

Write your name here

Surname

Other names

**Pearson**  
**Edexcel GCSE**

Centre Number

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Candidate Number

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**Chemistry/Additional Science**  
**Unit C2: Discovering Chemistry**

**Higher Tier**

Wednesday 15 June 2016 – Afternoon

**Time: 1 hour**

Paper Reference

**5CH2H/01****You must have:**

Calculator, ruler

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 60.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (\*) are ones where the quality of your written communication will be assessed  
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*

**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.

Turn over ►

P45930A

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**PEARSON**

# The Periodic Table of the Elements

1	2				3	4	5	6	7	0													
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	45 <b>Sc</b> scandium 21	48 <b>Ti</b> titanium 22	51 <b>V</b> vanadium 23	52 <b>Cr</b> chromium 24	55 <b>Mn</b> manganese 25	56 <b>Fe</b> iron 26	59 <b>Co</b> cobalt 27	59 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65 <b>Zn</b> zinc 30	70 <b>Ga</b> gallium 31	73 <b>Ge</b> germanium 32	75 <b>As</b> arsenic 33	79 <b>Se</b> selenium 34	80 <b>Br</b> bromine 35	84 <b>Kr</b> krypton 36		
85 <b>Rb</b> rubidium 37	88 <b>Sr</b> strontium 38	133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	89 <b>Y</b> yttrium 39	89 <b>Zr</b> zirconium 40	91 <b>Nb</b> niobium 41	93 <b>Mo</b> molybdenum 42	96 <b>Tc</b> [98] technetium 43	101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	119 <b>Sn</b> tin 50	122 <b>Sb</b> antimony 51	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54	204 <b>Tl</b> thallium 81	207 <b>Pb</b> lead 82	209 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated												

1  
**H**  
hydrogen  
1

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

\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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**Questions begin on next page.**



**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 ☒.

**The periodic table**

1 The positions of ten elements are shown in the outline periodic table.

The letters are not the symbols of the elements.

1	2											3	4	5	6	7	0
<b>E</b>													<b>G</b>		<b>J</b>		
<b>L</b>													<b>M</b>				
										<b>Q</b>							<b>R</b>
<b>T</b>													<b>X</b>				<b>Z</b>

(a) Use the letters given in the table to identify

(i) the element that is a noble gas.

(1)

.....

(ii) three elements that are in the same period.

(1)

.....

(b) Which element reacts with hydrogen to form a compound that dissolves in water to give an acidic solution?

Put a cross (☒) in the box to show your answer.

(1)

- A** element **G**
- B** element **J**
- C** element **R**
- D** element **Z**

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(c) Which elements, when combined, form an ionic compound?

Put a cross (☒) in the box to show your answer.

(1)

- A** **E** and **R**
- B** **G** and **J**
- C** **G** and **R**
- D** **R** and **Z**

(d) Element **Q** is a metal and a good conductor of electricity.

Explain how metals conduct electricity.

(2)

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(e) Reactivity increases down group 1 of the periodic table.

Elements **E** and **T** are in group 1 of the periodic table.

Explain why element **T** is more reactive than element **E**.

(2)

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**(Total for Question 1 = 8 marks)**



**Sodium sulfate**

2 Sodium sulfate is an ionic solid which is soluble in water.

(a) Which row of the table shows the likely properties of sodium sulfate?

Put a cross (☒) in the box to show your answer.

(1)

	melting point / °C	conducts electricity when dissolved in water
<input type="checkbox"/> <b>A</b>	22	yes
<input type="checkbox"/> <b>B</b>	22	no
<input type="checkbox"/> <b>C</b>	884	yes
<input type="checkbox"/> <b>D</b>	884	no

(b) Sodium sulfate contains sodium ions,  $\text{Na}^+$ , and sulfate ions,  $\text{SO}_4^{2-}$ .

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

(1)

The formula for sodium sulfate is

- A**  $\text{NaSO}_4$
- B**  $\text{Na}(\text{SO}_4)_2$
- C**  $\text{Na}_2\text{SO}_4$
- D**  $\text{Na}_2(\text{SO}_4)_2$

(ii) Sodium ions can be identified using a flame test.

Which colour in the flame shows the presence of sodium ions?

Put a cross (☒) in the box to show your answer.

(1)

- A** lilac
- B** red
- C** orange-red
- D** yellow

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(iii) Explain how a sodium atom, Na, becomes a sodium ion, Na<sup>+</sup>.

(2)

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(c) When sodium sulfate solution reacts with barium hydroxide solution, a white precipitate of barium sulfate forms in the mixture.

The barium sulphate precipitate can be separated from the mixture and purified.

(i) Describe how pure, dry barium sulfate can be obtained from the mixture.

(2)

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(ii) Before certain X-rays, patients are given a suspension of barium sulfate to drink.

Explain why this causes no harm to the patient, even though barium salts are toxic.

(2)

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**(Total for Question 2 = 9 marks)**

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### Chemical reactions

- 3 (a) When ammonium nitrate dissolves in water, the change is endothermic.

In an experiment, a thermometer is placed in some water in a beaker and ammonium nitrate crystals are added.

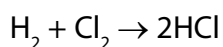
State what you would **see** to show that the reaction is endothermic.

