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A' Level Chemistry
Year 1

Unit 7: Group VII

Summer Examination Revision Pack

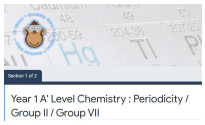
The questions in this pack should be attempted **AFTER** completing all other revision.

Grade Accelerator
Recall Definitions
Drawing Diagrams
Using Equations
Drawing Graphs

Quizlet

Quizlet Classes
Flashcard Based
Games
Tests & Quizzes
Keyword Spell Checker

Condensed Notes
Keywords & Definitions
Key Concepts
Application
Key Skills



Online Forms
Take Time to Answer
Use Paper & Calculator
Work It Out
Review Missed Marks

Use the 3 Wave Process when completing these revision packs.

1. Complete the questions without assistance
(Can't answer a question? Leave it and move on)
2. Use your notes to fill any gaps after step 1
3. Use the mark scheme to fill in any remaining gaps.

1. Having gaps after step 1 is normal, that's why we are doing revision!
2. If your notes don't help during step 2, they are not good enough!
(Change your note taking method and try to understand the problem)
3. If you don't understand why the mark scheme answer is correct, **see Andy.**

If you struggle with the questions in the pack, **STOP!** and complete some more revision.

If you come to a complete dead-end, **STOP!** and speak to **Andy** asap.

8 A student oxidised a solution of hydrochloric acid with a few drops of sodium chlorate(I) solution. The reaction mixture effervesced and turned pale green. The gas formed bleached universal indicator paper.

0 8 . 1 Write a half-equation for the oxidation of chloride ions.

[1 mark]

0 8 . 2 Write a half-equation for the reduction of chlorate(I) ions to chlorine in acidic conditions.

[1 mark]

0 8 . 3 Write an overall equation for the redox reaction of chlorate(I) ions with hydrochloric acid.

[1 mark]

0 8 . 4 A solution of sodium chlorate(I) was added to a colourless solution of potassium iodide.
Suggest what is observed.

Explain the reaction that leads to this observation.

[3 marks]

Question	Marking Guidance	Mark	Comments ClO^-
08.1	$2Cl^- \rightarrow Cl_2 + 2e^{(-)}$	1	Allow $2Cl^- - 2e^{(-)} \rightarrow Cl_2$ Alow correct equation forming ClO^- but not Cl^+
08.2	$2ClO^- + 4H^+ + 2e^- \rightarrow Cl_2 + 2H_2O$	1	Allow HClO in correctly balanced equation
08.3	$ClO^- + Cl^- + 2H^+ \rightarrow Cl_2 + H_2O$	1	allow $HClO + HCl + \rightarrow Cl_2 + H_2O$
08.4	Goes brown (or shades of brown) Due to iodine or I_3^- Because I^- oxidised	1 1 1	Allow black ppt/solid but NOT black solution or purple Correct ½ equation scores M2 and M3

0 4 . 1 Separate unlabelled solid samples of three anhydrous sodium compounds are provided for a student to identify.

These compounds are known to be sodium carbonate, sodium fluoride and sodium chloride but it is not known which sample is which.

Outline a logical sequence of test-tube reactions that the student could carry out to identify each of these compounds.
Include the observations the student would expect to make.
Give equations, including **state symbols**, for any reactions that would take place.

[6 marks]

6

Turn over for the next question

04.1 LOR Mark Scheme

Marks awarded for this answer will be determined by the quality of written communication as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking. **Additional tests limits to lower mark within a level.** This would include, for example, adding silver nitrate to the already identified sodium carbonate. Use of hydrochloric acid with silver nitrate also limits to lower mark within a level as this would not be a logical sequence/method that would work.	**Indicative Chemistry Content** **Stage 1 Suggested tests** 1a Add named acid to all 3 1b Add water / <u>make into</u> a solution 1c Add $AgNO_3$ Ignore addition of NH_3 / Ignore additional test for CO_2 produced **Stage 2 Expected observations - conclusions** 2a Na_2CO_3 will fizz with acid 2b NaCl gives white ppt with $AgNO_3$ 2c NaF shows no (visible) change / no ppt Additional incorrect observations loses point **Stage 3 Equations** – state symbols must match method 3a $Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$ … or ionic 3b $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ … or ionic 3c correct state symbols
Level 3 (5—6 marks)	
All stages are covered and each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 to identify all three compounds in a logical sequence with results and equations for all compounds stated. **Covers 2 tests with matching observations, conclusions and equations**	
Level 2 (3—4 marks)	
All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete. Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3. **Covers 2 compounds** Isolated tests on named compounds – max LEVEL 2	
Level 1 (1—2 marks)	
Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete. Answer includes isolated statements but these are not presented in a logical order.	

