Elements of Groups 16, 17 and 18

EXERCISE [PAGES 163 - 164]

Exercise | Q 1.01 | Page 163

Select appropriate answers for the following.

Which of the following has highest electron gain enthalpy?

1. Fluorine
2. **Chlorine**
3. Bromine
4. Iodine

Solution: Chlorine

Exercise | Q 1.02 | Page 163

Select appropriate answers for the following.

Hydrides of group 16 are weakly acidic. The correct order of acidity is ______.

1. $H_2O > H_2S > H_2Se > H_2Te$
2. $H_2Te > H_2O > H_2S > H_2Se$
3. **$H_2Te > H_2Se > H_2S > H_2O$**
4. $H_2Te > H_2Se > H_2O > H_2S$

Solution:

Hydrides of group 16 are weakly acidic. The correct order of acidity is **$H_2Te > H_2Se > H_2S > H_2O$**.

Exercise | Q 1.03 | Page 163

Select appropriate answers for the following.

Which of the following element does not show an oxidation state of +4?

1. **O**
2. S
3. Se
4. Te

Solution: O

Exercise | Q 1.04 | Page 163

Select appropriate answers for the following.

HI acid when heated with conc. H_2SO_4 forms _______.

1. HIO_3
2. KIO_3
3. **I_2**
4. KI

Solution:

HI acid when heated with conc. H_2SO_4 forms **I_2**

Exercise | Q 1.05 | Page 163

Select appropriate answers for the following.

Ozone layer is depleted by _______.

1. **NO**
2. NO_2
3. NO_3
4. N_2O_5

Solution:

Ozone layer is depleted by **NO**.

Exercise | Q 1.06 | Page 163

Select appropriate answers for the following.

Which of the following occurs in a liquid state at room temperature?

1. HIO_3
2. HBr
3. HCl
4. **HF**

Solution: HF

Exercise | Q 1.07 | Page 163

Select appropriate answers for the following.

In pyrosulfuric acid oxidation state of sulfur is _______.

1. only +2
2. only +4
3. +2 and +6
4. **only +6**

Solution:

In pyrosulfuric acid oxidation state of sulfur is **only +6**.

Exercise | Q 1.08 | Page 163

Select appropriate answers for the following.

Stability of interhalogen compounds follows the order _______.

1. BrF > IBr > ICl > ClF > BrCl
2. IBr > BeF > ICl > ClF > BrCl
3. **ClF > ICl > IBr > BrCl > BrF**
4. ICl > ClF > BrCl > IBr > BrF

Solution:

Stability of interhalogen compounds follows the order **ClF > ICl > IBr > BrCl > BrF**.

Exercise | Q 1.09 | Page 163

Select appropriate answers for the following.

BrCl reacts with water to form _______.

1. HBr
2. $Br_2 + Cl_2$
3. HOBr
4. **HOBr + HCl**

Solution:

BrCl reacts with water to form **HOBr + HCl**.

Exercise | Q 1.1 | Page 163

Select appropriate answers for the following.

Chlorine reacts with excess of fluorine to form _______.

1. ClF
2. **ClF_3**
3. ClF_2
4. Cl_2F_3

Solution:

Chlorine reacts with excess of fluorine to form **ClF_3**.

Exercise | Q 1.11 | Page 163

Select appropriate answers for the following.

In interhalogen compounds, which of the following halogens is never the central atom?

1. I
2. Cl
3. Br
4. **F**

Solution: F

Exercise | Q 1.12 | Page 163

Select appropriate answers for the following.

Which of the following has one lone pair of electrons?

1. IF_3
2. ICl
3. **IF_5**
4. ClF_3

Solution: IF_5

Exercise | Q 1.13 | Page 163

Select appropriate answers for the following.

In which of the following pairs, molecules are paired with their correct shapes?

1. $[I_3]^-$: bent
2. BrF_5 : trigonal bipyramidal
3. ClF_3 : trigonal planar

4. **[BrF$_4$]$^-$: square planar**

Solution: [BrF$_4$]$^-$: square planar

Exercise | Q 1.14 | Page 163

Select appropriate answers for the following.

