Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number | Candidate Number

Chemistry

Advanced Subsidiary

Paper 1: Core Inorganic and Physical Chemistry

Friday 27 May 2016 – Morning
Time: 1 hour 30 minutes

Paper Reference
8CH0/01

You must have:
Data Booklet
Calculator

Total Marks

Instructions

- Use **black** ink or 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.*
- You may use a scientific calculator.
- For questions 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.

Advice

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

Turn over ▶

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PEARSON

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 This question is about Group 7 elements and their compounds.

(a) (i) Give the physical states of chlorine and iodine at room temperature and pressure.

(1)

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(ii) Predict the physical state of astatine under these conditions. Justify your answer.

(1)

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(b) Write the equation for the reaction of chlorine with cold, dilute sodium hydroxide solution to form bleach. Name this type of reaction.

(2)

Type of reaction ....

(c) Hydrogen bromide gas reacts with ammonia gas

$$HBr + NH_3 \rightarrow NH_4Br$$

What would be observed during this reaction?

(1)

☐ **A** bubbles

☐ **B** decolorisation

☐ **C** steamy fumes

☐ **D** white smoke

(d) State what is meant by the term electronegativity and hence explain the polarity, if any, of the **bonds** in chlorine trifluoride, ClF_3.

(3)

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(e) What is the number of ions in 9.53 g of magnesium chloride, $MgCl_2$?

[Avogadro constant = 6.02×10^{23} mol^{-1}]

(1)

☒ **A** 6.02×10^{22}

☒ **B** 1.20×10^{23}

☒ **C** 1.81×10^{23}

☒ **D** 6.02×10^{23}

(Total for Question 1 = 9 marks)

2 This question is about the structure of the atom and isotopes.

The following excerpt is taken from the book *Inorganic Chemistry* by Bailey and Snellgrove, fourth impression 1938.

> "*Some of the electrons are also contained in the nucleus, whilst the remainder are ..... arranged in rings revolving round the nucleus ..... The two isotopes* [*of chlorine*] *have therefore 18 and 20 electrons respectively in the nucleus and 17* [*electrons*] *external to it.*"

(a) Identify and correct **two** errors in the excerpt.

(2)

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(b) What is the structure of a 1+ ion of the carbon-13 isotope?

(1)

☒ **A** six protons, six neutrons and five electrons

☒ **B** six protons, seven neutrons and six electrons

☒ **C** six protons, seven neutrons and five electrons

☒ **D** seven protons, six neutrons and six electrons

(c) (i) State what is meant by the term **relative atomic mass**.

(2)

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(ii) A 5.000 g sample of lithium, containing the two isotopes lithium-6 and lithium-7, was found to contain 0.460 g of the isotope lithium-6.

Calculate the relative atomic mass of lithium for this sample. Give your answer to an appropriate number of significant figures.

Isotope	Relative isotopic mass
Lithium-6	6.015
Lithium-7	7.016

(3)

(d) A mass spectrometer was used to analyse a sample of bromine, Br_2, with only the ^{79}Br and ^{81}Br isotopes present.

Explain why a very small peak occurs at *m/z* = 80.

(2)

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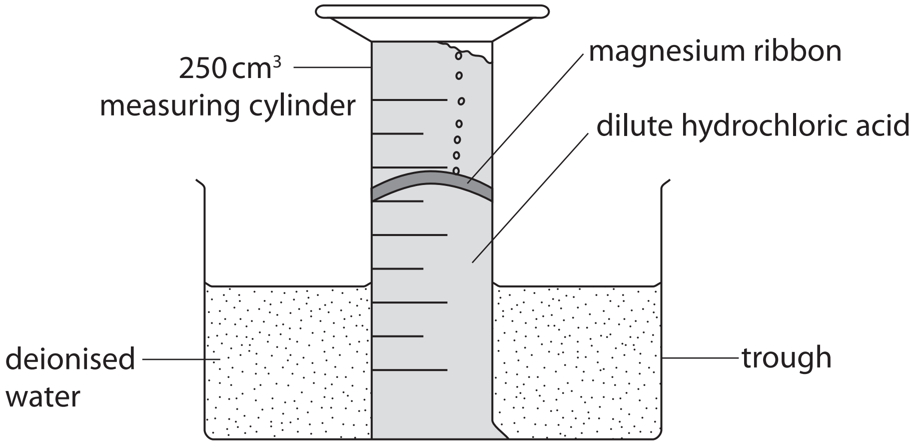
(Total for Question 2 = 10 marks)

