Class 12 P - Block Elements Important Questions with Answers

Short Answer Type Questions

Q1. In the preparation of H_2SO_4 by Contact Process, why is SO_3 not absorbed directly in water to form H_2SO_4?

Answer:

SO_3 is not absorbed directly in water to form H_2SO_4 because SO_3 forms a dense fog of sulphuric acid which does not condense easily.

Q2. Write a balanced chemical equation for the reaction showing catalytic oxidation of NH_3 by atmospheric oxygen.

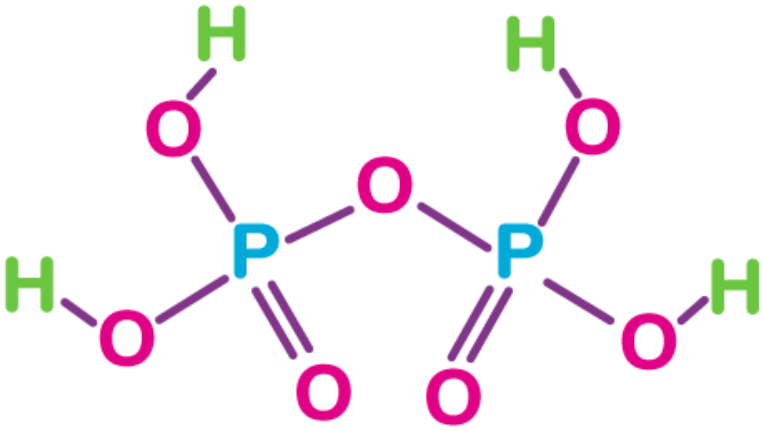
Answer:

The balanced chemical equation for the reaction catalytic oxidation of NH_3 by atmospheric oxygen is

$$4NH_3 + 5O_2 \xrightarrow[500K/9Bar]{Pt/RaugeCatalyst} 4NO + 6H_2O$$

Q3. Write the structure of pyrophosphoric acid.

Answer:



Pyrophosphoric acid

Q4. PH_3 forms bubbles when passed slowly in water, but NH_3 dissolves. Explain why?

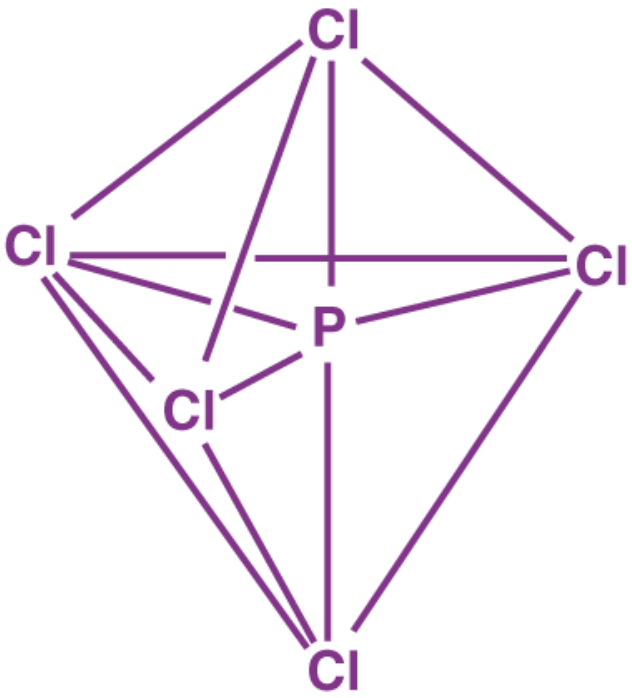
Answer:

PH_3 forms bubbles because it is insoluble in water and cannot form hydrogen bonds with water, whereas NH_3 dissolves because it is soluble in water and can form hydrogen bonds with water.

Q5. In PCl_5, phosphorus is in a. sp_3d hybridised state, but its five bonds are not equivalent. Justify your answer with reason.

Answer:

PCl_5 has a trigonal bipyramidal structure. It has three equivalent equatorial bonds and two equivalent axial bonds. The size of axial bonds is greater than equatorial bonds to overcome repulsion because the three equatorial bonds cause more repulsion.



