

**Inorganic Chemistry: Group 17***(Past Year Topical Questions 2010-2015)*May/June 2010 (21)

- 5 The gaseous hydrogen halides HCl, HBr and HI, may be prepared by reacting the corresponding sodium salt with anhydrous phosphoric(V) acid,  $\text{H}_3\text{PO}_4$ .

When the sodium halide NaX was used, the following reaction occurred and a sample of gaseous HX was collected in a gas jar.



A hot glass rod was placed in the sample of HX and immediately a red/orange colour was observed.

- (a) What is the identity of NaX?

..... [1]

- (b) What gas, other than HX, would be formed if concentrated sulfuric acid were used with NaX instead of phosphoric(V) acid?

..... [1]

- (c) Suggest why phosphoric(V) acid rather than concentrated sulfuric acid is used to make samples of HX from the corresponding sodium salt.  
Explain your answer.

.....  
..... [1]

Oct/Nov 2010 (23)

- 5 A student placed separate small samples of 1-chlorobutane, 1-bromobutane and, 1-iodobutane, in three separate test-tubes. To each test-tube, 1 cm<sup>3</sup> of ethanol was added, followed by 1 cm<sup>3</sup> of aqueous silver nitrate, AgNO<sub>3</sub>. The tubes were then carefully shaken, placed in a test-tube rack and observed for 30 minutes.

A precipitate was formed in each test-tube but **not** at the same time; the fastest taking about two minutes to become opaque and the slowest about 20 minutes.

- (a) What is the identity of the precipitate formed when 1-chlorobutane is used?

..... [1]

- (b) What will be the colour of this precipitate?

..... [1]

- (c) Which of the three halogenoalkanes will produce a precipitate in about two minutes?

..... [1]

- (d) Use appropriate data from the *Data Booklet* to explain why this reaction takes place most quickly of the three.

.....  
.....  
..... [2]

Oct/Nov 2012 (21)

2 Each of the Group VII elements chlorine, bromine and iodine forms a hydride.

(a) (i) Outline how the relative thermal stabilities of these hydrides change from  $\text{HCl}$  to  $\text{HI}$ .

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(ii) Explain the variation you have outlined in (i).

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.....  
.....

[3]

Oct/Nov 2012 (23)

2 Concentrated sulfuric acid may be used in a school or college laboratory to produce hydrogen chloride by reaction with solid chlorides such as sodium chloride.

(a) (i) What will be seen when concentrated sulfuric acid is carefully added to solid sodium chloride?

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(ii) Write a balanced equation for this reaction.

.....

(b) If the same reaction is carried out with solid sodium iodide and concentrated sulfuric acid, hydrogen iodide is **not** produced.

(i) State **one** observation you would make when carrying out this reaction with solid sodium iodide.

.....

(ii) Explain why hydrogen iodide is **not** a product of this reaction.

.....

.....

[3]

(c) Aqueous silver nitrate and aqueous ammonia are used to test for the presence of halide ions.

(i) Aqueous silver nitrate is slowly added to aqueous sodium chloride and the resulting mixture is then shaken with an excess of aqueous ammonia.

Describe what you would observe at each stage of this process.

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- (ii) Write balanced equations, with state symbols, for **all** reactions that occur in this process.

- (iii) The same process of adding aqueous silver nitrate followed by an excess of aqueous ammonia is repeated using aqueous sodium iodide instead of aqueous sodium chloride.

State **two** differences that would be observed with aqueous sodium iodide.

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.....

[8]

Oct/Nov 2013 (21)/Q3

- (b) Chlorine is very reactive and will form compounds by direct combination with many elements.

Describe what you would see when chlorine is passed over separate heated samples of sodium and phosphorus.

In **each** case write an equation for the reaction.

sodium

.....  
.....  
.....

phosphorus

.....  
.....  
.....

[4]

- (c) Chlorine reacts with aqueous sodium hydroxide in two different ways, depending on the conditions used. In each case, water, sodium chloride and one other chlorine-containing compound are formed.

For **each** condition below, give the formula of the **other** chlorine-containing compound and state the oxidation number of chlorine in it.

condition	formula of <b>other</b> chlorine-containing compound	oxidation number of chlorine in this compound
cold dilute NaOH(aq)		
hot concentrated NaOH(aq)		

[4]

Oct/Nov 2013 (23)

3 The elements of Group VII of the Periodic Table show variation in their properties.

(a) (i) Complete the table below, stating the colour of each element in its normal state at room temperature.

halogen	melting point/ $^{\circ}\text{C}$	colour
chlorine	-101	
bromine	-7	
iodine	114	

(ii) Briefly explain why the melting points of the halogens increase from chlorine to iodine.

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.....

[4]



(c) Interhalogen compounds like  $\text{BrCl}$  have similar properties to the halogens.

