Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

Monday 20 May 2019

Morning (Time: 1 hour 30 minutes) | Paper Reference **8CH0/01**

Chemistry

Advanced Subsidiary
Paper 1: Core Inorganic and Physical Chemistry

Candidates must have: Scientific calculator
Data Booklet

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- For the question marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing the points that you make are related or follow on from each other where appropriate.
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶

Answer ALL questions.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒
and then mark your new answer with a cross ☒.

1 How many **ions** are present in 306 g of aluminium oxide, Al_2O_3?

[Avogadro constant = $6.02 \times 10^{23}\ mol^{-1}$ Molar mass of Al_2O_3 = $102\ g\ mol^{-1}$]

☒ **A** 6.02×10^{23}

☒ **B** 1.81×10^{24}

☒ **C** 3.01×10^{24}

☒ **D** 9.03×10^{24}

(Total for Question 1 = 1 mark)

2 What is the electronic configuration of the sulfide ion, S^{2-}?

☒ **A** $1s^2 2s^2 2p^6 3s^2 3p^2$

☒ **B** $1s^2 2s^2 2p^6 3p^4$

☒ **C** $1s^2 2s^2 2p^6 3s^2 3p^4$

☒ **D** $1s^2 2s^2 2p^6 3s^2 3p^6$

(Total for Question 2 = 1 mark)

3 This question is about isotopes.

(a) State, in terms of subatomic particles, what is meant by the term **isotopes**.

(2)

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(b) The element gallium has a relative atomic mass of 69.735 and only contains two isotopes.
A sample of gallium contained the isotope ^{69}Ga, with a relative abundance of 63.25 %.

Calculate the mass number of the other isotope.
You **must** show all your working.

(2)

(Total for Question 3 = 4 marks)

4 This question is about trends within Group 2 of the Periodic Table.

(a) Which of the following describes the trends in thermal stability of the Group 2 carbonates and nitrates going down the group?

(1)

	Thermal stability	
	Carbonates	Nitrates
☒ **A**	increases	increases
☒ **B**	increases	decreases
☒ **C**	decreases	increases
☒ **D**	decreases	decreases

(b) Describe, with the aid of a labelled diagram, how you would compare the thermal stability of two different Group 2 nitrates using simple laboratory equipment.

Your answer **must** include **one** safety precaution (excluding the use of gloves, laboratory coat and eye protection).

(4)

(c) Which of the following describes the trends in the solubility in water of the Group 2 hydroxides and sulfates going down the group?

(1)

	Solubility in water	
	Hydroxides	Sulfates
☒ **A**	increases	increases
☒ **B**	increases	decreases
☒ **C**	decreases	increases
☒ **D**	decreases	decreases

(Total for Question 4 = 6 marks)

5 This question is about iron(II) salts.

(a) What is the percentage by mass of iron in anhydrous iron(II) sulfate, $FeSO_4$, to 3 significant figures?

(1)

☒ **A** 21.3%

☒ **B** 35.1%

☒ **C** 36.7%

☒ **D** 53.8%

(b) Describe a chemical test, and the expected result, to show that sulfate ions are present in a solution of iron(II) sulfate in water.

(2)

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(c) Mohr's salt is another compound containing iron(II) ions.

It has the formula $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$.

What is the molar mass, in $g\,mol^{-1}$, of Mohr's salt?

(1)

☒ **A** 392.0

☒ **B** 312.0

☒ **C** 302.0

☒ **D** 284.0

(Total for Question 5 = 4 marks)

6 A solid, white, water-soluble compound was thought to be magnesium bromide.
A student carried out tests to confirm the identity of both ions present.

(a) A flame test was carried out to test for the cation.

(i) Describe how a flame test is carried out.

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(ii) Explain the origin of flame test colours.

(4)

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(iii) Give a reason why the magnesium ion does not produce a flame colour.

(1)

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(iv) Give a reason why the lack of a flame colour is not a positive test for the magnesium ion.

(1)

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(b) (i) Give the **formula** of a reagent that would produce a cream-coloured precipitate when added to an aqueous solution of magnesium bromide.

(1)

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(ii) The identity of the anion may be confirmed by testing the solubility of the cream-coloured precipitate in ammonia solution. Which pair of responses helps to confirm the identity of the anion?

(1)

	Solubility in dilute ammonia solution	Solubility in concentrated ammonia solution
☒ **A**	insoluble	insoluble
☒ **B**	insoluble	soluble
☒ **C**	soluble	insoluble
☒ **D**	soluble	soluble