Among the known interhalogen compounds, the maximum number of atoms is _______.

1. 3
2. 6
3. 7
4. **8**

Solution:

Among the known interhalogen compounds, the maximum number of atoms is **8.**

Exercise | Q 2.01 | Page 163

Answer the following.

Write the order of the thermal stability of the hydrides of group 16 elements.

Solution:

The decreasing order of thermal stability: $H_2O > H_2S > H_2Se > H_2Te$

Exercise | Q 2.02 | Page 163

Answer the following.

What is the oxidation state of Te in TeO_3?

Solution:

(Oxidation number of Te) + (Oxidation number of O) = 0

(Oxidation number of Te) + 3 × (- 2) = 0

Oxidation number of Te - 6 = 0

Hence, oxidation number of Te in TeO_3 = +6

Exercise | Q 2.03 | Page 163

Answer the following.

Name two gases which deplete ozone layer.

Solution:

Two gases that deplete ozone layer: Nitric oxide (NO), chlorofluoro carbons (freons).

Exercise | Q 2.04 | Page 163

Answer the following.

Give two uses of ClO_2.

Solution:

1. ClO_2 is used as a bleaching agent for paper pulp and textiles.
2. It is also used in the water treatment.

Exercise | Q 2.05 | Page 163

Answer the following.

What is the action of bromine on magnesium metal?

Solution:

Bromine reacts with magnesium to form magnesium bromide.

$$\underset{\text{Magnesium}}{Mg_{(s)}} + \underset{\text{Bromine}}{Br_{2(l)}} \longrightarrow \underset{\text{Magnesium Bromide}}{MgBr_{2(s)}}$$

Exercise | Q 2.06 | Page 163

Answer the following.

Write the names of allotropic forms of selenium.

Solution:

Allotropes of Selenium: Red and grey selenium

Exercise | Q 2.07 | Page 163

Answer the following.

What is the oxidation state of ‘S’ in H_2SO_4?

Solution:

(Oxidation number of H) + (Oxidation number of S) + (Oxidation number of O) = 0

2 × (+1) + (Oxidation number of S) + 4 × (- 2) = 0

Oxidation number of S + 2 - 8 = 0

Hence, oxidation number of ‘S’ in H_2SO_4 = +6

Exercise | Q 2.08 | Page 163

Answer the following.

The pK_a value of HCl is - 7.0 and that of HI is -10.0. Which is the stronger acid?

Solution:

Smaller is the pK_a value, greater is its acidity. Hence, HI is stronger acid than HCl.

Exercise | Q 2.09 | Page 163

Answer the following.

Give one example showing reducing property of ozone.

Solution:

Reaction showing reducing property of ozone is,

$$\underset{\text{Hydrogen peroxide}}{H_2O_2} + O_3 \longrightarrow H_2O + \underset{\text{Dioxygen}}{2\,O_2}$$

Exercise | Q 2.1 | Page 164

Answer the following.

Write the reaction of conc. H_2SO_4 with sugar.

Solution:

The reaction is,

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} \xrightarrow{H_2SO_4} \underset{\text{Carbon}}{12\,C} + \underset{\text{Water}}{11\,H_2O}$$

Exercise | Q 2.11 | Page 164

Write any two uses of Chlorine.

Solution:

Uses of chlorine:

1. Large quantities of chlorine are used industrially for bleaching wood pulp (required for the manufacture of paper and rayon), bleaching cotton and textiles.
2. It is used in the extraction of gold and platinum.
3. It is used for the manufacture of dyes, drugs and organic compounds such as

CCl_4, $CHCl_3$, refrigerants, etc.
4. It is used in sterilising drinking water.
5. It is used in preparation of poisonous gases such as phosgene ($COCl_2$), tear gas (CCl_3NO_2), mustard gas ($Cl.C_2H_4$-S - C_2H_4Cl).
6. It is used in the manufacture of DDT and BHC which are important insecticide.
7. It is used in the manufacture of vinyl chloride which is starting material for polyvinyl chloride plastics.
8. It is used in the manufacture of bleaching powder, aluminium chloride, hydrogen chloride, hypochlorites, chlorates, perchlorates, etc., which are important industrial compounds.