Therefore two axial P-Cl bonds are more prolonged and different from equatorial bonds.

Q6. Why is nitric oxide paramagnetic in a gaseous state, but the solid obtained on cooling it is diamagnetic?

Answer:

NO_2 exists as a monomer with one unpaired electron in a gaseous state. In the solid state, it dimerises to N_2O_4 , so no unpaired electron is left; hence solid form is diamagnetic.

Q7. Give reason to explain why ClF_3 exists but FCl_3 does not exist.

Answer:

Chlorine has vacant d orbitals; hence it can show an oxidation state of +3. Fluorine has no d orbitals; it cannot exhibit a positive oxidation state. Thus, FCl_3 does not exist.
The concept of atomic size can also explain it. The size of the chlorine atom is more significant. Small size fluorine atoms cannot accommodate three large chlorine atoms.
Thus, ClF_3 exists, but FCl_3 does not exist.

Q8. Out of H_2O and H_2S, which one has a higher bond angle and why?

Answer:

H_2O has a higher bond angle than H_2S.
The bond angle of H_2O is larger because oxygen is more electronegative than sulphur; therefore, the bond pair electron of the O−H bond will be closer to oxygen. Due to bond-pair bond-pair repulsion between bond pairs of two O−H bonds, the bond angle would be more prominent.

Q9. SF_6 is known, but SCl_6 is not. Why?

Answer:

A fluorine atom is smaller, so six F^- ions can surround a sulphur atom. The case is not so with chlorine atoms due to their large size. So, SF_6 is known, but SCl_6 is not known due to interionic repulsion between larger ions.

Q10. In reaction with Cl_2, phosphorus forms two halides, 'A' and 'B'. Halide A is yellowish-white powder, but halide "B' is a colourless oily liquid. Identify A and B and write the formulas of their hydrolysis products.

Answer:

A is PCl_5 (Yellowish-white powder)
$P_4 + 10Cl_2 \rightarrow 4PCl_5$
B is PCl_3 (Colourless Oily liquid)
$P_4 + 6Cl_2 \rightarrow 4PCl_3$
Hydrolysis products of A and B
$PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$
$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$

Q11. In the ring test of NO_3^- ion, Fe^{2+} ion reduces nitrate ion to nitric oxide, which combines with Fe^{2+} (aq) ion to form a brown complex. Write the reactions involved in the formation of the brown ring.

Answer:

$NO_3^- + 3Fe^{2+} + 4H^+ \rightarrow NO + 3Fe^{3+} + 2H_2O$

$[Fe(H_2O)_6]^{2+} + NO \rightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$

Q12. Explain why the stability of oxyacids of chlorine increases in the order given below: $HClO < HClO_2 < HClO_3 < HClO_4$.

Answer:

Oxygen is more electronegative than chlorine. Therefore dispersal of negative charge present on chlorine increases from ClO^- to ClO_4^- ion because the number of oxygen atoms attached to chlorine increases. Therefore, the stability of ions will increase in the order given below.
$ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$
Due to the increased stability of the conjugate base, the acidic strength of the corresponding acid rises in the same order.
$HClO < HClO_2 < HClO_3 < HClO_4$.

Q13. Explain why ozone is thermodynamically less stable than oxygen.

Answer:

Ozone is thermodynamically unstable concerning oxygen since its decomposition into oxygen results in the liberation of heat (ΔH is negative) and increased entropy (ΔS is positive). These two effects reinforce each other, resulting in significant negative Gibbs energy change (ΔG) for its conversion into oxygen.

Q14. P_4O_6 reacts with water according to equation $P_4O_6 + 6H_2O \rightarrow 4H_3PO_3$. Calculate the volume of 0.1MNaOH solution required to neutralise the acid formed by dissolving 1.1g of P_4O_6 in H_2O.

