

1. **Nov/2023/Paper_9701/11/No.22**

In this question, Q represents an atom of chlorine, bromine or iodine.

Which explanation for the variation in volatility down Group 17 is correct?

- A Instantaneous dipole–induced dipole forces between molecules become stronger.
- B Permanent dipole–permanent dipole forces between molecules become stronger.
- C The bond energy of the Q_2 molecules decreases.
- D The first ionisation energy $Q(g) \rightarrow Q^+(g) + e^-$ decreases.

2. **Nov/2023/Paper_9701/11/No.23**

Which statement about the halogens or halide ions is correct?

- A Bromide ions react to form a white precipitate when added to silver nitrate solution.
- B Bromine does **not** oxidise chloride ions when added to sodium chloride solution.
- C Fluorine atoms form cations by accepting electrons when they react.
- D Chloride ions are stronger reducing agents than iodide ions.

3. **Nov/2023/Paper_9701/12/No.24**

Iodine has a higher melting point than chlorine.

What is the reason for this?

- A Iodine has stronger covalent bonds than chlorine.
- B Iodine molecules have stronger permanent dipoles than chlorine molecules.
- C Iodine is more volatile than chlorine.
- D Iodine has stronger instantaneous dipole–induced dipole forces than chlorine.

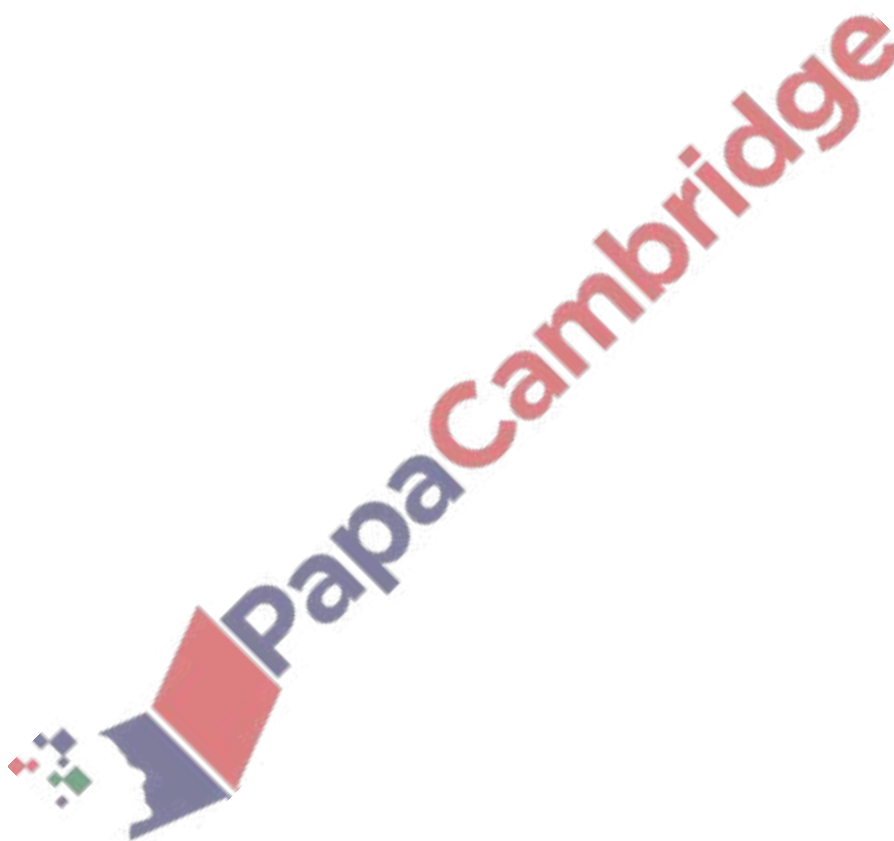
4. Nov/2023/Paper_9701/12/No.25

When concentrated sulfuric acid is added to solid sodium chloride, HCl is formed but **not** Cl_2 .

When concentrated sulfuric acid is added to solid sodium iodide, I_2 is formed.

Which statement explains these observations?

- A Sulfuric acid is an oxidising agent and chloride ions are more easily oxidised than iodide ions.
- B Sulfuric acid is an oxidising agent and iodide ions are more easily oxidised than chloride ions.
- C Sulfuric acid is a reducing agent and chloride ions are more easily reduced than iodide ions.
- D Sulfuric acid is a reducing agent and iodide ions are more easily reduced than chloride ions.