Exercise | Q 2.12 | Page 164

Complete the following.
$ICl_3 + H_2O \rightarrow$ _______ + _______ + ICl
Solution:

$ICl_3 + H_2O \rightarrow \mathbf{HIO_3} + \mathbf{5HCl} + ICl$

Exercise | Q 2.12 | Page 164

Complete the following.
$I_2 + KClO_3 \rightarrow$ _______ + KIO_3
Solution:

$I_2 + KClO_3 \rightarrow \mathbf{ICl} + KIO_3$

Exercise | Q 2.12 | Page 164

Complete the following.
$BrCl + H_2O \rightarrow$ _______ + HCl
Solution:

$BrCl + H_2O \rightarrow \mathbf{HOBr} + HCl$

Exercise | Q 2.12 | Page 164

Complete the following.
$Cl_2 + ClF_3 \rightarrow$ _______

Solution:

$Cl_2 + ClF_3 \rightarrow$ **<u>3ClF</u>**

Exercise | Q 2.12 | Page 164

Complete the following.

$H_2C = CH_2 + ICl \rightarrow$ _______

Solution:

$H_2C = CH_2 + ICl \rightarrow$ **$I - CH_2 - CH_2 - Cl$**

Exercise | Q 2.12 | Page 164

Complete the following.

$2XeOF_4 + SiO_2 \rightarrow$ _______ $+ SiF_4$

Solution:

$2XeOF_4 + SiO_2 \rightarrow$ **$2XeO_2F_2$** $+ SiF_4$

Exercise | Q 2.12 | Page 164

Complete the following.

$XeF_6 + H_2O \rightarrow$ _______ $+ 2HF$

Solution:

$XeF_6 + H_2O \rightarrow$ **$XeOF_4$** $+ 2HF$

Exercise | Q 2.12 | Page 164

Complete the following.

$XeOF_4 + H_2O \rightarrow$ _______ $+ HF$

Solution:

$XeOF_4 + H_2O \rightarrow$ **XeO_2F_2** $+ HF$

Exercise | Q 2.13 | Page 164

Match the following:

A	B
$XeOF_2$	Xenon trioxydifluoride

XeO_2F_2	Xenon monooxydifluoride
XeO_3F_2	Xenon dioxytetrafluoride
XeO_2F_4	Xenon dioxydifluoride

Solution:

A	B
$XeOF_2$	Xenon monooxydifluoride
XeO_2F_2	Xenon dioxydifluoride
XeO_3F_2	Xenon trioxydifluoride
XeO_2F_4	Xenon dioxytetrafluoride

Exercise | Q 2.14 | Page 164

What is the oxidation state of xenon in the following compounds?

$XeOF_4$, XeO_3, XeF_6, XeF_4, XeF_2.

Solution:

Compound	Oxidation state of xenon
$XeOF_4$	+ 6
XeO_3	+ 6
XeF_6	+ 6
XeF_4	+ 4
XeF_2	+ 2

Exercise | Q 3.01 | Page 164

Answer the following.

The first ionization enthalpies of S, Cl, and Ar are 1000, 1256 and 1520 kJ/mol^{-1}, respectively. Explain the observed trend.

Solution:

1. The elements S, Cl, and Ar belong to third period of the periodic table.
2. Across a period, effective nuclear charge increases and atomic size decreases with increase in atomic number. Therefore, the energy required for the removal of an electron from the valence shell (I.E.) increases in the order: S < Cl < Ar.

Exercise | Q 3.02 | Page 164

Answer the following.

Acidic character of hydrides of group 16 elements increases from H_2O to H_2Te. Explain.

Solution:

The acidic character of the hydrides increases from H_2O to H_2Te because the bond dissociation enthalpy of the H–E bond decreases down the group. (where, E = O, S, Se, Te)

Exercise | Q 3.03 | Page 164

Answer the following.