0 7 Chlorine is used to decrease the numbers of microorganisms in water.

When chlorine is added to water, there is a redox reaction, as shown by the equation

$$Cl_2 + H_2O \rightleftharpoons HClO + HCl$$

0 7 . 1 Deduce the oxidation state of chlorine in HClO and the oxidation state of chlorine in HCl

[1 mark]

Oxidation state of chlorine in HClO _____

Oxidation state of chlorine in HCl _____

0 7 . 2 Give two half-equations to show the oxidation and reduction processes that occur in this redox reaction.

[2 marks]

Oxidation half-equation _____

Reduction half-equation _____

0 7 . 3 Chlorine is reacted with cold, aqueous sodium hydroxide in the manufacture of bleach.

Give an equation for this reaction between chlorine and sodium hydroxide.

[1 mark]

_____

0 7 . 4 The concentration of ClO^- ions in bleach solution can be found by reaction with iodide ions.

The overall equation for this reaction is shown.

$$ClO^- + 2I^- + 2H^+ \rightarrow I_2 + Cl^- + H_2O$$

A sample of bleach solution was found to contain ClO^- ions with a concentration of 0.0109 mol dm^{-3}
Potassium iodide is added to a 20.0 cm^3 portion of this bleach solution.

Calculate the mass, in mg, of potassium iodide needed to react with all of the ClO^- ions in the sample of bleach.
Give your answer to the appropriate number of significant figures.
Give **one** observation during this reaction.

[4 marks]

Mass of potassium iodide _____ mg

Observation _____

_____

_____

_____

Question 7 continues on the next page

0 7 . 5 Potassium chlorate(VII), $KClO_4$, is used in fireworks. When potassium chlorate(VII) decomposes, it produces potassium chloride and oxygen.

Give an equation for the decomposition of potassium chlorate(VII).
Use the data in **Table 3** to calculate the enthalpy change for this reaction.

[2 marks]

Table 3

Substance	$\Delta_f H$ **/ kJ mol^{-1}**
$KClO_4(s)$	−434
KCl(s)	−436

Equation _____

Enthalpy change _____ kJ mol^{-1}

10

Qu	Marking Guidance	Additional Comments	Mark
7.1	Two correct Cl ox states: HClO = +1 HCl = -1		1
7.2	Oxidation: $Cl_2 + 2H_2O \rightarrow 2HClO + 2H^+ + 2e^-$ Reduction: $Cl_2 + 2H^+ + 2e^- \rightarrow 2HCl$	Accept - $2e^-$ on the other side Allow $Cl_2 + 2H_2O \rightarrow 2ClO^- + 2e^-$ Allow $Cl_2 + 2e^- \rightarrow 2Cl^-$ If both equations correct but incorrect order, allow 1 Ignore state symbols	1 1
7.3	$2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$	Allow $2OH^- + Cl_2 \rightarrow Cl^- + ClO^- + H_2O$ Allow NaOCl Ignore state symbols	1
7.4	mol ClO^- = conc × vol = 0.0109 × 0.02 = 0.000218 / 2.18×10^{-4} mol mol KI = 0.000218 × 2 = 0.000436 mol mass KI = M_r ×mol = 166.0 × 0.000436 = 0.072376 g = 72.4 (mg) black solid/ppt appears/forms (in a colourless solution) or (colourless solution) turns brown (solution)	 M2 = M1 x2 If incorrect ratio, M2 & M3 = 0 M3 = M1 x 2 x 166.0 x 1000 Must be to 3 sig figs Not purple. Not red. Not brown ppt/solid Ignore grey.	1 1 1 1

7.5	$KClO_4 \rightarrow KCl + 2O_2$	Ignore state symbols Allow multiples	1
	$\Delta H = -436 - -434 = -2$ kJ mol^{-1}	Must be negative Mark independently Allow consequential for multiples	1

Do not write outside the box

0 8 The following pairs of compounds, each in aqueous solution, can be distinguished by simple test-tube reactions.