(c) Fig. 3.1 shows a reaction scheme that involves H_3PO_4 in several reactions.

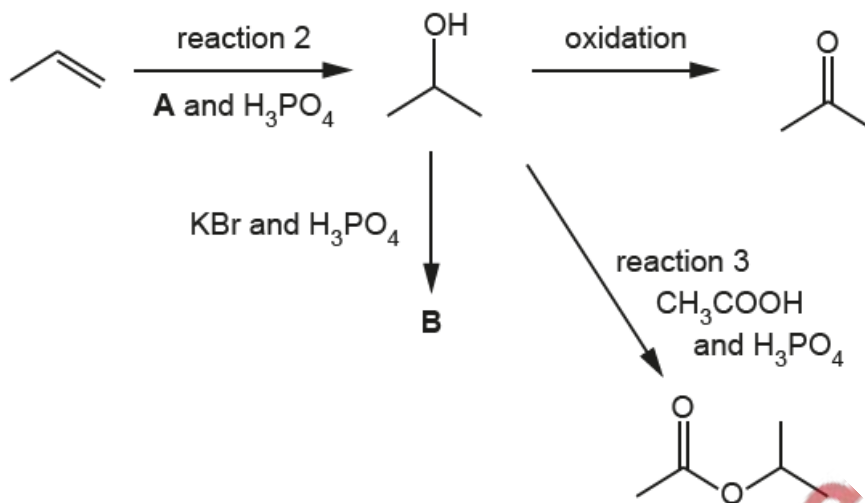


Fig. 3.1

(i) Identify **A**, which reacts with propene in the presence of H_3PO_4 in reaction 2.

..... [1]

(ii) Draw the structure of **B**.



[1]

(iii) Name the type of reaction that occurs in reaction 3.

..... [1]

- (iv) Reaction 3 is monitored using infrared spectroscopy. It is not possible to use the O—H absorption frequency to monitor the reaction.

Use Table 3.2 to identify a suitable bond whose absorption frequency can be used to monitor the progress of reaction 3.

State the change you would see in the infrared spectrum during reaction 3.

bond

change in infrared spectrum

.....

[2]

Table 3.2

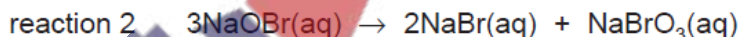
bond	functional groups containing the bond	characteristic infrared absorption range (in wavenumbers)/cm ⁻¹
C—O	hydroxy, ester	1040–1300
C=C	aromatic compound, alkene	1500–1680
C=O	amide carbonyl, carboxyl ester	1640–1690 1670–1740 1710–1750
C—H	alkane	2850–2950

6. June/2023/Paper_9701/11/No.9

Bromine reacts with aqueous sodium hydroxide at 25 °C.



The NaOBr formed is unstable at 25 °C and reacts further.



Which reactions are disproportionations?

- A both reaction 1 and reaction 2
- B neither reaction 1 nor reaction 2
- C reaction 1 only
- D reaction 2 only

7. June/2023/Paper_9701/11/No.14

Chlorine dioxide, ClO_2 , reacts with aqueous sodium hydroxide to produce water and a mixture of two sodium salts, NaClO_2 and NaClO_3 .

What is the mole ratio of NaClO_2 to NaClO_3 in the product mixture?

- A 1:2 B 3:5 C 1:1 D 5:3

8. June/2023/Paper_9701/11/No.17

The solids sodium chloride and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaCl , the products are NaHSO_4 and HCl .

With NaI , the products are NaHSO_4 , HI , I_2 , SO_2 , H_2O , S and H_2S .

What is the explanation for this difference in products?

- A Chloride ions will displace iodine from the solution.
 B Hydrogen chloride is more volatile than hydrogen iodide.
 C Iodide ions are better reducing agents than chloride ions.
 D Sulfuric acid is able to act as a dehydrating agent with NaI .

9. June/2023/Paper_9701/11/No.22

The boiling points of Br_2 , ICl and IBr are given in the table.

