is:

A. Producer gas

B. Water gas

C. Coal gas

D. None of these

Answer: B

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20. In BF_3, the $B-F$ bond length is $1.30A$, when BF_3 is allowed to be treated with Me_3N, it forms an adduct, $Me_3N \rightarrow BF_3$, The bond length of $B-F$ in the adduct is :

A. Greater than $1.30A$

B. Smaller than $1.30A$

C. Equal to $1.30A$

D. None of these

Answer: A

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21. Aluminium is extracted in the electrolysis of :

A. alumina

B. bauxite

C. molten cryolite.

D. alumina mixed with molten cryolite

Answer: D

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22. A compound of boron X reacts at $200^{\circ}C$ temperature with NH_3 to give another compound Y which is called as inorganic benzene. The compound Y is a colourless liquid and is highly light sensitive. Its melting point is $-57^{\circ}C$. The compound X with excess of NH_3 and at a still higher temperature gives boron nitride $(BN)_n$. The compounds X and Y are respectively:

A. BH_3 and B_2H_6

B. $NaBH_4$ and C_6H_6

C. B_2H_6 and $B_3N_3H_6$

D. B_4C_3 and C_6H_6

Answer: C

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23. For given processes, choose the correct order of purity of silicon obtained.

I.$SiO_2 + 2C \rightarrow Si + 2CO$

II.$Si(\text{pure}) + 2Cl_2 \rightarrow Si + MgCl_2$

III.$Na_2[SiF_6] + 4Na \rightarrow 6NaF + Si \rightarrow$ Zone refined Si

A. $I > Ii > III$

B. $III > II > I$

C. $I = II = III$

D. $II < I < III$

Answer: B

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24. E represents an element belonging to boron family.

$2E + 3X_2 \rightarrow 2EX_3 (X = F, Cl, Br, I)$

A. Oxidation state of E in all EX_3 is $+3$

B. All EX_3 are predominantly ionic

C. Ti does not form TIX_3 as TI^{+1} is more stable than TI^{+3}

D. There exists some EX_3 for which E shows $+1$ oxidation state.

Answer: D

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25. E represents an element belonging to boron family.

$E + 2X_2 \rightarrow EX_4 (X = F, Cl, Br, l)$

A. Stability of EX_4 decreases down the 14^{th} group

B. PbL_4 does not exist

C. Ge & Pb forms EX_2 as well.

D. All are correct

Answer: D

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26. When Al is added to KOH solution

A. No action takes place

B. Oxygen is evolved

C. Water is produced

D. hydrogen is evolved

Answer: D

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27. Which of the following reactions lead to chemical inertness :

A. Lead with dilute H_2SO_4

B. Lead with conc. HCI

C. Aluminium with oxygen

D. All of above reactions

Answer: D

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28. Which of the following statements regarding boric acid is false?