3 A student used the apparatus in the diagram to determine the molar volume of a gas.



Assume clamps are in place to secure the apparatus

The student used a piece of magnesium ribbon, which was about 5 cm in length, and the dilute hydrochloric acid was in excess. The experiment was repeated three times at 24 °C and the following results were obtained.

	Experiment 1	**Experiment 2**	**Experiment 3**
Mass of magnesium / g	0.04	0.04	0.04
Volume of hydrogen gas / cm^3	31	25	32

The equation for the reaction is

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(a) (i) Calculate the number of moles of magnesium used by the student in each experiment.

(1)

(ii) Use your answer from part (a)(i) to deduce the number of moles of hydrogen gas that should be produced.

(1)

(iii) Calculate, using the Ideal Gas Equation, the volume of hydrogen gas, in **cm^3**, that should be produced in each of these experiments.

[$pV = nRT$ $R = 8.31\ J\ mol^{-1}\ K^{-1}$ $p = 101\,000\ Pa$]

(4)

(b) Give a reason why the student repeated the experiment three times.

(1)

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....

(c) Give three reasons for the difference between your calculated value in (a)(iii) and the actual volumes of hydrogen gas obtained by the student.

For each reason, identify a change to either the apparatus or the chemicals that could be made by the student to improve the result.

(6)

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(Total for Question 3 = 13 marks)

4 The labels on four colourless solutions had fallen off in storage. It was known that the solutions were:

hydrochloric acid | magnesium sulfate
potassium chloride | sodium carbonate

In order to identify each solution, a number of tests were carried out.

(a) Solutions can be sprayed into a flame to produce a flame colour identical to that seen in the more conventional method with a solid on a nichrome wire.

Which solution would produce a lilac flame?

(1)

☒ **A** hydrochloric acid

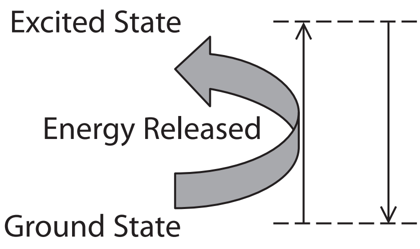
☒ **B** magnesium sulfate

☒ **C** potassium chloride

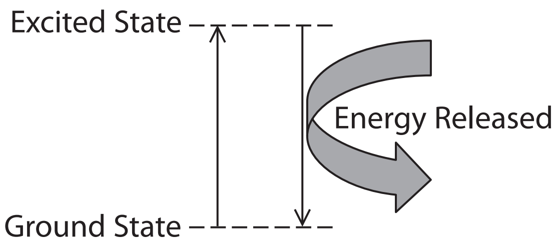
☒ **D** sodium carbonate

(b) Which of the following diagrams best illustrates the electronic transitions that take place during a flame test?

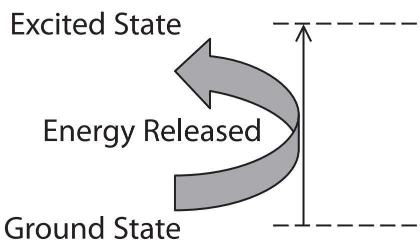
(1)



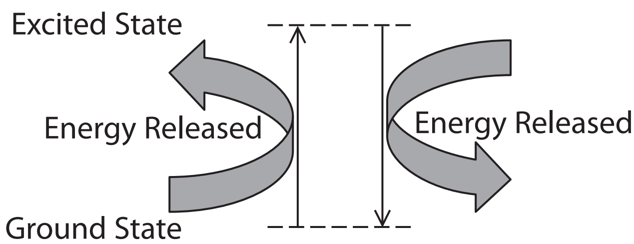
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(c) Which solution produces a white precipitate with acidified barium chloride solution?