Answer:

$P_4O_6 + 6H_2O \rightarrow 4H_3PO_3$ ... (i)

For neutralisation

$4\times [H_3PO_3 + 2NaOH \rightarrow Na_2HPO_3 + 2H_2O]$ ... (ii)

Adding eq. (i) and (ii)

$P_4O_6 + 8NaOH \rightarrow 4Na_2HPO_3 + 2H_2O$

P_4O_6 (mol. mass) = (4×31+16×6) = 220

The number of moles of P_4O_6 = Given mass / Molar Mass.

= 1.1 / 220

∵ The product formed by 1.1 / 220 of P_4O_6 will be neutralised by 8 moles of NaOH.

∴ P_4O_6 = 8 × 1.1 / 220 = 8.8 / 220 mol NaOH

Given molarity of NaOH in 1L = 0.1M

Molarity = No. of Moles / Volume in litres

Volume= No. of Moles / Molarity

= 8.8 / 220 × 1 / 0.1
=0.4L

Q15. White phosphorus reacts with chlorine, and the product hydrolyses in the presence of water. Calculate the mass of HCl obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water.

Answer:

$P_4 + 6Cl_2 \rightarrow 4PCl_3$

$[PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl] \times 4$

$P_4 + 6Cl_2 + 12H_2O \rightarrow 4H_3PO_3 + 12HCl$

1 mol of white phosphorus produces 12 moles of HCl

62 g of white phosphorus has been taken, which is equivalent to 62 / 124 = 1 / 2 mol

Therefore 6 moles of HCl will be formed.

Mass of 6 moles of HCl = 6 × 36.5 = 219.0 g of HCl

Q16. Name three oxoacids of nitrogen. Write the disproportionation reaction of that oxoacid of nitrogen in which nitrogen is in +3 oxidation state.

Answer:

The three oxoacids of nitrogen are

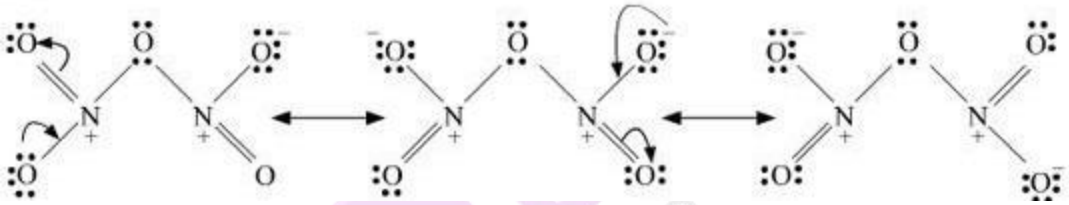
(a) Nitrous acid, HNO_2
(b) Nitric acid, HNO_3
(c) Hyponitrous acid, $H_2N_2O_2$

$$3HNO_2 \xrightarrow{\text{Disproportionation}} HNO_3 + H_2O + 2NO$$

Q17. Nitric acid forms an oxide of nitrogen on reaction with P_4O_{10}. Write the reaction involved. Also, write the resonating structures of the oxide of nitrogen formed.

Answer:

Nitric acid reacts with P_4O_{10} to form an oxide of nitrogen, N_2O_5 and metaphosphoric acid, HPO_3.
The reaction follows
$HNO_3 + P_4O_{10} \rightarrow 4HPO_3 + 2N_2O_5$.
The resonating structure of N_2O_5 is



Q18. Phosphorus has three allotropic forms- (A) White phosphorus, (B) Red phosphorus and (C) Black phosphorus. Write the difference between white and red phosphorus based on their structure and reactivity.

Answer:

Property	White Phosphorous	Red Phosphorous
Colour	White Phosphorous is white, but on exposure, it turns yellow.	Red phosphorous is dark red in colour.
State	It is a waxy solid.	It is a brittle powder.
Density	Its density is 1.84 $g/cm^{3.}$	Its density is 2.1 $g/cm^{3.}$
Ignition temperature	Its ignition temperature is 307 K.	Its ignition temperature is 543 K.

Chemical Reactivity	It is highly reactive	It is less reactive.

Q19. Give an example to show the effect of nitric acid concentration on the formation of an oxidation product.