How is dioxygen prepared in the laboratory from $KClO_3$?

Solution:

Dioxygen is prepared by heating potassium chlorate ($KClO_3$) in presence of the catalyst, MnO_2.

$$\underset{\text{Potassium chlorate}}{2\,KClO_{3(s)}} \xrightarrow[MnO_2]{\text{Heat}} 2\,KCl_{(s)} + \underset{\text{Dioxygen}}{3\,O_{2(g)}}$$

Exercise | Q 3.04 | Page 164

Answer the following.

What happens when lead sulfide reacts with ozone (O_3)?

Solution:

Ozone oxidizes lead sulfide to lead sulfate

$$\underset{\text{Lead sulfide}}{PbS_{(s)}} + 4\,O_{3(g)} \longrightarrow \underset{\text{Lead sulfate}}{PbSO_{4(s)}} + 4\,O_{2(g)}$$

Exercise | Q 3.04 | Page 164

Answer the following.

What happens when nitric oxide reacts with ozone.

Solution:

Ozone oxidizes nitric oxide and gives nitrogen dioxide.

$$\underset{\text{Nitric oxide}}{NO_{(g)}} + \underset{\text{Ozone}}{O_{3(g)}} \longrightarrow \underset{\text{Nitrogen dioxide}}{NO_{2(g)}} + \underset{\text{Dioxygen}}{O_{2(g)}}$$

Exercise | Q 3.05 | Page 164

Answer the following.

Give two reactions showing the oxidising property of concentrated H_2SO_4.

Solution:

Metals and nonmetals both are oxidized by hot, concentrated sulfuric acid which itself gets reduced to SO_2.

1) $\underset{\text{Copper}}{Cu} + \underset{\text{Sulfuric acid (Conc.)}}{2\,H_2SO_4} \longrightarrow \underset{\text{Copper sulfate}}{CuSO_4} + \underset{\text{Sulfur dioxide}}{SO_2} + 2\,H_2O$

2) $\underset{\text{Sulfur}}{S} + \underset{\text{Sulfuric acid (Conc.)}}{2\,H_2SO_4} \longrightarrow \underset{\text{Sulfur dioxide}}{3\,SO_2} + 2\,H_2O$

Exercise | Q 3.06 | Page 164

Answer the following.

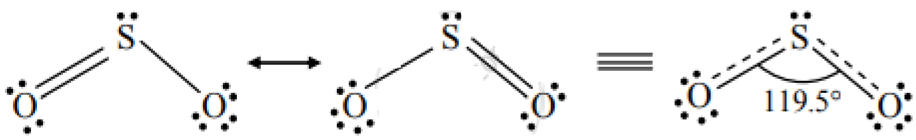
Discuss the structure of sulfur dioxide.

Solution:

1) Sulfur dioxide is angular with O – S – O bond angle of 119.5°.

2) The S – O double bond arises from dπ-pπ bonding.

3) It is a resonance hybrid of two canonical forms as shown below:



Resonance structures Resonance hybrid

Exercise | Q 3.07 | Page 164

Answer the following.

Fluorine shows only –1 oxidation state while other halogens show –1, +1, +3, +5 and +7 oxidation states. Explain.

Solution:

1) The fluorine atom has no d-orbitals in its valence shell and therefore, cannot expand its octet. Thus, fluorine is the most electronegative exhibit –1 oxidation state only.

2) Cl, Br, and I exhibit –1, +1, +3, +5, and +7 oxidation states. This is because they are less electronegative than F and possess empty d-orbitals in the valence shell and therefore, can expand the octet.

Exercise | Q 3.08 | Page 164

Answer the following.

What is the action of chlorine on Excess NH_3.

Solution:

Chlorine when reacted with excess of ammonia gives ammonium chloride and nitrogen.

$$\underset{\text{Ammonia (excess)}}{8\,NH_3} + \underset{\text{Chlorine}}{3\,Cl_2} \longrightarrow \underset{\text{Ammonium chloride}}{6\,NH_4Cl} + \underset{\text{Nitrogen}}{N_2}$$

Exercise | Q 3.08 | Page 164

Answer the following.