(1)

☒ **A** hydrochloric acid

☒ **B** magnesium sulfate

☒ **C** potassium chloride

☒ **D** sodium carbonate

(d) Two of the solutions produce the same result on the addition of dilute nitric acid followed by silver nitrate solution.

State the observation with this test and the **two** solutions that give this result.

(2)

Observation ....

Solutions ....

(e) The hydrochloric acid and the sodium carbonate solution react together. State an observation you would make and write the **ionic** equation for the reaction. State symbols are not required.

(2)

Observation ....

Ionic equation

(Total for Question 4 = 7 marks)

5 A solution of nitric acid, HNO_3, of concentration 100 g dm^{-3}, can be used to artificially age wood.

A sample of nitric acid, thought to be suitable for this use, was diluted by pipetting 10.00 cm^3 of this acid into a 250 cm^3 volumetric flask, adding deionised water and making the solution up to the mark. The solution was thoroughly mixed.

A titration was carried out using this diluted solution of nitric acid. The burette was filled with 0.0800 mol dm^{-3} sodium hydroxide solution and 25.00 cm^3 of the diluted nitric acid was pipetted into each of three conical flasks. The following results were obtained.

	Titration 1	Titration 2	Titration 3
Final burette reading / cm^3	20.50	40.40	20.00
Initial burette reading / cm^3	0.00	20.50	0.00
Volume added / cm^3	20.50	19.90	20.00

The equation for the reaction is

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

(a) Select the appropriate titres and calculate the mean titre in cm^3.

(1)

(b) Calculate the concentration of the **undiluted** nitric acid in g dm^{-3}. Give your answer to one decimal place.

Deduce whether this nitric acid is suitable for use in artificially ageing wood.

(5)

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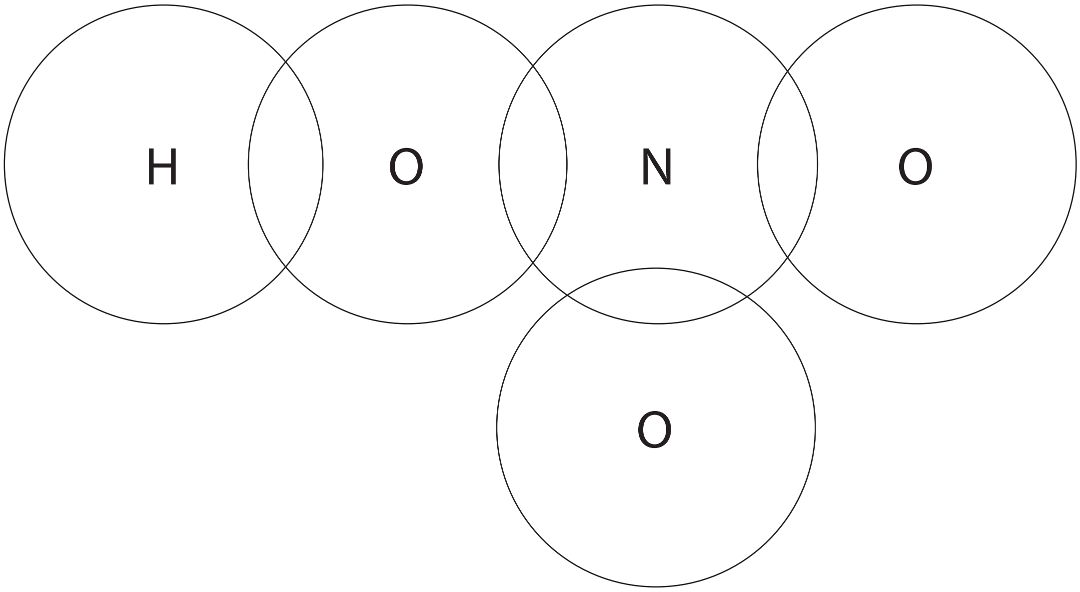
(c) Complete the dot-and-cross diagram for the bonding in nitric acid, showing only outer shell electrons.

