Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

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.
- Good luck with your examination.

Turn over ▶

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 Bromine exists as two stable isotopes. The two isotopes are represented by the symbols $^{79}_{35}Br$ and $^{81}_{35}Br$.

(a) Give one similarity and one difference between these two isotopes by referring to the **number of particles** in the nuclei of the two isotopes.

(2)

(b) The relative abundance of the two isotopes in a sample cannot be found in a chemical test.

(i) Give the reason why, despite the difference in atomic structure, the isotopes have the same chemical reactions.

(1)

(ii) State how the relative abundance of the two isotopes can be found.

(2)

(c) (i) Complete the electronic configuration of a bromine atom.

(1)

$1s^2\ 2s^2$ .....

(ii) What is the number of electrons in the fourth quantum shell of bromine?

(1)

☒ **A** 2

☒ **B** 7

☒ **C** 17

☒ **D** 18

(Total for Question 1 = 7 marks)

2 This question is about sodium carbonate.

(a) Sodium carbonate forms a number of hydrates with the general formula $Na_2CO_3.xH_2O$.

A 250 cm^3 standard solution of one of these hydrates contained 10.0 g of the compound.

Describe, including the names of any relevant apparatus, how to make this standard solution when provided with 10.0 g of the hydrate in a beaker.

(5)

(b) 25.0 cm^3 portions of the standard solution described in (a) are titrated with hydrochloric acid solution of concentration 0.300 mol dm^{-3}, using methyl orange as an indicator.

The table shows the results for this titration.

	Titration **1**	Titration **2**	Titration **3**
Final volume / cm^3	30.25	29.75	31.25
Initial volume / cm^3	0.30	0.90	2.60
Total titre / cm^3	29.95	28.85	28.65

(i) What is the colour change at the end-point of the reaction?

(1)

	From	To
☒ **A**	red	orange
☒ **B**	red	yellow
☒ **C**	yellow	orange
☒ **D**	yellow	red

(ii) State why the value for the total titre in Titration **1** should not be used to calculate the mean titre.

(1)

.....

.....

.....

(iii) Calculate the mean titre.

(1)

(iv) Calculate the relative formula mass, M_r, of the hydrated sodium carbonate, $Na_2CO_3.xH_2O$.

The equation for the reaction in the titration is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

(4)

(c) In an experiment, the M_r of a **different** hydrated sodium carbonate was found to be 286 g mol^{-1}.

(i) Calculate the relative formula mass of anhydrous sodium carbonate, Na_2CO_3.

(1)

(ii) Calculate the number of molecules of water of crystallisation, x, for this hydrated sodium carbonate, $Na_2CO_3.xH_2O$.

(1)

(d) Sodium carbonate is manufactured from sodium chloride in a two-stage process.

$$NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3 + NH_4Cl$$
$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Calculate the maximum mass of sodium carbonate, Na_2CO_3, which could be obtained from 500 kg of sodium chloride.

(3)

(Total for Question 2 = 17 marks)

3 Ammonia reacts with sodium to form sodium amide, $NaNH_2$, and hydrogen.

(a) (i) Write the equation for this reaction.
State symbols are not required.

(1)

(ii) Draw diagrams showing the 3-dimensional shape of an ammonia molecule and of an amide ion, NH_2^-.
Include any lone pairs of electrons in each species.

(3)

ammonia molecule

amide ion

(iii) What is the H—N—H bond angle in an ammonia molecule?

(1)

☒ **A** 104.5°

☒ **B** 107°

☒ **C** 109.5°

☒ **D** 120°

(iv) Explain the difference between the H—N—H bond angle in ammonia and in the amide ion.

(2)

(b) Give a possible reason why samples of sodium amide are stored in oil.

(1)

(Total for Question 3 = 8 marks)

4 Sulfur is a bright yellow crystalline solid at room temperature.

Sulfur forms rings of 8 sulfur atoms so the formula of the yellow solid is S_8.

(a) A section of a periodic table showing values of first ionisation energy in kJ mol^{-1} is shown.