What is the action of chlorine on Fe?

Solution:

Chlorine reacts with Fe to form ferric chloride.

$$\underset{\text{Iron}}{2\,Fe} + \underset{\text{Chlorine}}{3\,Cl_2} \xrightarrow{\Delta} \underset{\text{Ferric chloride}}{2\,FeBr_3}$$

Exercise | Q 3.09 | Page 164

Answer the following.

How is hydrogen chloride prepared from sodium chloride?

Solution:

1) In the laboratory, hydrogen chloride is prepared by heating sodium chloride (common salt) with concentrated sulfuric acid

$$\underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Sulfuric acid (conc.)}}{H_2SO_4} \xrightarrow{420\text{ K}} \underset{\text{Sodium hydrogen sulfate}}{NaHSO_4} + \underset{\text{Hydrogen chloride}}{HCl}$$

$$\underset{\text{Sodium hydrogen sulfate}}{NaHSO_4} + \underset{\text{Sodium chloride}}{NaCl} \xrightarrow{823\text{ K}} \underset{\text{Sodium sulfate}}{Na_2SO_4} + \underset{\text{Hydrogen chloride}}{HCl}$$

2) HCl gas can be dried by passing it through concentrated sulfuric acid.

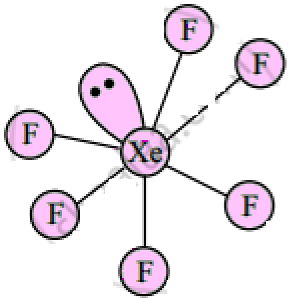
Exercise | Q 3.1 | Page 164

Answer the following.

Draw structures of XeF_6

Solution:

structures of XeF_6 :



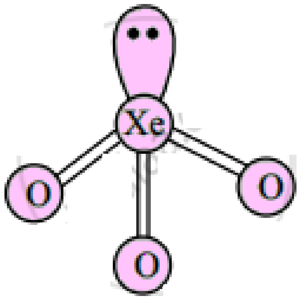
Exercise | Q 3.1 | Page 164

Answer the following.

Draw structures of XeF_3

Solution:

structures of XeF_3 :



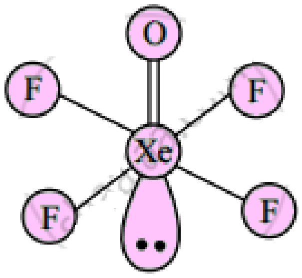
Exercise | Q 3.1 | Page 164

Answer the following.

Draw structures of $XeOF_4$

Solution:

structures of $XeOF_4$:



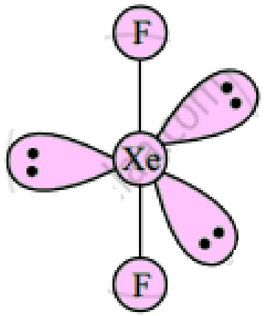
Exercise | Q 3.1 | Page 164

Answer the following.

Draw structures of $XeOF_2$

Solution:

structures of $XeOF_2$:



Exercise | Q 3.11 | Page 164

Answer the following.

What are interhalogen compounds? Give two examples.

Solution:

An interhalogen compound is a compound formed by a combination of atoms of different halogens.

e.g. ClF, BrF_3

Exercise | Q 3.12 | Page 164

Answer the following.

What is the action of hydrochloric acid on NH_3?

Solution:

Hydrochloric acid reacts with ammonia and gives white fumes of ammonium chloride.

$$\underset{\text{Ammonia}}{NH_3} + HCl \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl}$$

Exercise | Q 3.12 | Page 164

Answer the following.

What is the action of hydrochloric acid on Na_2CO_3?

Solution:

Hydrochloric acid reacts with sodium carbonate to give sodium chloride with the release of CO_2 gas.

