Group 17 – 2021 AS

1. Nov/2021/Paper_11/No.14

In which list are all three compounds soluble in water?

A barium chloride, calcium carbonate, magnesium hydroxide

B barium hydroxide, calcium hydroxide, strontium carbonate

C barium chloride, barium hydroxide, magnesium sulfate

D barium sulfate, calcium sulfate, magnesium hydroxide

2. Nov/2021/Paper_11/No.16

In a series of nine experiments, to test the reactivity of the halogens, an aqueous solution of each halogen is added to an equal volume of an aqueous solution containing halide ions, as shown in the table.

halogen solution	halide solution		
	sodium chloride (aq)	sodium bromide (aq)	sodium iodide (aq)
chlorine (aq)	experiment 1	experiment 2	experiment 3
bromine (aq)	experiment 4	experiment 5	experiment 6
iodine (aq)	experiment 7	experiment 8	experiment 9

The nine resulting mixtures are then shaken separately with an equal volume of hexane. The nine tubes are left to stand so that the aqueous and organic solvents separate into layers.

How many test-tubes contain a purple upper hexane layer?

A 1 **B** 2 **C** 3 **D** 5

3. Nov/2021/Paper_12/No.15

Redox reactions are common in the chemistry of Group 17 elements.

Which statement is correct?

A Br^- ions will reduce Cl_2 but not I_2.

B Cl_2 will oxidise Br^- ions but not I^- ions.

C F_2 is the weakest oxidising agent out of F_2, Cl_2, Br_2 and I_2.

D I^- ions are the weakest reducing agent out of F^-, Cl^-, Br^- and I^-.

4. Nov/2021/Paper_12/No.18

Oxides of nitrogen are present in the environment due to natural and man-made sources.

Which row is correct?

	natural source of nitrogen oxides	man-made source of nitrogen oxides
A	electrical discharges in the atmosphere	internal combustion engines
B	electrical discharges in the atmosphere	as a by-product of the Haber process
C	decomposition of dead plants in rivers	internal combustion engines
D	decomposition of dead plants in rivers	as a by-product of the Haber process

5. Nov/2021/Paper_13/No.16

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6. March/2021/Paper_12/No.16

Chlorine gas is reacted with aqueous sodium hydroxide. The oxidation number of chlorine changes from 0 to –1 and also from 0 to +1.

Under which conditions does this reaction occur and what is the colour of the solid silver salt with chlorine in the oxidation state –1?

	reaction conditions	colour of silver salt
A	cold, dilute alkali	white
B	cold, dilute alkali	yellow
C	hot, concentrated alkali	white
D	hot, concentrated alkali	yellow

7. March/2021/Paper_12/No.17

When concentrated sulfuric acid reacts with sodium iodide the products include sulfur, iodine, hydrogen sulfide and sulfur dioxide.

Which statement is correct?

A Hydrogen sulfide is the product of a reduction reaction.

B Iodide ions are stronger oxidising agents than sulfate ions.

C Sulfur atoms from the sulfuric acid are both oxidised and reduced.

D Sulfur atoms from the sulfuric acid are oxidised to make sulfur dioxide.

8. March/2021/Paper_22/No.2

Chlorine, Cl_2, is a reactive yellow-green gas. It is a strong oxidising agent.

(a) State how Cl_2 is used in water purification.

.....

..... [1]

(b) Chlorine has the highest first ionisation energy of the Period 3 elements Na to Cl.

(i) Construct an equation for the first ionisation energy of chlorine.

Include state symbols.

..... [1]

(ii) Explain the general increase in the first ionisation energies of the Period 3 elements.

.....

.....

.....

..... [2]

(c) The halide ions, X^- (where X = C*l*, Br, I), show clear trends in their physical and chemical properties.

(i) State and explain the relative thermal stabilities of the hydrogen halides, HX.

.....

.....

..... [2]

The halide ions react easily with concentrated H_2SO_4.