A. It acts as a weak monobasic acid

B. It is soluble in hot water

C. It has a planar structure

D. It acts as a tribasic acid

Answer: D

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Section 1

1. Which of the following statements are false.

A. PbO, PbO_2 are amphoteric, CO is neutral and CO_2, SiO_2 are acidic.

B. Carbon shows oxidation number from -4 to $+4$ in its various compounds.

C. B_2O_3 is acidic, SnO is amphoteric and Ga_2O_3, GeO_2 are acidic.

D. Boron is non metal, Ge, Ga are metalloids and Pb, Sn, In are metals.

Answer: C

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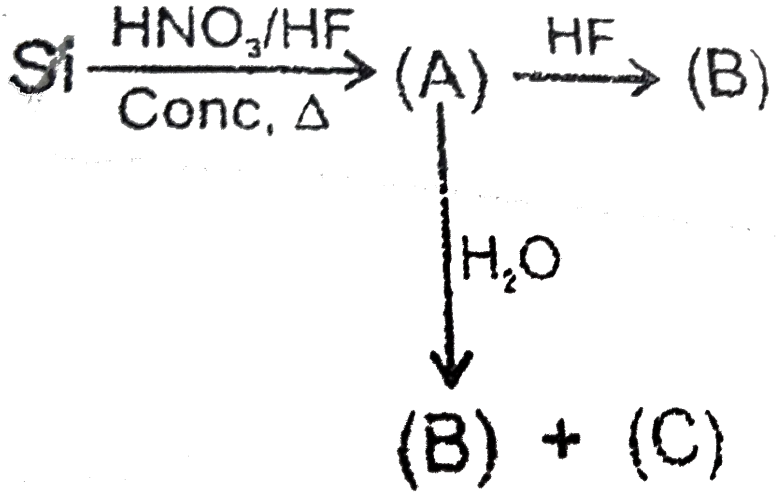
2.



Select the correct option :

A. (A) is SiF_4

B. (B) is H_2SiF_6

C. (C) is H_4SiO_4

D. All of these

Answer: D

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3. $NaBH_4 + l_2 \rightarrow X \uparrow + Y \uparrow + 2Nal$

$X + C_2H_5OH \rightarrow Y \uparrow + D$

$X + HCl \rightarrow Y \uparrow + E$

D gives folowwing colour with flame.

A. Red

B. Green

C. Blue

D. No colour

Answer: B

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4. $B_2H_6 + NH_3 \xrightarrow[\text{Heating}]{\text{Slowly}} X \xrightarrow{\Delta} Y$

Which of the following around X is correct.

A. X is ionic in nature, Hybridisation state of B in both cationic and anionic part is same.

B. X is ionic in nature, hybridisation state of B in cationic and anionic part are different.

C. Y is covalent and hybridisation state of all B is not same.

D. Y is ionic and hybridisation state of all B are same.

Answer: A

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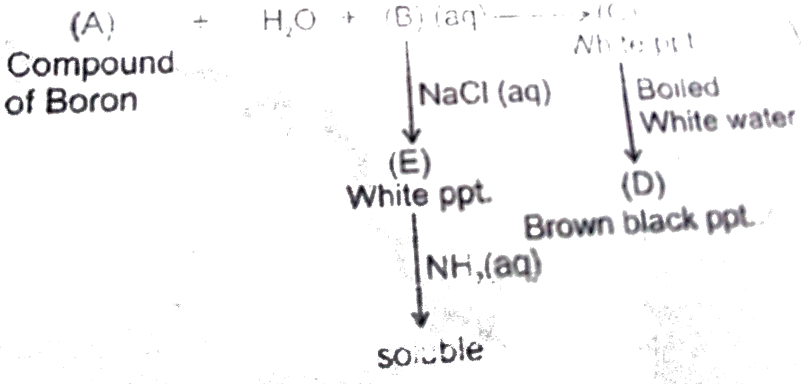
5.



(C) and (D) are respectively

A. $Mn(BO_2)_2, MNO_2$

B. $AgNO_2, Ag_2O$

C. $Cu(BO_2)_2, CuO$

D. none of these

Answer: B

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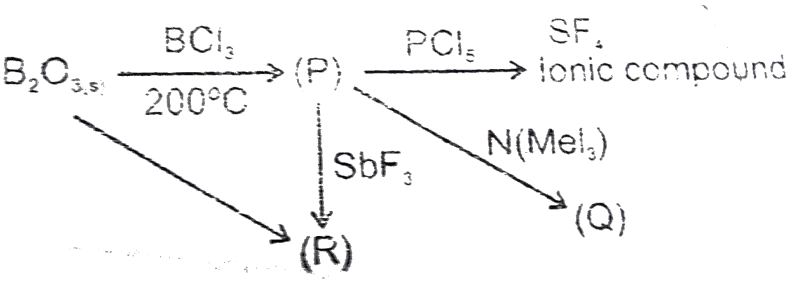

6.

Select the correct option ?