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Hydrochloric acid}}{2\,HCl} \longrightarrow \underset{\text{Sodium chloride}}{2\,NaCl} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2}$$

Exercise | Q 3.13 | Page 164

Answer the following.

Give two uses of HCl.

Solution:

1. It is used in the manufacture of chlorine and chlorides such as ammonium chloride.
2. It is used in the preparation of aqua regia which is used to dissolve noble metals like gold.

Exercise | Q 3.14 | Page 164

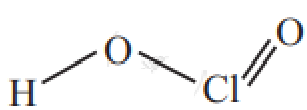
Answer the following.

Write the names and structural formulae of oxoacids of chlorine.

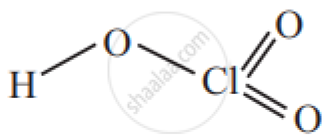
Solution:

1) Hypochlorous acid, HOCl

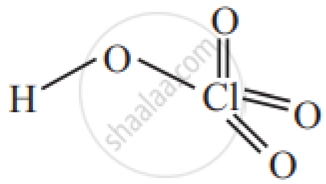
2) Chlorous acid, HOClO or $HClO_2$



3) Chloric acid, $HClO_3$



4) Perchloric acid, $HClO_4$



Exercise | Q 3.15 | Page 164

Answer the following.

What happens when Cl_2 reacts with F_2 in equal volume at 437 K.

Solution:

When Cl_2 reacts with F_2 in equal volume at 437 K, chlorine monofluoride is formed.

$$\underset{\text{Chlorine}}{Cl_2} + \underset{\text{Fluorine}}{F_2} \longrightarrow \underset{\text{Chlorine monofluoride}}{2\,ClF}$$

Exercise | Q 3.15 | Page 164

Answer the following.

What happens when Br_2 reacts with excess of F_2.

Solution:

When Br_2 reacts with excess of F_2, bromine trifluoride is formed.

$$\underset{\text{Bromine}}{Br_2} + \underset{\text{Fluorine (Excess)}}{3\,F_2} \longrightarrow \underset{\text{Bromine trifluoride}}{2\,BrF_3}$$

Exercise | Q 3.16 | Page 164

Answer the following.

How are xenon fluorides XeF_2, XeF_4 and XeF_6 obtained? Give suitable reactions.

Solution:

Xenon fluorides are generally prepared by direct reaction of xenon and fluorine in different ratios and conditions, such as temperature, electric discharge and photochemical reaction.

1) $\underset{\text{Xenon}}{Xe} + \underset{\text{Fluorine}}{F_2} \xrightarrow[400^\circ C]{\text{Sealed Ni tube}} \underset{\text{Xenon difluoride}}{XeF_2}$

2) $\underset{\text{Xenon}}{Xe} + \underset{\text{Fluorine}}{2F_2} \xrightarrow[400^\circ C 5-6\text{ atm}]{\text{Electric discharge}} \underset{\text{Xenon tetrafluoride}}{XeF_4}$

(1:5)

3) $\underset{\text{Xenon}}{Xe} + \underset{\text{Fluorine}}{2Fe_2} \xrightarrow[-80^\circ C]{\text{Electric discharge}} \underset{\text{Xenon tetrafluoride}}{XeF_4}$

4) $\underset{\text{Xenon}}{Xe} + \underset{\text{Fluorine}}{3F_2} \xrightarrow[\text{Low temp}\cdot]{\text{Electric discharge}} \underset{\text{Xenon tetrafluoride}}{XeF_6}$

Exercise | Q 3.17 | Page 164

Answer the following.

How are XeF_2 and $XeOF_4$ prepared?