N 1400	O 1310	F 1680
P 1010	S 1000	Cl 1250
As 950	Se 940	Br 1140

(i) Which equation represents the first ionisation energy of sulfur?

(1)

☒ **A** $S(s) \rightarrow S^+(g) + e^-$

☒ **B** $S_8(s) \rightarrow S_8^+(g) + e^-$

☒ **C** $S(g) \rightarrow S^+(g) + e^-$

☒ **D** $S_8(g) \rightarrow S_8^+(g) + e^-$

(ii) Explain the trend in the values of the first ionisation energies for the group containing sulfur.

(3)

(iii) Explain why the first ionisation energy of sulfur is lower than that of chlorine.

(2)

(iv) Explain why the first ionisation energy of sulfur is lower than that of phosphorus.

(2)

(b) Compound **X** is an oxide of sulfur. A gaseous sample of 0.318 g of **X** occupied a volume of 132 cm^3 at a temperature of 420 K and pressure of 105 kPa.

The number of moles of a gas and the volume occupied by it can be found using the ideal gas equation

$$pV = nRT$$

Calculate the relative molecular mass of **X** and hence its molecular formula.
You must show **all** your working.

[$R = 8.31\ J\,mol^{-1}\,K^{-1}$]

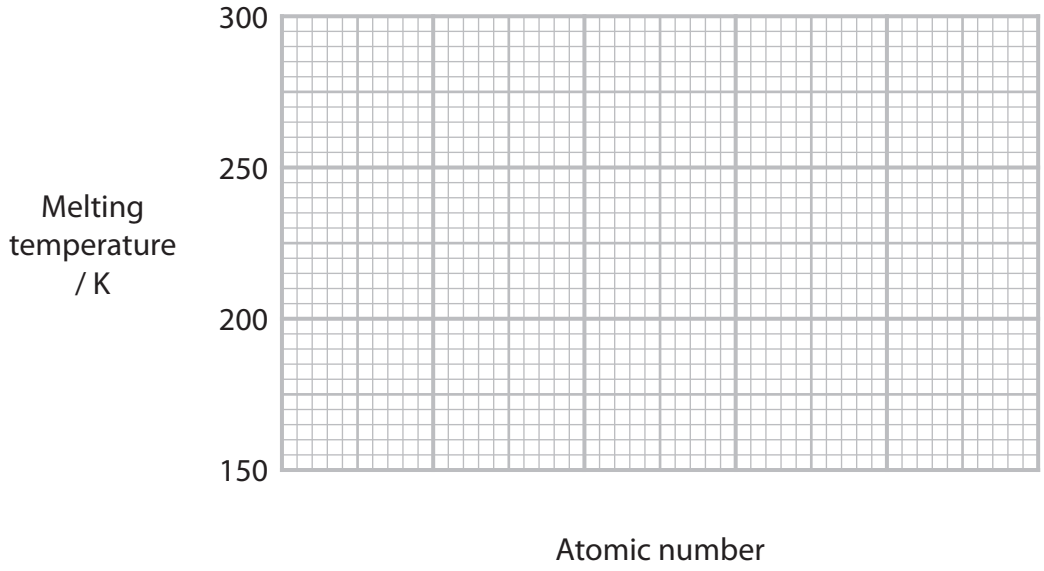
(5)

(c) Sulfur and the other elements in Group 6 form dihydrogen compounds.

Compound	Atomic number of Group 6 element	Melting temperature / K
H_2O	8	273
H_2S	16	To be estimated
H_2Se	34	207
H_2Te	52	224
H_2Po	84	238

(i) Plot a graph of atomic number of the Group 6 element on the *x*-axis against melting temperature of the dihydrogen compound on the *y*-axis.

(2)



(ii) Give an estimate of the melting temperature of H_2S.

(1)

.....

(Total for Question 4 = 16 marks)

5 This question is about crystalline solids.

(a) Iodine and diamond are crystalline solids at room temperature.

Explain why diamond has a much higher melting temperature than iodine.