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7. Thortretite, $Sc_2Si_2O_7$ is :

A. a orthosilicate

B. a pyrosilicate

C. a sheet silicate

D. a cyclic silicate

Answer: B

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Section 2

1. Which of the following are the ores of Boron

A. Tincal

B. Kemite

C. Colemanite

D. Bauxite

Answer: A::B::C

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2. When as inorganic compound X having electron dificient bounding (banana bonding) react with ammonia gas at certain temperature gives a compound (Y), isostructural with benzene. Compound (X) with ammonia at a high temperature produces a substance (Z).

A. X is B_2H_6

B. Y is $B_3N_3H_6$

C. Z is hard substance

D. compound X contain $3C-2e$ and $2C-2e$ bond.

Answer: A::B::C::D

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3. Which of the following statement is/are correct ?

A. All III A group elemts froms trihalide

B. Only Al react dirrelly with N_2 at high temperature and form AIN

C. Al Passivated by concentrated HNO_3

D. All $IVA\left(14^{th}\right)$ group elements forms trihalide.

Answer: A::B::C

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4. Which of the following is/are true about silicones.

A. Silicones contain repeated R_2SiO units

B. $RSiCl_3$ gives a complex cross linked silicones

C. $(CH_3)_2SiCl_2$ gives a chain silicones

D. When silicone undergo combustion, it form solid white powder as one of the products.

Answer: A::B::C::D

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5. Cation exchanger zeolite $Na_{12}Al_{12}Si_{17}O_{58}.27H_2O$ can exchange cation with which of the following in aqueous solution ?

A. $Mg(HCO_3)_2$

B. K_2SO_4

C. $CaCl_2$

D. NH_4NO_3

Answer: A::C::D

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Section 3

1. How many of the following parameters/properties are greater for diamond as compared to graphite ? Denisty, Electrical resistivity, Thermal conductivity, stability, % s-character for hybridised orbitals, Hardness, Bond angle, $C-C$ (bond length), Standard enthalpy of formation.

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2. $Na_2B_4O_7 \xrightarrow{\Delta} NaBO_2 + B_2O_3$

$NaBO_2 + H_2O_2 + H_2O \rightarrow$ compound $A(aq)$

The compound A the sum of oxidation states of all the oxygen atoms is X. Then the value of (X) is

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3. A Boron mineral have pentaborate anion whose molecular formula is $\left[B_5O_6(OH)_4\right]^-$. The number of $B-O-B$ linkage present are?

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4. Consider the following sequence of reactions:

$B_2O_3 + CaF_2 + H_2SO_4 \rightarrow (A) + (B) + H_2O$

$(A) + LiAlH_4 \rightarrow (C)(g) + (D) + LiF$

$(C) + H_2O \xrightarrow[\Delta]{} (D) + H_2 \uparrow$

$(D) + Na_2CO_3 \rightarrow (E) + NaBO_2 + CO_2 \uparrow$

$(E) + NH_4Cl \rightarrow (F) + B_2O_3 + NaCl + H_2O$

What is the empirical mass of compound (F)?

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5. How many of the following statement are correct ?

(1) CF_4 can be prepared by reaction between SiC and F_2.

(2) In $SiF_4Si - F$ observed bond length is shorter than actual $Si - F$ bond length

(3) $(C_2F_4)_n$ is known as $PTFE$.

(4) CCl_4 react with Anyelrony HF, gives Chloro Flouro carbon (CCl_2F_2)

(5) CCl_4 can hydrolysis under super heating conditious.

(6) Hydrolysis of SiF_4 is not complete of SiF_4 is partially hydrolysis.

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6. How many of the following may react with $SiCl_4$ to produce a non-polar product ?