	Br_2	ICl	IBr
boiling point / °C	59	97	116

Which row explains:

- why the boiling point of ICl is greater than Br_2
- why the boiling point of IBr is greater than ICl ?

	boiling point of ICl is greater than Br_2	boiling point of IBr is greater than ICl
A	ICl has stronger instantaneous dipole-induced dipoles	IBr has stronger instantaneous dipole-induced dipoles
B	ICl has permanent dipoles	IBr has stronger instantaneous dipole-induced dipoles
C	ICl has stronger instantaneous dipole-induced dipoles	IBr has stronger permanent dipoles
D	ICl has permanent dipoles	IBr has stronger permanent dipoles

10. June/2023/Paper_9701/12/No.22

J dissolves in water to give an aqueous solution K.

K gives a dense white precipitate when aqueous silver nitrate is added.

When heated with aqueous potassium hydroxide, K gives off a gas that turns moist universal indicator paper blue.

What is J?

- A ammonium chloride
- B ammonium sulfate
- C sodium chloride
- D sodium hydroxide

11. June/2023/Paper_9701/13/No.17

Which row shows the expected properties of the element astatine when compared to the properties of the element iodine?

	electronegativity of astatine compared to iodine	volatility of astatine compared to iodine
A	less electronegative	higher
B	more electronegative	higher
C	less electronegative	lower
D	more electronegative	lower

12. June/2023/Paper_9701/13/No.24

Which statement about the halogens is correct?

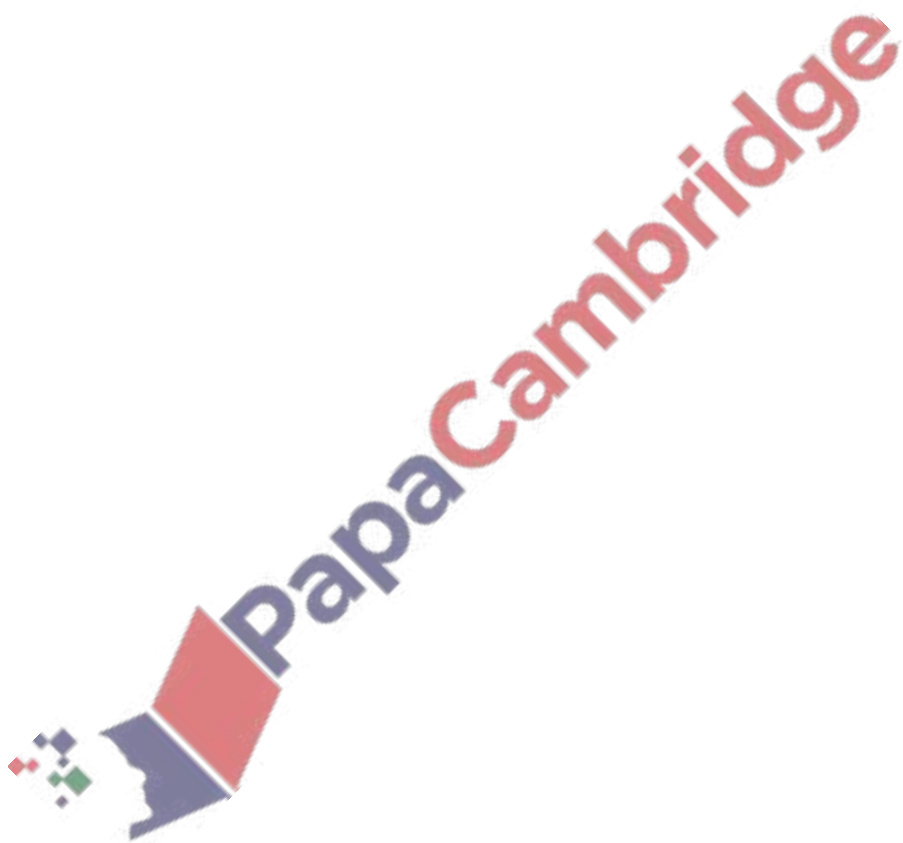
- A Iodine cannot behave as an oxidising agent.
- B The volatility of the elements increases from chlorine to iodine because of the increase in molecular size down the group.
- C When an equimolar mixture of chlorine and hydrogen is exploded, only one product is formed.
- D When concentrated sulfuric acid is added to solid sodium bromide, hydrogen sulfide is one of the products.