(i) By considering your answers to (a) and (b), predict the physical state of  $\text{BrCl}$  at room temperature. Explain your answer.

physical state .....

explanation .....

.....

.....

(ii) Suggest the colour of  $\text{BrCl}$ .

.....

[4]

(d)  $Cl_2$  and  $BrCl$  each react with aqueous  $KI$ .

(i) Describe what would be seen when  $Cl_2$  is bubbled through aqueous  $KI$  for several minutes.

initially .....

.....

after several minutes .....

.....

(ii) Construct an equation for the reaction that occurs.

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(iii) Suggest an equation for the reaction that occurs between  $BrCl$  and aqueous  $KI$ .

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(iv) How do  $Cl_2$  and  $BrCl$  behave in these reactions?

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[5]

May/June 2014 (21)

**3 (a)** In this question, **K**, **L** and **M** refer to a halogen atom or halide ion.

For each part question, read the information and complete the answer lines below.

(i) When concentrated sulfuric acid is added to solid  $NaK$ , white fumes are produced that turn damp blue litmus paper red. No other colour changes are observed.

identity of **K** = .....

equation for reaction .....

explanation of observation .....

..... [3]

- (ii) When silver nitrate solution is added to an aqueous solution of NaL, a precipitate forms that remains after the addition of concentrated ammonia solution.

identity of L = .....

colour of precipitate .....

equation for reaction ..... [3]

- (iii) M<sub>2</sub> is a liquid at room temperature with a boiling point higher than that of chlorine but lower than that of iodine.

identity of M = .....

explanation .....

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..... [2]

May/June 2014 (23)

4 The halogens and their compounds have a wide variety of uses and the chemical and physical properties of the elements show regular patterns related to their positions in Group VII.

(a) Chlorine, bromine and iodine all react with hydrogen.

(i) State the trend in the reactivities of the halogens with hydrogen.

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..... [1]

(ii) Explain this trend in terms of bond energies.

.....  
.....  
..... [2]

(b) In the laboratory it is not very convenient to prepare hydrogen halides from their elements.

Hydrogen halides can be prepared from their salts.

(i) Write an equation for the reaction of calcium chloride,  $\text{CaCl}_2$ , with concentrated sulfuric acid.

..... [1]

(ii) Explain why hydrogen iodide is not prepared in this way.

.....  
..... [1]

(iii) When potassium bromide,  $\text{KBr}$ , reacts with concentrated sulfuric acid, sulfur dioxide,  $\text{SO}_2$ , is produced. State what you would see and write an equation for this reaction.

.....  
..... [3]

- (d) Aqueous silver nitrate solution was added to separate tubes containing chloroethane, bromoethane and iodoethane. The tubes were heated in a water bath.

A yellow precipitate appeared first in the tube containing iodoethane, followed by a cream precipitate in the tube containing bromoethane and finally a white precipitate appeared in the tube containing chloroethane.

Explain these observations.

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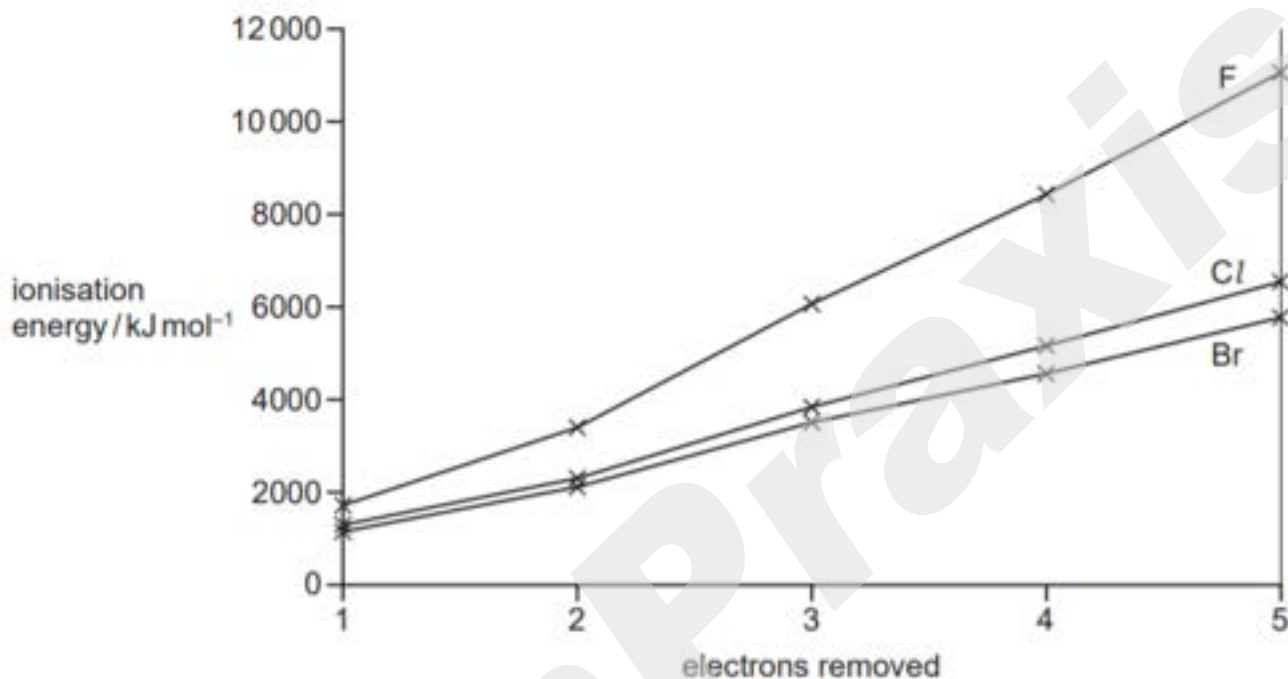
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..... [2]