The main sulfur-containing product of each reaction is shown in the table.

halide ion	C*l*$^-$	Br^-	I^-
main sulfur-containing product of reaction with concentrated H_2SO_4	HSO_4^-	SO_2	H_2S
oxidation number of sulfur			

(ii) Complete the table to show the oxidation number of sulfur in each of the sulfur-containing products. [1]

(iii) Explain why different sulfur-containing products are produced when each of these halide ions reacts with concentrated H_2SO_4.

.....

..... [1]

(d) Cl_2 reacts with aqueous sodium hydroxide in a disproportionation reaction.

(i) State what is meant by *disproportionation*.

.....

..... [1]

(ii) Write an equation for the reaction of Cl_2 with cold aqueous sodium hydroxide.

..... [1]

(e) Aluminium reacts with chlorine to form aluminium chloride.

Aluminium chloride can exist as the gaseous molecule $Al_2Cl_6(g)$. This molecule contains coordinate bonds.

(i) Draw a diagram that clearly shows all the types of bond present in $Al_2Cl_6(g)$.

[2]

(ii) Describe what you would see when solid aluminium chloride reacts with water.

Name the type of reaction that occurs.

.....

.....

..... [2]

(f) 0.020 mol of element **Z** reacts with excess Cl_2 to form 0.020 mol of a liquid chloride.

The liquid chloride has formula $\mathbf{Z}Cl_n$, where n is an integer.

$\mathbf{Z}Cl_n$ reacts vigorously with water at room temperature to give an acidic solution and a white solid.

When excess $AgNO_3(aq)$ is added to the solution, 11.54 g of $AgCl(s)$ forms.

(i) Suggest the type of bonding and structure shown by $\mathbf{Z}Cl_n$.

..... [1]

(ii) Calculate the value of n in $\mathbf{Z}Cl_n$.

n = ... [2]

(g) Dichloromethane, CH_2Cl_2, is widely used as an organic solvent.

CH_2Cl_2 can be prepared by reacting CH_3Cl and Cl_2 at room temperature.

The reaction proceeds via several steps, as shown.

$$Cl_2 \xrightarrow{\text{initiation}} 2Cl^{\bullet}$$

$$Cl^{\bullet} + CH_3Cl \xrightarrow{\text{propagation 1}} HCl + {}^{\bullet}CH_2Cl$$

$$Cl_2 + {}^{\bullet}CH_2Cl \xrightarrow{\text{propagation 2}} \text{products}$$

$$Cl^{\bullet} + {}^{\bullet}CH_2Cl \xrightarrow{\text{final step}} CH_2Cl_2$$

(i) Give the name of the mechanism of this reaction.

..... [1]

(ii) State the essential condition required for the initiation step to take place.

..... [1]

(iii) Give the electronic configuration of $Cl^{\bullet}$.

$1s^2$ ..... [1]

(iv) Identify the products of the step labelled propagation 2.

..... [1]

(v) Name the type of reaction shown in the final step.

..... [1]

(vi) Suggest the identity of another organic molecule that is a product of the reaction of CH_3Cl and Cl_2 under the same conditions.

..... [1]

[Total: 23]

9. June/2021/Paper_11/No.17

The volatility of the Group 17 elements, chlorine, bromine and iodine, decreases down the group.

What is responsible for this trend?

A bond length in the halogen molecule

B bond strength in the halogen molecule

C electronegativity of the halogen atom

D number of electrons in the halogen atom

10. June/2021/Paper_12/No.12

A sample of $SiCl_4$ is added to cold water.

Which statement describes the mixture formed at the end of the reaction?