13. June/2023/Paper_9701/13/No.25

When concentrated sulfuric acid is added to solid sodium bromide, bromine gas is produced, along with a number of other products. However, when concentrated sulfuric acid is added to solid sodium chloride, only hydrogen chloride and sodium hydrogensulfate are produced.

What is the reason for this difference?

- A Bromine is less volatile than chlorine.
- B Hydrochloric acid is a weak acid.
- C Sulfuric acid is **not** an oxidising agent.
- D The bromide ion is a stronger reducing agent than the chloride ion.



14. June/2023/Paper_9701/21/No.3(a_c)

Chlorine is a very reactive element.

- (a) Chlorine reacts with silicon to form silicon(IV) chloride.
Describe the appearance of silicon(IV) chloride at room temperature and pressure. State its structure and bonding.

appearance

structure and bonding

[2]

- (b) Samples of magnesium chloride and phosphorus(V) chloride are added to separate beakers of cold water.

Complete Table 3.1. Ignore temperature changes when considering observations for these reactions.

Table 3.1

	magnesium chloride	phosphorus(V) chloride
appearance at room temperature		
one similarity in observation on addition to cold water		
one difference in observation on addition to cold water		
pH of final solution		

[4]

- (c) (i) State the reagent and conditions required for the formation of sodium chlorate(V) from $Cl_2(g)$.

..... [1]

- (ii) Explain why the reaction in (c)(i) is described as a disproportionation reaction. Your answer should refer to relevant species and their oxidation numbers.

.....

..... [1]

Chlorine is a reactive element. It forms many compounds.

- (a) (i) Complete Table 2.1 to show the maximum oxidation number of the elements Na to P in their chlorides.

Table 2.1

element	Na	Mg	Al	Si	P
maximum oxidation number					

[1]

- (ii) State what determines the maximum oxidation number of elements in Period 3.

.....
 [1]

- (b) An excess of cold water is added to the chloride of silicon.

- (i) Write an equation for the reaction between an excess of cold water and the chloride of silicon.

..... [1]

- (ii) Suggest the pH of the solution produced in (b)(i).

..... [1]

- (c) An excess of cold water is added to the chloride of phosphorus.

- (i) Write an equation for the reaction between an excess of cold water and the chloride of phosphorus.

..... [1]

- (ii) Suggest the pH of the solution produced in (c)(i).

..... [1]

- (d) (i) Write an equation for the reaction of chlorine with water.

..... [1]

- (ii) Write an equation for the reaction of chlorine with hot NaOH(aq).

..... [1]

(e) Bleach is used as a cleaning product to kill bacteria. It is made by adding compounds like sodium chlorate(I), NaClO , to water.

(i) Identify the formula of the ion present in bleach that kills bacteria.

..... [1]

(ii) Sodium chlorate(I), NaClO , reacts with hydrogen peroxide to produce sodium chloride, water and oxygen gas.

Construct an equation for this reaction.

..... [1]

(iii) A sample of bleach **W** contains an unknown concentration of sodium chlorate(I).

10.0cm^3 of **W** is diluted with distilled water to make a total volume of 100cm^3 of bleach solution. 25.0cm^3 of this diluted bleach solution is added to an excess of hydrogen peroxide and the volume of gas produced measured under room conditions. The experiment is repeated and on average 25.0cm^3 of diluted bleach solution produces 42.0cm^3 of gas.

Calculate the concentration, in g dm^{-3} , of sodium chlorate(I) in **W**.



concentration of NaClO in **W** = g dm^{-3} [3]

[Total: 13]

16. March/2023/Paper_9701/12/No.18

Powder P is a mixture containing two of AgCl , AgBr or AgI .

P is shaken with dilute aqueous ammonia. A yellow solid, Q, remains.

The mixture is filtered and Q is washed and dried. The filtrate is collected and treated with aqueous nitric acid to produce a white precipitate, R, which is filtered off, washed and dried.

Q and R are warmed separately with concentrated sulfuric acid, H_2SO_4 .

Which observations are made?

	Q + concentrated H_2SO_4	R + concentrated H_2SO_4
A	violet fumes	orange fumes
B	violet fumes	steamy fumes
C	steamy fumes	violet fumes
D	orange fumes	steamy fumes