Answer:

Dilute and concentrated nitric acid give different oxidation products on reaction with copper metal.
$3Cu + 8HNO_3$ (dil.) $\rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
$Cu + 4HNO_3$ (Conc) $\rightarrow 3Cu(NO_3)_2 + 2NO_2 + 2H_2O$

Q20. PCl_5 reacts with finely divided silver on heating, and a white silver salt is obtained, which dissolves on adding excess aqueous NH_3 solution. Write the reactions involved to explain what happens.

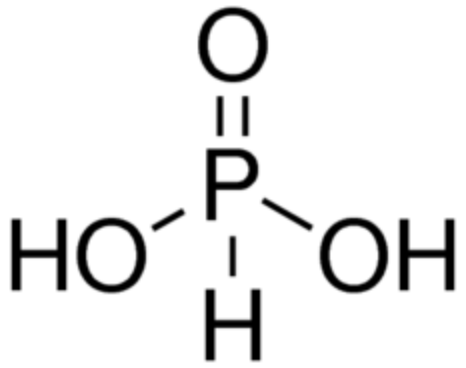
Answer:

$PCl_5 + 2Ag \rightarrow 2AgCl + PCl_3$
$AgCl + 2NH_3$ (aq) $\rightarrow [Ag(NH_3)_2] + Cl^-$

Q21. Phosphorus forms several oxoacids. Out of these oxoacids, phosphinic acid has strong reducing property. Write its structure and also write a reaction showing its reducing behaviour.

Answer:

Structure of Phosphinic Acid.



The reducing behaviour of phosphinic acid is observable in the reaction with silver nitrate given below:

$4AgNO_3 + 2H_2O + H_3PO_2 \rightarrow 4Ag + 4HNO_3 + H_3PO_4$

Long Answer Type Questions

Q1. An amorphous solid A burns in air to form a gas B which turns lime water milky. The gas is also produced as a by-product during the roasting of sulphide ore. This gas decolourises acidified aqueous $KMnO_4$ solution and reduces Fe^{3+} to Fe^{2+}. Identify the solid A and the gas B.

Answer:

(i) Since gas 'B' is obtained as a by-product during roasting of sulphide, therefore, gas 'B' must be Sulphur dioxide, SO_2.
$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ (B)
(ii) Since gas 'B' is obtained when amorphous solid 'A' burns in air, therefore, amorphous solid 'A' must be sulphur, S_8.
S_8 (A) + $8O \rightarrow 8S_2$ (B)
Thus,solid′A′= Sulphur S_8 and gas ′B′= Sulphur dioxide (SO_2).

Q2. On heating lead (II) nitrate gives a brown gas " A". The gas " A" on cooling changes to colourless solid "B" . Solid B on heating with NO changes to a blue solid 'C . Identify ' A', 'B' and' C and also write reactions involved and draw the structures of 'B' and 'C' .

Answer:

(i) Since lead (II) nitrate on heating gives a brown gas 'A' therefore, gas 'A' must be nitrogen dioxide (NO_2).
$2Pb(NO_3) \rightarrow 2PbO + 4NO_2 + O_2$

(ii) The brown gas 'A' on cooling dimerises to give a colourless solid 'B'; therefore ', B' must be N_2O_4 (dinitrogen tetroxide).
$2NO_2 \leftrightarrow N_2O_4$

(iii) Since colourless solid 'B' on heating with NO gives a blue solid 'C' therefore ', C' must be dinitrogen trioxide.
$2NO + N_2O_4 \rightarrow 2N_2O_3$
Thus, A = NO_2, B = N_2O_4 and C = N_2O_3.

Q3. On heating, compound A gives a gas B, a constituent of air. When treated with 3mol of hydrogen (H_2) in the presence of a catalyst, this gas provides another gas with C, which is basic. Gas C on further oxidation in moist conditions gives a compound D part of acid rain. Identify compounds A to D.
Give the necessary equations of all the steps.

Answer:

Here,
A = NH_4NO_2
B = N_2
C = NH_3
D = HNO_3
The necessary equations are:
$NH_4NO_2 \rightarrow N_2 + 2H_2O$
$N_2 + 3H_2 \rightarrow 2NH_3$
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
$4NO + O_2 \rightarrow 4NO_2$
$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$