Solution:

1) Preparation of XeO_3:

Fluorides of xenon react with water to form XeO_3.

i) $\underset{\text{Xenon tetrfluoride}}{3XeF_4} + \underset{\text{Water}}{6H_2O} \longrightarrow \underset{\text{Xenon}}{2Xe} + \underset{\text{Xenon trioxide}}{XeO_3} + 12HF + 1\frac{1}{2}O_2$

ii) $\underset{\text{Xenon hexafluoride}}{XeF_6} + \underset{\text{Water}}{3H_2O} \longrightarrow \underset{\text{Xenon trioxide}}{XeO_3} + 6HF$

2) Preparation of $XeOF_4$:

Partial hydrolysis of XeF_6 yields $XeOF_4$.

$$\underset{\text{Xenon hexafluoride}}{XeF_6} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Xenon monooxytetrafluoride}}{XeOF_4} + \underset{\text{Hydrogen fluoride}}{2HF}$$

Exercise | Q 3.18 | Page 164

Answer the following.

List the uses of Neon and argon gases.

Solution1:

Uses of neon gas:

(i) It is mixed with helium to protect electrical equipments from high voltage.

(ii) It is filled in discharge tubes with characteristic colours.

(iii) It is used in beacon lights.

Uses of Argon gas:

(i) Argon along with nitrogen is used in gas-filled electric lamps. This is because Ar is more inert than N.

(ii) It is usually used to provide an inert temperature in a high metallurgical process.

(iii) It is also used in laboratories to handle air-sensitive substances.

Solution2:

Uses of Neon
Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Glow'of different colours 'neon signs' can be produced by mixing neon with other gases. Neon bulbs and used in botanical gardens and in green' houses.

Uses of Argon
Argon is used mainly to provide an inert atmosphere in high temperature metallurgical processes such as arc welding of metals and alloys. In the laboratory, it is used for handling substance which are air sensitive.
It is used in filling incandescent and fluorescent lamps where its presence retards the sublimation of the filament and thus increases the life of the lamp.It is also used in "neon signs" for obtaining lights of different colours.

Exercise | Q 3.19 | Page 164

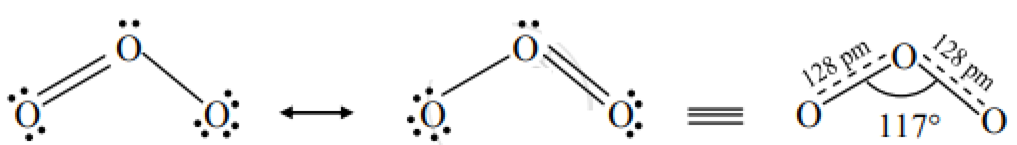
Answer the following.

Describe the structure of the Ozone. Give two uses of ozone.

Solution:

Structure of ozone:

Ozone (O_3) is an angular molecule. The two O – O bond lengths in the ozone molecule are identical, 128 pm, and the O – O – O bond angle of about 117°. It is a resonance hybrid of two canonical forms.



Resonating structures of ozone　　　Resonance hybrid

Exercise | Q 3.2 | Page 164

Answer the following.

Explain the trend in following atomic properties of group 16 elements:

Atomic radii

Solution:

Atomic radii:

The atomic radii increase down the group, as a result of an increase in the number of quantum shells.

Exercise | Q 3.2 | Page 164

Answer the following.

Explain the trend in following atomic properties of group 16 elements:

Ionisation enthalpy

Solution:

Ionisation enthalpy:

The ionisation enthalpy decreases down the group due to an increase in the atomic size. Group 16 elements have less ionization energy than the corresponding group 15 elements.

Exercise | Q 3.2 | Page 164

Answer the following.

Explain the trend in following atomic properties of group 16 elements:

Electronegativity

Solution:

Electronegativity:

The electronegativity decreases down the group. Oxygen has the highest electronegativity next to fluorine amongst all the elements.

Exercise | Q 4.1 | Page 164

Answer the following.

Distinguish between rhombic sulfur and monoclinic sulfur.

Solution:

The following are the points of difference between rhombic (α-sulfur) and monoclinic (β - sulfur):

Rhombic sulfur (α-sulfur)	Monoclinic sulfur (β- sulfur)
1. It is a pale yellow coloured solid.	1. It is bright yellow solid
2. It forms orthorhombic crystals	2. It forms needle-shaped monoclinic crystals
3. Its melting point is 385.8 K.	3. Its melting point is 393 K.
4. Its density is 2.06 g/cm^3	4. Its density is 1.98 g/cm^3
5. It is insoluble in water and soluble in CS_2	5. Soluble in CS_2
6. It is stable below 369 K and transforms to β-sulfur above this temperature	6. It is stable above 369 K and transforms into α-sulfur below this temperature.
7. It is prepared by the evaporation of rolls sulfur in CS_2.	7. It is prepared from rhombic sulfur.