(5)

(b) Graphite is also a crystalline solid at room temperature.
Unlike diamond, graphite conducts electricity.

Describe the key feature of the bonding of the carbon atoms in graphite that results in it being an electrical conductor.

(2)

(Total for Question 5 = 7 marks)

6 This question is about the reactions of the halogens and their salts.

(a) The potassium halides react with concentrated sulfuric acid to form hydrogen halides.

(i) The equation for this reaction for potassium chloride can be written

$$KCl + H_2SO_4 \rightarrow HCl + KHSO_4$$

The hydrogen chloride does not react further.

State why this reaction is not a redox reaction.

(1)

(ii) On descending Group 7, the hydrogen halides become better reducing agents.

Explain how the reactions of potassium chloride, potassium bromide and potassium iodide with concentrated sulfuric acid provide evidence for this statement.

No explanation of the trend is required.

(3)

(b) The reaction that occurs between chlorine and sodium hydroxide depends on the temperature.

(i) At room temperature the reaction that occurs is

$$Cl_2 + NaOH \rightarrow NaClO + NaCl$$

Explain, with reference to oxidation numbers, why this is a disproportionation reaction.

(2)

.....

.....

.....

.....

.....

.....

(ii) With hot sodium hydroxide solution, a different disproportionation reaction occurs. Sodium chlorate(V) is one of the products.

Complete the equation for this reaction. State symbols are not required.

(2)

.....Cl_2 + ...NaOH $\rightarrow$

(c) Chlorine is used as a bleach in the textiles industry. Any excess chlorine can be removed by reduction to chloride ions.

The half-equation for the reaction of chlorine is

$$Cl_2 + 2e^- \rightarrow 2Cl^-$$

In one reaction, 768 cm^3 of chlorine gas was reduced.

(i) Calculate the number of moles of electrons gained by chlorine molecules during this reaction.
[Under these conditions one mole of gas occupies 24 dm^3]

(2)

(ii) The reducing agent was a solution containing thiosulfate ions, $S_2O_3^{2-}$.
The chlorine reacted with 40 cm^3 of a 0.20 mol dm^{-3} solution of these ions.

Deduce the number of moles of electrons lost by each atom of sulfur in the thiosulfate ion, and hence the final oxidation state of the sulfur in the product.

(3)

(Total for Question 6 = 13 marks)

7 The nitrates of lithium, rubidium and strontium are all white solids. The compounds are held together by ionic bonds.

(a) State the meaning of the term 'ionic bond'.

(2)

.....

.....

.....

.....

(b) What is the percentage by mass of strontium in strontium nitrate?

(1)

☒ **A** 38.0 %

☒ **B** 41.4 %

☒ **C** 58.6 %

☒ **D** 74.5 %

(c) These three compounds cannot be identified with certainty from a flame test as the colours seen are similar.

Concentrated hydrochloric acid is used in a flame test procedure.

(i) Which of the following is a reason for dipping the flame test wire in concentrated hydrochloric acid during a flame test procedure?

(1)

☒ **A** it dissolves metal ions from the wire

☒ **B** it neutralises hydroxide ions that might colour the flame

☒ **C** it reduces the metal ions to metal atoms

☒ **D** it reacts with the compounds to form volatile chlorides

(ii) The flame colour given by these three solids in the flame test are shades of

(1)

☒ **A** green

☒ **B** lilac

☒ **C** red

☒ **D** yellow

(iii) What is the best explanation for why metal ions produce different flame colours?

(1)

Different wavelengths of light energy are

☒ **A** required to promote electrons to higher energy levels

☒ **B** released because electrons move from lower to higher energy levels

☒ **C** released due to different gaps between energy levels

☒ **D** required for electron transfer from non-metal ions to metal ions

*(d) Devise a procedure to **identify** the nitrates of lithium, rubidium and strontium using the effect of heat on the three solids and any precipitation reactions of the compounds.

Practical details are not required, but you should give the observations expected in each case.

(6)

(Total for Question 7 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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