Give a reagent, or combination of reagents, that can be added to the solutions in each pair to distinguish between them in a single reaction.

State what is observed in each case.

0 8 . 1 NaCl(aq) and $BaCl_2$(aq)

[3 marks]

Reagent _____

Observation with NaCl _____

Observation with $BaCl_2$ _____

0 8 . 2 NaCl(aq) and Na_2CO_3(aq)

[3 marks]

Reagent _____

Observation with NaCl _____

Observation with Na_2CO_3 _____

6

Turn over for Section B

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.1	Reagent: H_2SO_4 / Na_2SO_4 / any soluble sulfate Observation with NaCl: no (visible) change Observation with $BaCl_2$: white ppt / white solid formed	If reagent incorrect then cannot score observations (ignore conc for H_2SO_4) If reagent incomplete (e.g. SO_4^{2-}), then lose M1 but mark on Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no ppt)	3

08.2	Reagent: H_2SO_4 / HCl / HNO_3 Observation with NaCl: no (visible) change Observation with Na_2CO_3: effervescence/bubbles/fizzing OR Reagent: <u>acidified</u> $AgNO_3$ Observation with NaCl: white ppt / white solid formed Observation with Na_2CO_3: effervescence/bubbles/fizzing	If reagent incorrect then CE=0 If reagent incomplete (e.g. H^+), then lose M1 but mark on. If reagent is acid and limewater, lose M1, but mark on. Allow “no reaction”; Do not allow “nothing” Allow (CO_2) gas produced Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no fizzing) If reagent = $AgNO_3$ (not acidified) – do not allow reagent mark, but allow white ppt for observation with NaCl and white ppt for observation with Na_2CO_3 (do not allow nvc for Na_2CO_3) If acid given as HCl with $AgNO_3$, then do not allow reagent mark, but mark on. Ignore references to ppt for observation with Na_2CO_3 Allow (CO_2) gas produced Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no ppt / no fizzing) Allow alternative reagents (e.g. $BaCl_2$) that would distinguish in a single reaction.	3

Do not write outside the box

0 7 This question is about Group 7 elements and their compounds.

0 7 . 1 Chlorine is used to treat water even though it is toxic to humans.

Give **one** reason why water is treated with chlorine.

Explain why chlorine is added to water even though it is toxic.

Give an equation for the reaction of chlorine with cold water.

[3 marks]

Reason _____

_____

Explanation _____

_____

_____

Equation

_____

Do not write outside the box

0 7 . 2 Solid sodium iodide reacts with concentrated sulfuric acid to form iodine and sulfur in a redox reaction.

Give a half-equation to show the conversion of iodide ions to iodine.

Give a half-equation to show the conversion of sulfuric acid to sulfur.

Give an overall equation for this redox reaction.

Identify one other sulfur-containing reduction product formed when solid sodium iodide reacts with concentrated sulfuric acid.

[4 marks]

Half-equation for the conversion of iodide ions to iodine

Half-equation for the conversion of sulfuric acid to sulfur

Overall equation

Other sulfur-containing reduction product

Question 7 continues on the next page

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.1	Reason: sterilise water / disinfect water / kill bacteria / kill microorganisms / kill microbes		1
	Explanation: health benefit outweighs risk / only used in small quantities/low concentrations		1
	Equation: $Cl_2 + H_2O \rightleftharpoons HCl + HClO$	$2\ Cl_2 + 2\ H_2O \rightarrow 4\ HCl + O_2$	1
07.2	$2I^- \rightarrow I_2 + 2e$		1
	$H_2SO_4 + 6H^+ + 6e \rightarrow S + 4H_2O$	Allow S_8	1
	$6H^+ + 6I^- + H_2SO_4 \rightarrow 3I_2 + S + 4H_2O$	Allow correct equations using $8H^+ + SO_4^{2-}$	1
	SO_2 or H_2S	Mark independently	1

Do not write outside the box

0 4 This question is about the identification of ions in unknown solutions.