Exercise | Q 4.2 | Page 164

Answer the following.

Give two reactions showing the oxidising property of concentrated H_2SO_4.

Solution:

Metals and nonmetals both are oxidised by hot, concentrated sulfuric acid which itself gets reduced to SO_2.

$$1)\ \underset{\text{Copper}}{Cu} + \underset{\text{Sulfuric acid (Conc.)}}{2\,H_2SO_4} \longrightarrow \underset{\text{Copper sulfate}}{CuSO_4} + \underset{\text{Sulfur dioxide}}{SO_2} + 2\,H_2O$$

$$2)\ \underset{\text{Sulfur}}{S} + \underset{\text{Sulfuric acid (Conc.)}}{2\,H_2SO_4} \longrightarrow \underset{\text{Sulfur dioxide}}{3\,SO_2} + 2\,H_2O$$

Exercise | Q 4.3 | Page 164

Answer the following.

How is SO_2 prepared in the laboratory from sodium sulfite?

Solution:

In laboratory, sulfur dioxide is prepared by treating sodium sulfite with dilute sulfuric acid.

$$\underset{\text{Sodium sulfite}}{Na_2SO_{3(aq)}} + \underset{\text{Sulfuric acid (dil)}}{H_2SO_{4(aq)}} \longrightarrow \underset{\text{Sulfur dioxide}}{SO_{2(g)}} + \underset{\text{Sodium sulfate}}{Na_2SO_{44(aq)}} + H_2O_{(l)}$$

Exercise | Q 4.4 | Page 164

Answer the following.

Describe the manufacturing of H_2SO_4 by the contact process.
Solution:

Sulfuric acid is manufactured by the contact process, which involves the following three steps.

1) Roasting in air:

Sulfur or sulfide ore (iron pyrites) on burning or roasting in air produces sulfur dioxide.

i) $\underset{\text{Sulfur}}{S_{(s)}} + O_{2(g)} \xrightarrow{\Delta} \underset{\text{Sulfur dioxide}}{SO_{2(g)}}$

ii) $\underset{\text{Iron sulfide}}{4\,FeS_{2(s)}} + 11\,O_{2(g)} \xrightarrow{\Delta} 2\,Fe_2O_{3(s)} + \underset{\text{Sulfur dioxide}}{8\,SO_{2(g)}}$

2) Catalytic oxidation of sulfur dioxide:

i) Sulfur dioxide is oxidised catalytically with oxygen to sulfur trioxide, in the presence of V_2O_5 catalyst.

$$\underset{\text{Sulfur dioxide}}{2\,SO_{2(g)}} + O_{2(g)} \xrightarrow{V_2O_5} \underset{\text{Sulfur trioxide}}{2\,SO_{3(g)}}$$

ii) The reaction is exothermic and reversible and the forward reaction leads to decrease in volume. Therefore, low temperature (720K) and high pressure (2 bar) are favourable conditions for maximum yield of SO_3.

3) Absorption, followed by dilution of sulfur trioxide gas:

i) Sulfur trioxide gas (from the catalytic converter) is absorbed in concentrated H_2SO_4 to produce oleum.

$$\underset{\text{Sulfur trioxide}}{SO_3} + H_2SO_4 \longrightarrow \underset{\text{Oleum}}{H_2S_2O_7}$$

ii) Dilution of oleum with water gives sulfuric acid of desired concentration.

$$\underset{\text{Oleum}}{H_2S_2O_7} + H_2O \longrightarrow \underset{\text{Sulfuric acid}}{2\,H_2SO_4}$$

iii) The sulfuric acid obtained by contact process is 96-98 % pure.