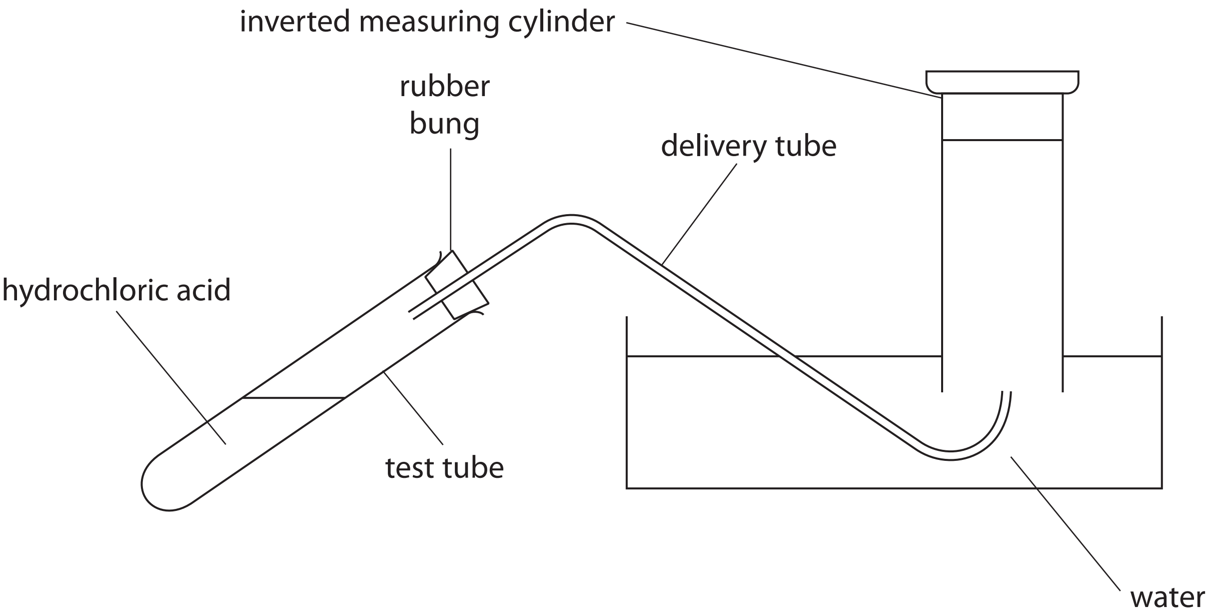
(Total for Question 6 = 11 marks)

7 This question is about the reaction of magnesium with dilute hydrochloric acid.

(a) Write an equation for the reaction of magnesium with hydrochloric acid.
Include state symbols.

(2)

(b) The apparatus shown in the diagram can be used to collect the gas produced during the reaction of magnesium with dilute hydrochloric acid.



The following procedure was used.

Step **1** The apparatus was set up as shown in the diagram. The test tube contained $10.0\,cm^3$ of $0.20\,mol\,dm^{-3}$ hydrochloric acid.

Step **2** A piece of magnesium ribbon was weighed. It had a mass of 0.12 g.

Step **3** The delivery tube and bung were removed from the test tube, the magnesium ribbon was added and the delivery tube and bung quickly replaced.

Step **4** When the reaction was complete, the final volume of gas was recorded.

(i) A measuring cylinder was used to measure the $10.0\,cm^3$ of dilute hydrochloric acid in Step **1**. The uncertainty for a volume measurement is $\pm\,0.5\,cm^3$.
Calculate the percentage uncertainty in the volume of hydrochloric acid.

(1)

(ii) Determine which reactant is in excess by calculating the number of moles of magnesium and of hydrochloric acid used in the experiment.

(3)

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(iii) Calculate the maximum number of moles of gas that could be produced, using your answers to (a) and (b)(ii).

(1)

(iv) Under the conditions of the experiment, the temperature was 23°C and the pressure 98 000 Pa.

Calculate the maximum volume of gas, **in cm³**, that could be produced using your answer in (b)(iii).
Give your answer to an appropriate number of significant figures.

[The ideal gas equation is $pV = nRT$. Gas constant (R) = 8.31 J mol^{-1} K^{-1}]

(4)

(c) (i) Deduce **two** possible reasons why the volume of gas collected in the experiment was smaller than that calculated in (b)(iv).

(2)

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(ii) Describe **two** changes to the procedure that would enable the volume of gas collected to be closer to that calculated in (b)(iv).

(2)

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(Total for Question 7 = 15 marks)

DO NOT WRITE IN THIS AREA

8 The table shows some information about a selection of elements and compounds.

	Graphene	Graphite	Diamond	Magnesium oxide	Potassium bromide	Iron
Melting temperature / K	> 4000	3950	3820	3125	1007	1808
Density / $g\,cm^{-3}$	not measured	2.2 to 2.8	3.51	3.58	2.75	7.86
Compressive strength / GPa	not measured	2.3 and 15.3	443	152	15	170

(a) Explain the difference in the melting temperatures of magnesium oxide and potassium bromide.

(3)

(b) Explain why the electrical conductivity of solid potassium bromide is poor but an aqueous solution of potassium bromide is a good electrical conductor.

(2)

*(c) Graphene, graphite and diamond are all forms of solid carbon.
Explain, in terms of structure and bonding, why graphene and graphite are good electrical conductors but diamond is a poor electrical conductor.

You may include labelled diagrams in your answer.

(6)

(d) Deduce **two** possible reasons why the density of iron (7.86 g cm^{-3}) is much greater than the density of graphite (2.2 to 2.8 g cm^{-3}).

(2)

(e) The compressive strength is a measure of the energy required to break some of the bonds within a substance.

Deduce possible reasons why there are two widely different values for the compressive strength of graphite.
Both the values (2.3 and 15.3 GPa) are valid experimental results.