$NaH, CH_3MgCl, H_2O, LiAlH_4, H_2SO_4(l), NH_3, Be$

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Section 4

1. (i)$P + C(\text{carbon}) + Cl_2 \rightarrow Q + CO \uparrow$, (ii)$Q + H_2O \rightarrow R + HCl$

(iii)$BN + H_2O \rightarrow R + NH_3$, (iv)$Q + LiAIH_4 \rightarrow S + LiCl + AlCl_3$

(v)$S + H_2 \rightarrow R + H_2 \uparrow$, (vi)$S + NaH \rightarrow T$

(P, Q, R, S and T do not represent their chemical symbols)

Compound Q has: (I) zero dipole moment (II) a planer trigonal structure

(III) an electron deficient compound (IV) a Lewis base Choose the correct code.

A. I,IV

B. I,II,IV

C. I,II,III

D. I,II,III,IV

Answer: B::D

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2. (i)$P + C(\text{carbon}) + Cl_2 \rightarrow Q + CO \uparrow$, (ii)$Q + H_2O \rightarrow R + HCl$

(iii)$BN + H_2O \rightarrow R + NH_3$, (iv)$Q + LiAIH_4 \rightarrow S + LiCl + AlCl_3$

(v)$S + H_2 \rightarrow R + H_2 \uparrow$, (vi)$S + NaH \rightarrow T$

(P, Q, R, S and T do not represent their chemical symbols)

Compound T is used as a/an:

A. oxidising agent

B. complexing agent

C. bleaching agent

D. reducing agent

Answer: D

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3. (i)$P + C(\text{carbon}) + Cl_2 \rightarrow Q + CO \uparrow$, (ii)$Q + H_2O \rightarrow R + HCl$ (iii)$BN + H_2O \rightarrow R + NH_3$, (iv)$Q + LiAIH_4 \rightarrow S + LiCl + AlCl_3$ (v)$S + H_2 \rightarrow R + H_2 \uparrow$, (vi)$S + NaH \rightarrow T$

(P, Q, R, S and T do not represent their chemical symbols)

Compound S is: (I) an odd compound (II) (III) an electron deficient compound (IV) a hybridized compound Choose the correct code:

A. III

B. I,III

C. II,III,IV

D. I,II,IV

Answer: A

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Part Iii Olympiad Problems Previous Years Stage I National Standard Examination In Chemistry Nsec

1. Carborundum is the commercial name of

A. H_3PO_4

B. $Ca(H_2PO_4)_2$

C. Al_2O_3

D. SiC

Answer: D

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2. Graphite is used in nuclear reactor :

A. for reducing the speed of neutrons

B. as a fuel

C. as a lubricant

D. for lining the inner surface of the reactor which will work as an insulator.

Answer: A

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3. The hybrid orbital of the central atom in AlF_4^- is :

A. sp

B. sp^2

C. sp^3

D. sp^3d

Answer: C

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4. Hydrogenation of benzoyl chloride in the presence of $Pd/BaSO_4$ gives :

A. benzyl alcohol

B. benzoic acid

C. benzaldehyde

D. toluene

Answer: C

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5. $SnCl^2$ acts as a reducing agent because

A. $SnCl_2$ can accept electrons readily

B. Sn^{3+} is more stable than Sn^{2+}

C. Sn^{4+} is more stable than Sn^{2+}

D. Sn^{2+} can be readily converted to metallic tin.

Answer: C

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6. At room temperature, CO_2 is a gas while SiO_2 is a solid because

A. CO_2 is a linear molecule, while SiO_2 is an angular one

B. the van der waal's forces are very strong in SiO_2

C. CO_2 is covalent, while SiO_2 is ionic

D. unlike C, Si cannot form stable bonds with O, hence Si has to form a $3D$ lattice.

Answer: D

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7. Colour of the bead in borax bead testis mainly due to the formation of

A. metal oxides

B. boron oxide

C. metal metaborates

D. elemental boron.

Answer: B

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8. In borax bead test, the borax used is $Na_2B_4O_7.10H_2O$. However, the species that is responsible for the test is

A. Na_3BO_3

B. B_2O_3

C. $Na\left[B(OH)_4\right]$

D. $Na[BO)_4$

Answer: D

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9. Which type of bond exists between the two boron atoms in a diborane molecule ?