Use (•) for the oxygen electrons,

(x) for the nitrogen electrons and (*) for the hydrogen electron.

(3)



(d) One possible method for the formation of nitric acid involves the reaction between dinitrogen tetroxide and water.

$$3N_2O_4 + 2H_2O \rightarrow 4HNO_3 + 2NO$$

Calculate the atom economy for the formation of nitric acid from this reaction.

(1)

(Total for Question 5 = 10 marks)

6 (a) The diagram shows bond angles in ammonia and water.

Explain why the bond angle in water is less than the bond angle in ammonia.

(2)

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(b) Explain why the O—H and S—H bond lengths are different.

(3)

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(Total for Question 6 = 5 marks)

7 *(a) A student suggested that the difference in the rates of reaction of strontium and barium with water is due to the difference in the sum of their first and second ionisation energies. Discuss this suggestion.

(6)

(b) Which is the equation for the **third** ionisation energy of barium?

(1)

☒ **A** Ba(s) → $Ba^{3+}(g) + 3e^-$

☒ **B** $Ba^{2+}(s)$ → $Ba^{3+}(g) + e^-$

☒ **C** $Ba^{2+}(g)$ → $Ba^{3+}(g) + e^-$

☒ **D** $Ba^{3+}(g)$ → $Ba^{4+}(g) + e^-$

(c) Explain why magnesium nitrate, $Mg(NO_3)_2$ decomposes more readily on heating than potassium nitrate, KNO_3.

(4)

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(d) Some metal carbonates also undergo thermal decomposition.

(i) Draw a diagram of the apparatus that could be used to compare the ease of thermal decomposition of lithium carbonate, Li_2CO_3, and magnesium carbonate, $MgCO_3$.

(2)

P 4 9 8 3 7 A 0 1 4 2 0

(ii) State **one** way in which you would ensure a fair test.

(1)

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(iii) State how data obtained in this experiment could be used to make a comparison.

(1)

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(Total for Question 7 = 15 marks)

8 The properties of elements and their compounds are determined by their structure and bonding.

(a) Magnesium oxide has a very high melting temperature.
Which of the following is the best description of its structure and bonding?

(1)

☒ **A** giant ionic

☒ **B** giant metallic

☒ **C** giant covalent

☒ **D** simple covalent

(b) Sulfur reacts with fluorine to form a number of different compounds.

(i) One compound contains 45.79% sulfur and 54.21% fluorine by mass.
Calculate the empirical formula of this compound.

(2)

(ii) In a dry container, a fluoride of silver reacts with sulfur to produce disulfur difluoride. Complete the equation for this reaction.
State symbols are not required.

(1)

$$S_8 + \ldots\ldots AgF_2 \rightarrow \ldots\ldots S_2F_2 + \ldots\ldots AgF$$

(iii) Explain, by using the oxidation numbers of **all** the atoms, whether or not this is a redox reaction.

(3)

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(c) Element **X** has the typical appearance of a metal.

Predict **two** other distinct physical properties that element **X** would exhibit if it is a metal. Explain your choices in terms of structure and bonding.

(4)

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(Total for Question 8 = 11 marks)

TOTAL FOR PAPER = 80 MARKS

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The Periodic Table of Elements

Key

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

1	2											3	4	5	6	7	0 (8)
							1.0 **H** hydrogen 1										*(18)* 4.0 **He** helium 2
(1)	*(2)*											*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	
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	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(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