(2)

(Total for Question 8 = 15 marks)

9 This question is about chlorine and its compounds.

(a) Potassium chlorate(V) can be produced by passing chlorine gas into hot, concentrated potassium hydroxide solution.

$$3Cl_2 + 6KOH \rightarrow 5KCl + KClO_3 + 3H_2O$$

(i) This reaction is an example of

(1)

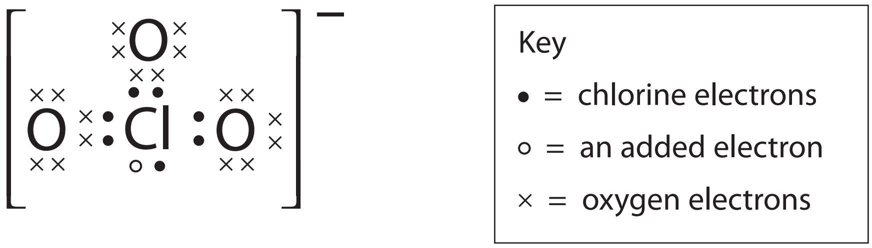
☒ **A** oxidation only

☒ **B** reduction only

☒ **C** disproportionation

☒ **D** decomposition

(ii) A dot-and-cross diagram for the chlorate(V) ion (ClO_3^-) is shown.



Predict the shape and bond angle (O—Cl—O) of the chlorate(V) ion.

Justify your answer.

(4)

(b) (i) The following reaction occurs when potassium chlorate(V) is heated at a suitable temperature.
Complete the equation by balancing it.
State symbols are not required.

$$\ldots\ldots\ KClO_3 \rightarrow \ldots\ldots KCl + \ldots\ldots KClO_4$$

(1)

(ii) The table shows some properties of potassium chloride and potassium chlorate(VII).

	Potassium chloride KCl	Potassium chlorate(VII) $KClO_4$
Solubility in water (mol/100 g)	4.81×10^{-1}	1.29×10^{-2}
Solubility in ethanol (mol/100 g)	2.9×10^{-4}	8.7×10^{-6}

Devise a brief method to show how the compounds produced in the decomposition of potassium chlorate(V) could most effectively be separated.
Use information from the table.

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(c) Chlorine gas, Cl_2, can be dissolved in swimming pool water to disinfect it.

An Olympic-sized swimming pool contains about 2500 m^3 of water.
The chlorine content is 2 ppm (parts per million) by mass.
Calculate the number of moles of chlorine, Cl_2, in the swimming pool.

[One ppm is equivalent to 1 g of chlorine dissolved in 1×10^6 g of water.
Density of water = 1 g cm^{-3}]

(3)

(d) When chlorine gas is dissolved in water, it reacts according to the equation

$$Cl_2 + H_2O \rightarrow HCl + HClO$$

The chloric(I) acid (HClO) produced is much more effective as a disinfectant than dissolved chlorine.
Chloric(I) acid is a weak acid and has little effect on the pH of the water.

Swimming pools usually have a chlorine content of 1 – 3 ppm.
Use the equation to explain one **disadvantage** of a chlorine content that is much lower than 1 ppm and one **disadvantage** of a chlorine content that is much higher than 3 ppm.

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(e) In many swimming pools, sodium chlorate(I) has replaced chlorine gas as a disinfectant.

Sodium chlorate(I) is an ionic compound. It is very soluble in water.

$$NaClO(aq) \rightarrow Na^{+}(aq) + ClO^{-}(aq)$$

(i) Describe, using diagrams to illustrate your answer, the interactions between each of the ions and the solvent when sodium chlorate(I) dissolves in water.

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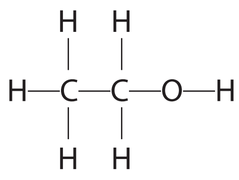
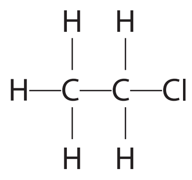
(ii) The displayed formulae of ethanol and chloroethane are shown.



ethanol



chloroethane

Ethanol is very soluble in water whereas chloroethane is almost insoluble in water.

Explain this observation by comparing the types of intermolecular forces formed by each of these molecules with water.

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(f) Calcium chlorate(I), $Ca(ClO)_2$, can be used to disinfect drinking water.

The concentration of chlorate(I) ions required to disinfect water is about $5.6 \times 10^{-6}\ mol\,dm^{-3}$.

Calculate the mass of calcium chlorate(I), in g, that should be added to $1000\ dm^3$ of water to produce a chlorate(I) ion concentration of $5.6 \times 10^{-6}\ mol\,dm^{-3}$.

(3)

(Total for Question 9 = 23 marks)

TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1.0 **H** hydrogen 1

1	2											3	4	5	6	7	0 (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
																	4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	95.9 **Mo** molybdenum 42	[98] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La*** lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **Dy** dysprosium 66	165 **Ho** holmium 67	167 **Er** erbium 68	169 **Tm** thulium 69	173 **Yb** ytterbium 70	175 **Lu** lutetium 71
* Actinide series	232 **Th** thorium 90	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103