A. 2-Center-2electron

B. 3-Center-2-electron

C. 3-Center-3-electron

D. 4-Center-4-electron

Answer: B

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10. Silicones are water repelling in nature because-

A. they have highly covalent $Si - O - Si$ linkages.

B. they have organic groups forming hydrophobic exterior.

C. they are polymoric in nature.

D. they have $Si - H$ bonds as in hydrocarbons.

Answer: B

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11. $[SiO_4]^{4-}$ has tetrahedral structure, the silicate formed by using the three oxygen has

A. Sheet silicates

B. Pyrosilicates

C. Linear Chain silicates

D. Three dimensional silicates

Answer: A

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12. The change in hybridization of aluminium when Al_2Cl_6 decomposes in the gas phase is :

A. $sp^2 \rightarrow sp^3$

B. $sp \rightarrow sp^2$

C. $sp \rightarrow sp^3$

D. $sp^3 \rightarrow sp^2$

Answer: D

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13. The hybridization of boron in the stable borane having thelowest molecular weight is-

A. sp^2

B. sp^3

C. sp

D. sp^3d

Answer: B

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14. The species that cannot exist is

A. SiF_6^{2-}

B. BF_6^3

C. SF_6

D. AIF_6^{3-}

Answer: B

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Part Iii Olympiad Problems Previous Years Stage Ii Indian National Chemistry Olympiad Incho Problem 1

1. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Draw the structures of CO_2 and SiO_2

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2. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

The reason for the distinct difference in the properties of CO_2 and SiO_2 is :

(a)carbon is more electronegative then O and in case of SiO_2 oxygen is more electronegative than silicon

(b)carbon has a small size and forms a π bond with good overlap whereas silicon has larger size hence has a poor π overlap

(c)carbon has only $'\rho'$ orbitals and lacks $'d'$ orbitals whereas silicon has

$'d'$ orbitals

(d)first ionization potential of carbon is higher than that of silicon ($1086kJmol^{-1}$ for C and $786kJmol^{-1}$ for Si).

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3. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Glass, made of SiO_2, Na_2SiO_3 and $CaSiO_3$ is attacked by hydrofluoric acid with formation of SiF_6^{2-} anion. The analogous CF_6^{2-} anion does not exist. The reason/s is/are :

(a)carbon is more electronegative than silicon

(b)silicon has larger atomic size than carbon

(c)silicon has $3d$ orbitals which form an sp^3d^2 hybrid orbitals

(d)carbon and fluorine have comparable atomic sizes

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4. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Group 14 elements have tendency to catenate. The first three members C, Si and Ge show significant catenation. Arrange these elements in decreasing order of their catenation tendency.

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5. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

The order in 1.4 can be explained on the basis of :

(a)atomic size , (b)electronegativity

(c)bond strength , (d)non-metallic character

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6. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

In a silicon manufacturing unit, silicon is obtained by heating $100kg$of pure sand with $45kg$ of high grade coke in an electric furnace. Write the balanced equation of the reaction.

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7. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Silicon can be purified by converted it into volatile $SiCl_4(b.\,p.\,58^\circ C)$ which is purified by fractional distillation $SiCl_4$ can then be converted into Si using molecular hydrogen. Write the balanced equations for the reactions involved.

Silicon is widely used in semiconductor industry in which the required is of the order of 1 part per billion. This can be achieved using "zone refining technique". The technique involves moving a heater coil across an impure Si rod.