A acidic solution with no precipitate

B acidic solution with white precipitate

C neutral solution with no precipitate

D neutral solution with white precipitate

11. June/2021/Paper_12/No.16

Which row gives mixtures that **both** result in the oxidation of a halide ion?

	mixture 1	mixture 2
A	$AgNO_3(aq)$ and $NaCl(aq)$	concentrated $H_2SO_4(aq)$ and $HI(aq)$
B	$Br_2(aq)$ and $NaCl(aq)$	concentrated $H_2SO_4(aq)$ and $HCl(aq)$
C	$Cl_2(aq)$ and $NaBr(aq)$	$CH_3CHBrCH_3(l)$ + NaOH (ethanolic)
D	$Br_2(aq)$ and $NaI(aq)$	concentrated $H_2SO_4(aq)$ and $NaBr(s)$

12. June/2021/Paper_12/No.17

Chlorine gas is widely used to treat contaminated water.

When chlorine is added to water, which chemical species present is responsible for killing bacteria?

A ClO_2^- **B** Cl^- **C** HCl **D** ClO^-

13. June/2021/Paper_13/No.15

When descending Group 17 from chlorine to iodine, which statement is correct?

A The hydrides become less thermally stable as they become weaker reducing agents.

B The hydrides become more thermally stable as the reactivity of the elements decreases.

C The volatility of the elements decreases as the van der Waals' forces increase.

D The volatility of the elements increases as the size of the molecules increases.

14. June/2021/Paper_13/No.16

A powder is known to be either a single sodium halide or a mixture of two sodium halides. A sample of the powder was dissolved in water.

Aqueous silver nitrate was added, and a pale yellow precipitate was formed. When concentrated aqueous ammonia was then added, this precipitate partly dissolved leaving a darker yellow precipitate.

What could the powder be?

A sodium bromide only

B sodium iodide only

C a mixture of sodium chloride and sodium bromide

D a mixture of sodium chloride and sodium iodide

15. June/2021/Paper_23/No.1

The elements in Group 17 are known as the halogens.

(a) Between the molecules of Group 17 elements van der Waals' forces exist.

(i) State the trend in the relative strength of van der Waals' forces down Group 17.

..... [1]

(ii) State the physical state of each of the halogens under room conditions.

chlorine .....

bromine .....

iodine .....

[1]

(b) A solution of aqueous bromide ions, $Br^-(aq)$, is added to separate samples of $Cl_2(aq)$ and $I_2(aq)$.

Describe what is observed in each reaction. Explain your answer in terms of the relative reactivity of these elements as oxidising agents.

observation on addition to $Cl_2(aq)$ .....

.....

observation on addition to $I_2(aq)$ .....

.....

explanation .....

.....

.....

[3]

(c) Bleach is made by reacting Cl_2 with cold NaOH(aq).

Write an equation for the reaction of Cl_2 with cold NaOH.

..... [1]

(d) When $C\ell O^-(aq)$ is added to water, it behaves as a Brønsted-Lowry base.

(i) Define the term *Brønsted-Lowry base*.

..... [1]

(ii) Write an ionic equation for the reaction between $C\ell O^-$ and H_2O.

..... [1]

(e) The concentration of $NaC\ell O$ in bleach **S** is $x\,g\,dm^{-3}$.

$NaC\ell O$ reacts with $H_2O_2(aq)$ as shown.

$$H_2O_2(aq) + NaC\ell O(aq) \rightarrow H_2O(l) + NaC\ell(aq) + O_2(g)$$

A $5.00\,cm^3$ sample of **S** completely reacts with $H_2O_2(aq)$. The volume of $O_2(g)$ produced is $24.0\,cm^3$ under room conditions.

Assume that only the $NaC\ell O$ in **S** reacts with $H_2O_2(aq)$.

Calculate x. Show your working.

x = ... $g\,dm^{-3}$
[3]

(f) Sodium chlorate(I), $NaC\ell O$, oxidises dilute hydrochloric acid to form three products. The products which contain chlorine have chlorine species with oxidation number –1 or 0.

No other species changes its oxidation number during the reaction.

Use this information to complete the ionic equation.

.....$C\ell O^-$ + ...$HC\ell$ → ..... + ... + ... [2]

[Total: 13]