Chapter 12: Group 17

Homework questions

1 A class of students were set a problem to identify a binary compound P that contained the metal strontium. They were asked to carry out various tests on the compound.

- When concentrated sulfuric acid was added to P, sulfur dioxide was produced, along with a reddish brown gas.
- Addition of an aqueous solution of silver nitrate gave a pale cream precipitate, which was soluble in concentrated ammonia solution but insoluble in dilute ammonia solution.

a The metal present in P is strontium. The isotopic composition of strontium is: strontium-84 (0.56%); strontium-86 (9.86%); strontium-87 (7.0%); strontium-88 (82.58%).

i Define the term 'relative atomic mass'. [3]

ii Calculate the relative atomic mass of strontium, giving your answer to 1 decimal place. [3]

iii Explain the similarities and differences between the isotopes ^{86}Sr and ^{88}Sr. [2]

b Identify the anion present in P. Explain the evidence that supports your answer, along with equations for the reactions taking place. [6]

c Predict what would happen if chlorine was bubbled through an aqueous solution of P and the product shaken with cyclohexane solution. Give ionic equations for any reactions taking place and give state symbols. [4]

Total = 18

2 Iodine is a grey-black solid that sublimes when heated to give a purple/violet gas. Iodine concentrates in seaweed and this is a major source of the element. One method of estimating the concentration of iodine in a solution is to titrate the solution against sodium thiosulfate.
The equation for this reaction is shown below:
$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}$

a Calculate the mass of iodine that would react with 32 cm^3 of 0.100 mol dm^{-3} sodium thiosulfate. [2]

b Bromine also reacts with sodium thiosulfate. In a laboratory investigation a student added some bromine to an excess of sodium thiosulfate solution. She then tested different portions of the solution to identify what was formed in the reaction. The results are shown below:

I The solution gave a white precipitate with hydrochloric acid and aqueous barium chloride solution.

II Addition of acidified silver nitrate solution produced a pale cream precipitate, which was partially soluble in ammonia solution.

III Universal indicator solution turned red when added to the solution.

i Which ion was identified using Test I? Give the ionic equation for the test. [3]

ii Which ion was identified using Test II? Give the ionic equation for the test. [3]

iii Which ion was identified using Test III? [1]

c Use these results to write a balanced ionic equation for the reaction of bromine with sodium thiosulfate solution. [4]

d Explain why this reaction is a redox reaction. [4]

Total = 17

3 Bromine is a Group 17 element.

a **i** Write down the electronic configuration of a bromine atom and a bromide ion. (Atomic/proton number of bromine is 35.) [1]

ii Write down the electronic configuration of a bromide ion. [1]

iii Explain why the atomic radius of a bromine atom is less than the ionic radius of the bromide ion. [3]

b Bromine can be extracted from seawater by bubbling chlorine gas through a concentrated solution of brine (which contains bromide ions).

i Explain why this process produces bromine and give the ionic equation for the reaction. [3]

ii What mass of bromine would be formed if 20 m^3 of chlorine gas are bubbled into a large volume of seawater at room temperature and pressure? (1 $m^3 = 10^3$ dm^3.) [3]

c Bromine is similar to chlorine in its reactions with cold and hot alkalis, such as aqueous potassium hydroxide. When bromine is added to hot aqueous potassium hydroxide, bromide ions and bromate(V) (BrO_3^-) ions are formed.

i Write a balanced ionic equation for this reaction. [2]

ii It is thought that the above reaction takes place in two stages.

Stage I The bromine reacts with OH^- ions to form bromide ions and BrO^- ions.

Stage II The BrO^- ions then react to form bromide ions and bromate(V) ions.

Write balanced ionic equations for both these reactions. [4]

Total = 17