A student completes a number of test-tube reactions on solutions **A**, **B** and **C**.

Table 2 shows the student's observations.

Table 2

	Test 1	**Test 2**	**Test 3**
	Add $H_2SO_4(aq)$	Warm with NaOH(aq)	Add acidified $AgNO_3(aq)$
A	white precipitate	no visible change	no visible change
B	effervescence	a gas is formed that turns damp red litmus blue	effervescence
C	no visible change	no visible change	off-white precipitate

0 4 . 1 Suggest the identity of the positive ion in solution **A**.

Give the simplest ionic equation for the formation of the white precipitate in **Test 1** for solution **A**.

[2 marks]

Identity of positive ion in **A** _____

Ionic equation

_____

0 4 . 2 Different gases are formed when solution **B** reacts in **Test 1** and in **Test 2**.

Suggest the identity of each gas.

Give the simplest ionic equation for the formation of the gas in **Test 2**.

[2 marks]

Gas formed in **Test 1** _____

Gas formed in **Test 2** _____

Ionic equation for the formation of the gas in **Test 2**

_____

Do not write outside the box

0 4 . 3 The student thinks that solution **C** contains either chloride ions or bromide ions.

Describe a further test, or tests, to show whether solution **C** contains chloride or bromide ions.

[3 marks]

7

Turn over for the next question

Question	Marking guidance	Additional Comments/Guidelines	Mark
04.1	Ba^{2+} $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$	Accept Ca^{2+} / Sr^{2+} / Pb^{2+} Ignore state symbols Conseq on Ca^{2+} / Sr^{2+} / Pb^{2+} for M1	1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
04.2	Gas in Test 1: CO_2 Gas in Test 2: NH_3 $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$	Both gases needed for mark Allow SO_2 as correct gas for Test 1 Ignore state symbols	1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
04.3	M1: Add <u>dilute</u> ammonia solution M2: If the precipitate dissolves chloride ions are present M3: If the precipitate does not dissolve then bromide ions are present	Allow M3 if concentrated ammonia is added after dilute ammonia and the precipitate then dissolves to identify presence of bromide ions. Accept alternative Add chlorine If there is no visible change chloride ions are present If an orange-brown solution forms then bromide ions are present	1 1 1

Do not write outside the box

0 5 This question is about chlorine.

0 5 . 1 Chlorine has a low boiling point because the forces between the molecules are weak.

Explain how these forces arise between molecules of chlorine.

[3 marks]

0 5 . 2 Give an equation for the reaction of chlorine with water.

Give a reason why chlorine is added to drinking water.

[2 marks]

Equation

Reason

0 5 . 3 Chlorine reacts with cold, aqueous sodium hydroxide in the manufacture of bleach.

Give an equation for this reaction.

[1 mark]

6

Question	Marking guidance	Additional Comments/Guidelines	Mark
05.1	(Random) movement of electrons in one molecule (creates a dipole) / a (temporary) dipole is formed in one molecule / an imbalance in electron density in one molecule Induces a dipole in a neighbouring molecule. (These) temporary dipoles attract / temporary attraction between δ+ and δ–		1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
05.2	$Cl_2 + H_2O \rightleftharpoons HCl + HClO$ / $2\,Cl_2 + 2\,H_2O \rightarrow 4\,HCl + O_2$ Kills bacteria / kills microorganisms / kills microbes / kills pathogens	 Allow sterilise water / disinfect water	1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
05.3	$Cl_2 + 2\,NaOH \rightarrow NaCl + NaClO + H_2O$		1

Do not write outside the box

0 6 Iodide ions can be oxidised to iodine using oxidising agents such as iodate(V) ions (IO_3^-) and concentrated sulfuric acid.

0 6 . 1 State, in terms of electrons, the meaning of the term oxidising agent.

[1 mark]

In acidic solution, IO_3^- ions oxidise iodide ions to iodine.

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

0 6 . 2 Give a half-equation for the oxidation of iodide ions to iodine.

Deduce the half-equation to show the reduction process in this reaction.