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8. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

In zone refining, silicon is purified as

(a)portions of Si rod are heated and cooled so that impurities are differentially evaporated

(b)impurities are more soluble in liquid phase than in solid

(c)impurities are less soluble in liquid phase than in solid

(d)impurities are insoluble in molten Si and can be separated

A. portions of Si rod are heated and cooled so that impurities are differentially evaporated

B. impurities are more soluble in liquid phase than in solid

C. impurities are less soluble in liquid phase than in solid

D. impurities are insoluble in moiten Si and can be separated

Answer: A::B::D

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9. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

The reactivities of CCl_4 and $SiCl_4$ are different. For example $SiCl_4$ can be easily hydrolysed and is prone to substitution reactions, whereas CCl_4 is inert.

The observed difference is because

(a)carbon atom has smaller size than hence substitution is not possible

(b)carbon is more electronegative than silicon

(c)silicon has low lying unoccupied orbitals

(d)$C-Cl$ bond is stronger than $Si-Cl$ bond

Silicon has high affinity for oxygen to form silicates having SiO_4^{4-} units.Silicates can have chain or cyclic structures.

A. carbon atom has smaller size hence substitution is not possible

B. carbon is more electronegative than silicon

C. silicon has low lying unoccupied orbitals

D. C-Cl bond is stronger than Si-Ci bond Silicon has high affinity for oxygen to form silicates having # units. Silicates can have chain or cyclic structures.

Answer: A::B::C::D

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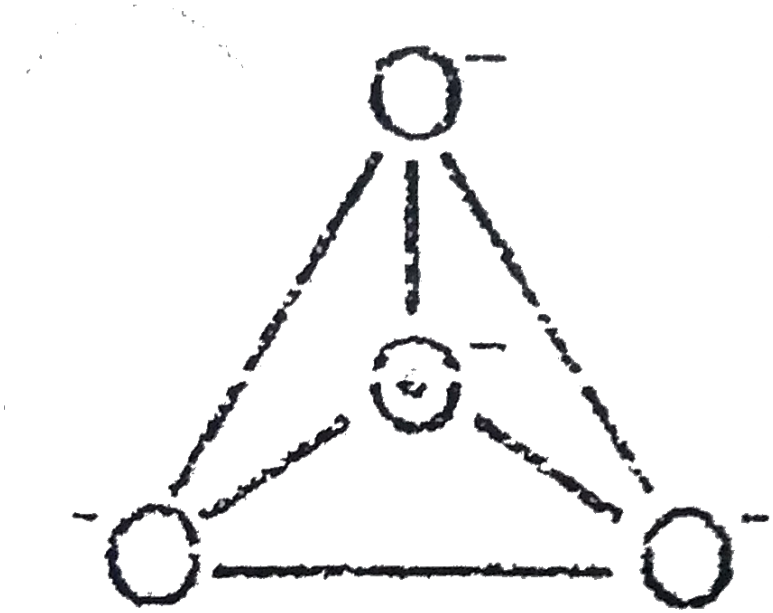
10. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Draw the structure of a cyclic silicate having structural formula of $[Si_6O_{18}]^{n-}$ .Also determine the value of n

[Hint : SiO_4^{4-} can be shown as



unit]

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11. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead

constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a covalent solid.

Draw the structure of the anion present in pyroxene $(MgCaSi_2O_6)$.

Silicones are important synthetic polymers which find extensive applications due to their chemical inertness and water repelling nature. Thet are produced via the following reactions.

$$2C_6H_5Cl + Si \xrightarrow[370\ \mathrm{K}]{\mathrm{Cu}} A$$

$$A \xrightarrow[-HCl]{H_2O} B$$

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12. Silicon is the second most abundant element $(\sim 27.2\,\%)$ in the earth's after oxygen $(45.5\,\%)$ Carbon. Silicon, germanium, tin and lead constitute the group 14 of the periodic table. Chemistry of silicon is distinctly different from that of carbon.

For example, under standard conditions CO_2 is a gas whereas SiO_2 is a

covalent solid.

Identify A and the corresponding linear polymer B.