Oct/Nov 2014 (23)

- 1 (a) Successive ionisation energies for the elements fluorine, F, to bromine, Br, are shown on the graph.



- (i) Explain why the first ionisation energies decrease down the group.

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..... [3]

- (ii) Explain why there is an increase in the successive ionisation energies of fluorine.

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..... [2]

- (b) Group VII is the only group in the Periodic Table containing elements in all three states of matter at room conditions.

State and explain, in terms of intermolecular forces, the trend in the boiling points of the elements down Group VII.

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[4]

- (c) Compounds containing different halogen atoms covalently bonded together are called interhalogen compounds.

- (i) One interhalogen compound can be prepared by the reaction between iodine and fluorine. This compound has  $M_r = 222$  and the percentage composition by mass: F, 42.8; I, 57.2.

Calculate the molecular formula of this interhalogen compound.

molecular formula ..... [3]

(ii) Another interhalogen compound has the formula  $\text{ICl}$ .

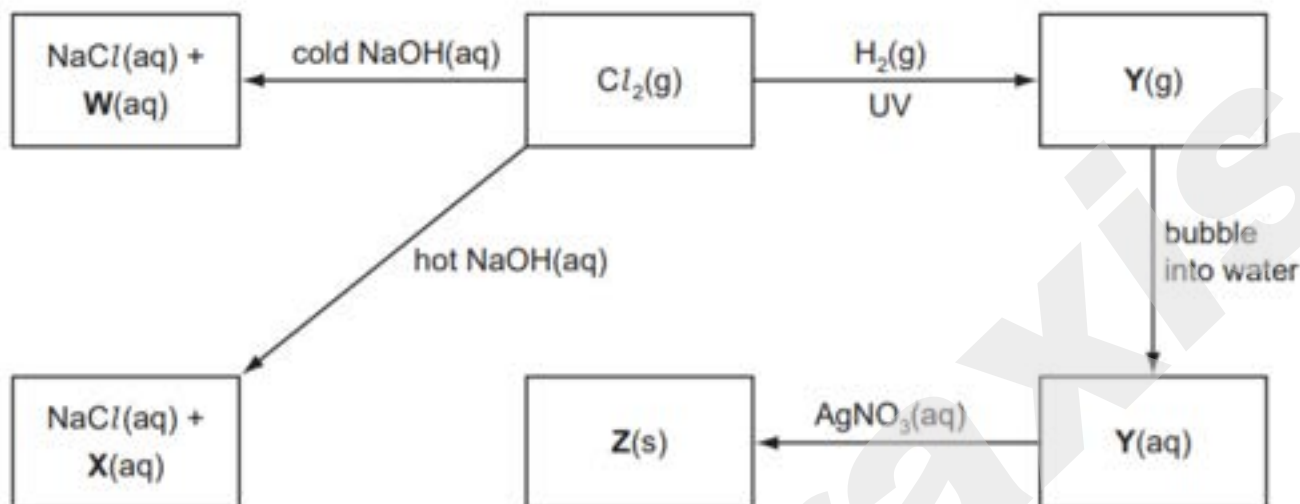
Draw a 'dot-and-cross' diagram of a molecule of this compound, showing outer shell electrons only. Explain whether or not you would expect this molecule to be polar.

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..... [2]

(d) Some reactions involving chlorine and its compounds are shown in the reaction scheme below.



(i) Give the formulae of W, X, Y and Z.

W .....

X .....

Y .....

Z .....

[4]

(ii) Write an equation for the reaction of chlorine with hot  $\text{NaOH}(\text{aq})$ .

..... [2]

(iii) State the oxidation numbers of chlorine at the start and at the end of the reaction in (ii).

..... [2]

(iv) Write an ionic equation for the reaction of Y with  $\text{AgNO}_3(\text{aq})$ . Include state symbols.

..... [1]