[2 marks]

Oxidation half-equation

Reduction half-equation

0 6 . 3 When iodide ions are oxidised using concentrated sulfuric acid, sulfur dioxide, a yellow solid and a foul-smelling gas are all formed.

Give an equation to show the reaction between iodide ions and concentrated sulfuric acid to form the yellow solid.

Identify the foul-smelling gas.

[2 marks]

Equation

Identity of foul-smelling gas

5

Question	Marking guidance	Additional Comments/Guidelines	Mark
06.1	Electron acceptor / gains electrons	Do not allow electron pair acceptor / gain of electrons	1 (AO1)

Question	Marking guidance	Additional Comments/Guidelines	Mark
06.2	Oxidation half equation $2\ I^- \rightarrow I_2 + 2\ e^-$ Reduction half equation $2\ IO_3^- + 12\ H^+ + 10\ e^- \rightarrow I_2 + 6\ H_2O$	Allow multiples. Award 1 mark if the two equations are shown transposed	1 1 (2 x AO2)

Question	Marking guidance	Additional Comments/Guidelines	Mark
06.3	Equation: $6\ I^- + 6\ H^+ + H_2SO_4 \rightarrow S + 3\ I_2 + 4\ H_2O$ Foul smelling gas – H_2S / hydrogen sulphide	Allow 6HI Allow $6I^- + 8H^+ + SO_4^{2-}$	1 1 (2 x AO1)

Do not write outside the box

0 8 A student does two test-tube reactions on four colourless solutions (**A**, **B**, **C** and **D**).

Table 4 shows the student's observations.

Table 4

Solution	**Test 1** Add $Na_2CO_3(s)$	**Test 2** Add acidified $AgNO_3(aq)$
A	Effervescence	No visible change
B	Effervescence	White precipitate
C	No visible change	No visible change
D	No visible change	Very pale yellow precipitate

0 8 . 1 Identify the gas formed in **Test 1**.

Describe a further test to confirm the identity of this gas.

[2 marks]

Identity of gas _____

Test

_____

_____

0 8 . 2 Explain how the observations from **Test 1** and **Test 2** can be used to show that solution **B** contains hydrochloric acid.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 8 . 3 Describe a series of tests that the student can use to show that solution **C** contains ammonium sulfate.

[4 marks]

0 8 . 4 The student does an additional experiment to show that solution **D** contains a mixture of halide ions. One of the halide ions is chloride.

Method:

Step 1 Add an excess of $AgNO_3(aq)$ to 10.0 cm^3 of solution **D**.
Step 2 Filter, wash, dry and weigh the precipitate.
Step 3 Add an excess of dilute ammonia to the dry precipitate.
Step 4 Filter, wash, dry and weigh the solid that remains.

Explain how the masses recorded during this experiment can be used to show that solution **D** contains a mixture of halide ions.

[2 marks]

10

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.1	Identity of gas: Carbon dioxide / CO_2 Test: When gas bubbled through limewater, a white ppt formed	 When gas bubbled through limewater, it turns milky/cloudy M2 dependent on M1	1 (AO3) 1 (AO1)

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.2	Effervescence (with Na_2CO_3,) so contains H^+ ions / Effervescence (with Na_2CO_3,) so is acidic White ppt (with $AgNO_3$,) so contains chloride ions	The result from Test 1 shows the presence of H^+ / acidic The result from Test 2 shows the presence of chloride ions. Allow balanced equation for each test that links to each observation	1 1 (2 x AO2)

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.3	 (Warm with some) NaOH, Damp red litmus at the mouth of the tube turns blue Add (acidified) $BaCl_2$ / $Ba(NO_3)_2$ White ppt formed	Use of $Ba(OH)_2$ can score M1 and M3 Do not allow red litmus dipped in solution If reagent incorrect, cannot score observation mark If reagent incomplete, mark on	 1 1 1 1 (4 x AO3)

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.4	The second mass is smaller / the mass after step 4 is smaller than the mass after step 2 AgCl dissolves in dilute ammonia / some ppt dissolves as AgCl is soluble in dilute ammonia	 The ppt formed by chloride ions dissolves in dilute ammonia.	1 1 (2 x AO3)