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Part Iii Olympiad Problems Previous Years Stage Ii Indian National Chemistry Olympiad Incho Problem 2

1. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Draw the structure of B_2H_6.

The unusual bond present in $B_2H_6$is a-

(a)Two centered $3e-$ bond ☐ , (b)Three centered $2e-$ bond ☐

(c)Four centered $2e-$ bond ☐ , (d)Four centered $4e-$ bond ☐

B_2O_3	acidic	basic	amphoteric	neutral
Al_2O_3	acidic	basic	amphoteric	neutral
Tl_2O_3	acidic	basic	amphoteric	neutral

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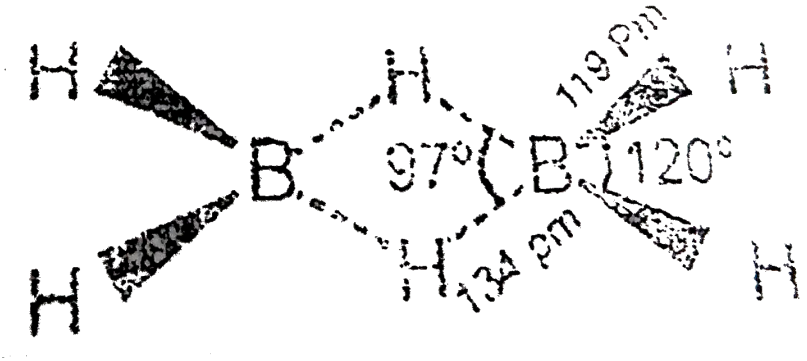
2. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Draw the structure of B_2H_8.



A. Two centered $3e^-$ bond square

B. Three centered $2e^-$ bond square

C. Four centered $2e^-$ bond square

D. Four centered $4e^-$ bond square

Answer: B

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3. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Diborane reacts violently with water and releases hydrogen. Write a balanced equation of this reaction.

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4. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Draw the structure of Y.

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5. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Write the general formula of arachano-boranes.

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6. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Draw the structures of the possible arachano-boranes derived from X.

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7. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these

oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Write the molecular formula of a carorane (Z) obtained by replacing two Boron by carbon atoms in closo-dodecaborane anions.

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8. Most elements form oxides and hydroxides with different characteristics. Often, regular periodic trends are observed in these oxides and hydroxides. Hydroxides of Na and Mg are distinctly alkaline, while oxides of N and S are distinctly acidic.

Draw the structures of all possible isomers of Z (show only boron-carbon framework).

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Part Iii Olympiad Problems Previous Years Stage V International Chemistry Olympiad Icho Problem 1

1. A mixture of two solid elements with a mass of $1.52g$ was treated with an excess of hydrochloric acid. A volume of $0.896dm^3$ of a gas was liberated in this process and $0.56g$ of a residue remained which was undissolved in the excess of the acid.

In another experiment, $1.52g$ of the same mixture were allowed to react with an excess of a $10\,\%$ sodium hydroxide solution. In this case $0.896dm^3$ of a gas were also evolved but $0.96g$ of an undissolved residue remained.

In the third experiment, $1.52g$ of the initial mixture were heated to high temperature without acess of the air. In this way a compound was formed which was totally soluble in hydrochloric acid and $0.448dm^3$ of an unknown gas were released. All the gas obtained was introduced into a one litre closed vessel filled with oxygen. After the reaction of the unknown gas with oxygen the pressure in the vessel decreased by approximately ten times $(T = const)$.

Write chemical equations for the above reactions and prove their correctness by calculations. In solving the problem consider that the

volumes of gases were measured at STP and round up the relative atomic masses to whole numbers.

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Part Iii Olympiad Problems Previous Years Stage V International Chemistry Olympiad Icho Problem 3

1. Silicates as the base of the Earth crust

Silica and compounds derived from it, silicates, constituteca. $90\,\%$ of the Earth crust substances. Silica gives rise to a beautiful meterial-glass. Nobody knows exactly how glass was discovered. There is a well-favoured story related to phoenician sailors who fused occassionally sea sand and soda ash. It is likely that they discovered the secret of "liquid glass" (LGL) sodium metasilicate (Na_2SiO_3) soluble in water.