(1)

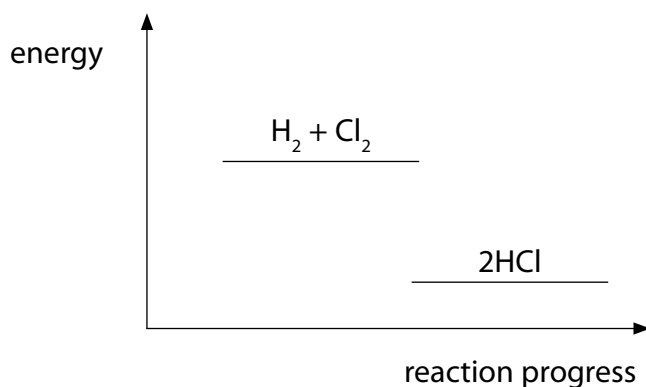
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- (b) The reaction between hydrogen and chlorine to form hydrogen chloride is exothermic.



The energy change taking place when the reactants, hydrogen and chlorine, form the product, hydrogen chloride, is shown in the diagram.



Explain, in terms of the breaking of bonds and the making of bonds, why this reaction is exothermic.

(2)

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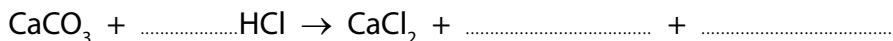


(c) Marble chips react with dilute hydrochloric acid.

Marble is a form of calcium carbonate.

(i) Complete the balanced equation for this reaction.

(2)



(ii) Explain how using smaller sized marble chips affects the rate of this reaction, when all the other conditions remain the same.

(2)

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(iii) Explain, in terms of collisions between particles, how increasing the concentration of the hydrochloric acid affects the rate of this reaction, when all the other conditions remain the same.

(2)

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**(Total for Question 3 = 9 marks)**

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**Atomic structure and isotopes**

4 (a) An atom of potassium has an atomic number of 19 and a mass number of 39.

(i) Complete the table to show the number of protons, neutrons and electrons in this potassium atom.

(2)

number of		
protons	neutrons	electrons

(ii) Describe the positions of these particles in the potassium atom.

(2)

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(iii) State the electronic configuration of this potassium atom.

(1)

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(iv) Give the relative mass of an electron.

(1)

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(b) A sample of gallium, Ga, contains the isotopes gallium-69 and gallium-71.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

(1)

Isotopes are different atoms of the same element that contain

- A different numbers of electrons
- B different numbers of protons but same number of electrons
- C same number of protons but different numbers of neutrons
- D same number of neutrons

(ii) The sample of gallium contains

60.2% of gallium-69

39.8% of gallium-71

Calculate the relative atomic mass of gallium.

(3)

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**(Total for Question 4 = 10 marks)**



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### Chlorine

5 Chlorine is an element in group 7 of the periodic table.

(a) Chlorine,  $\text{Cl}_2$ , is a simple molecular, covalent substance.

The atoms in a molecule of chlorine are held together by a covalent bond.

(i) Explain what is meant by the term **covalent bond**.

(2)

(ii) Phosphorus reacts with chlorine to form phosphorus trichloride,  $\text{PCl}_3$ .

A phosphorus atom has five electrons in its outer shell.

A chlorine atom has seven electrons in its outer shell.

Draw the dot and cross diagram to show the bonding in a molecule of phosphorus trichloride,  $\text{PCl}_3$ .

Show outer electrons only.

(2)

(iii) Aluminium reacts with chlorine to form aluminium chloride,  $\text{AlCl}_3$ .

Write the balanced equation for this reaction.

(2)

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\*(b) Chlorine,  $\text{Cl}_2$ , is a simple molecular, covalent substance.  
 Diamond is a giant molecular, covalent substance.  
 Sodium chloride is an ionic substance.  
 Zinc is metallic.

As a result of their different structures these substances have the following different properties.

- Solid chlorine has a very low melting point but diamond, sodium chloride and zinc have high melting points.
- Diamond and sodium chloride have different solubilities in water.

In terms of the structure and bonding of these substances, explain these properties.

(6)

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**(Total for Question 5 = 12 marks)**



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**Composition, yield and empirical formulae**

- 6 (a) Calculate the percentage by mass of nitrogen in ammonium nitrate,  $\text{NH}_4\text{NO}_3$ .  
(relative atomic masses: H = 1.0, N = 14, O = 16)

(3)

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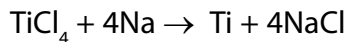
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percentage by mass of nitrogen = ..... %

- (b) In the extraction of titanium from its ore, the final stage involves the reaction between titanium(IV) chloride,  $\text{TiCl}_4$ , and sodium.



Calculate the maximum mass of titanium that can be obtained from 500 tonnes of titanium(IV) chloride in this reaction.

(relative atomic mass: Ti = 48  
relative formula mass of  $\text{TiCl}_4$  = 190)

(2)

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mass of titanium = ..... tonnes

- (c) Reactions used in the chemical industry often produce unwanted products together with the required product.

State a problem this may cause for the manufacturer.

(1)

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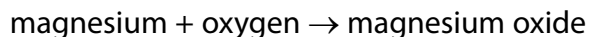
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\*(d) An experiment is carried out to determine the empirical formula of magnesium oxide.



The following results are obtained

mass of magnesium ribbon reacted = 0.420 g

mass of magnesium oxide formed = 0.700 g

Describe an experiment to produce these results. As part of your answer show how these results can be used to obtain the empirical formula of the magnesium oxide.

(relative atomic masses: Mg = 24.0, O = 16.0)

(6)

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(Total for Question 6 = 12 marks)

**TOTAL FOR PAPER = 60 MARKS**



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