The solution of LGL was used earlier as office glue. Write down the net ionic equation accounting for the ability of LGL to set in air. Hydrolysis of LGL in water allows abtaining a colloidal solution of silicic acid.

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Write down the net ionic equations matching the prosesses enumerated. For each prosess mark Yes if if leads to changes of pH. Otherwise mark NO.

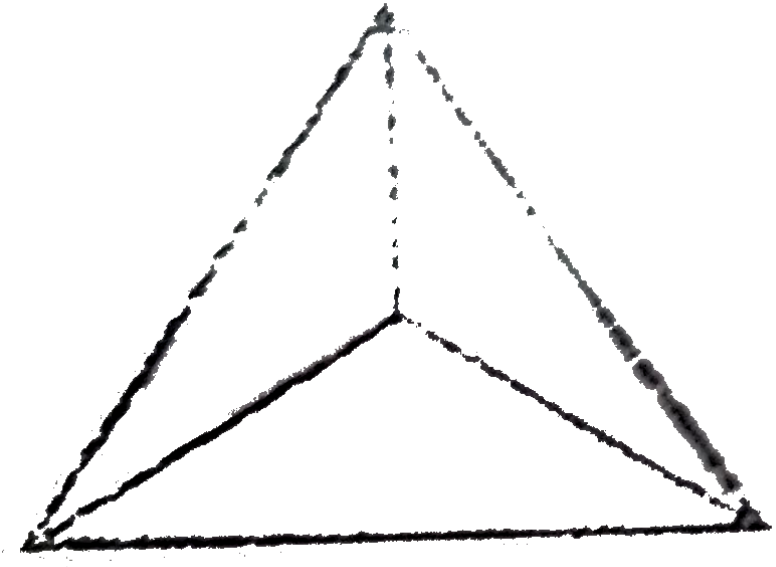
(a) Protonation of ortho-silicate ions leading to the formation of $Si-OH$ groups.

(b) Formation of hydrated $\left[SiO_4(H_2O)_2\right]^{4-}$ anions

(c) Polycondensation of ortho-silicate ions leading to the formation of $Si-O-Si$ bonds.

The structure of species occurring in aqueous solutions of silicates in rather complex. However, it is possible to distinguish the main building

block of all species-orthosilicate tetrahedron $\left(SiO_4^{4-}\right)$



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Determine the charge (n).

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Determine the number of oxygen atoms bridging adjacent tetrahedra.

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Depict its structure joining together several tetrahedra (i).

Take into account that any adjacent terahedron shares one vertex.

Charged monolayers with the composition $[Si_4O_{10}]^{m-}$ are found in daolinite (clay).

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Using the same strategy as in 3.3 to 3.5 depict a fragment of the layered

structure joining 16 tetrahedra (i). Note that 10 tetrahedra have shared vertices with 2 neighbours each, and the rest 6 have shared vertices with 3 neighbours each.

Being placed into the LGL solution, salts of transition metals give rise to fancy "trees" tinted relevant to the colour of the salt of the the corrsponding transition metal. Crystals of $CuSO_4.5H_2O$ produce "trees" of blue colour whereas those of $NiSO_4.7H_2O$ form green "trees".

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Determine the pH of $0.1M$ aqueous solution of copper sulphate at $25^\circ C$

assuming that its hydrolysis occurs in small degree only. Use the value of the first acidity constant of $\left[Cu(H_2O)_4\right]^{2+}$ $K_a = 1 \times 10^{-7} M$.

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Write down equation of a reaction between aqueous of $CuSO_4$ and sodium metasilicate (LGL). Take into account the pH values of aqueous solutions of the salts.

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