Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Atomic structure

Time allowed: 1 hour 15 minutes

Subject code **0620**

Chemistry

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 80

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 80 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Substances can be classified as elements, compounds or mixtures.

State whether each of the following is an element, a compound or a mixture.

(a) brass ..... [1]

(b) gold ..... [1]

(c) butane ..... [1]

(d) air ..... [1]

[Total: 4]

Elements, compounds and mixtures Click for more variations

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1(a)	mixture	**1**
1(b)	element	**1**
1(c)	compound	**1**
1(d)	mixture	**1**

2 Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of electrons	number of neutrons
$^{37}_{17}Cl$		17	
$^{63}_{29}Cu^{+}$			34
	16	18	17

[5]

Protons, neutrons, electrons and electronic configuration Click for more variations

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2	**M1** : C*l*: 17 **AND** 20 (1) **M2** Cu^{+}: 29 **AND** 28 (1) **M3** 33(above) **and** 16(below) on left hand side of symbol (1) **M4** S (1) **M5** 2^{-} (1)	**5**

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3 The table gives information about five particles, **A**, **B**, **C**, **D** and **E**.

particle	number of electrons	number of neutrons	number of protons
A	10	13	11
B	18	20	18
C	18	18	18
D	10	12	8
E	10	10	10

(a) State the atomic number of **A**.

..... [1]

(b) State the nucleon number of **B**.

..... [1]

(c) Write the electronic structure of **C**.

..... [1]

(d) Give the letters of all the particles which are:

(i) atoms ..... [1]

(ii) positive ions ..... [1]

(iii) negative ions ..... [1]

(iv) isotopes of each other. ..... [1]

[Total: 7]

Protons, neutrons, electrons and electronic configuration Click for more variations

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3(a)	11	1
3(b)	38	1
3(c)	2,8,8	1
3(d)(i)	B, C and E	1
3(d)(ii)	A	1
3(d)(iii)	D	1
3(d)(iv)	B and C	1

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4 The table gives some information about four different particles, **A**, **B**, **C** and **D**.

particle	number of electrons	number of neutrons	number of protons	electronic structure	charge on particle
A	11	12	11	2,8,1	0
B		14	11	2,8,1	0
C	18	20		2,8,8	0
D	18	20	17		

(a) Complete the table. The first row has been done for you. [4]

(b) Give **two** particles from the table which are isotopes of each other.

..... [1]

(c) Element **Z** is in the same group of the Periodic Table as **A** and is less reactive than **A**.

State the identity of element **Z**.

..... [1]

(d) **C** is unreactive.

Use information from the table to explain why.

..... [1]

[Total: 7]

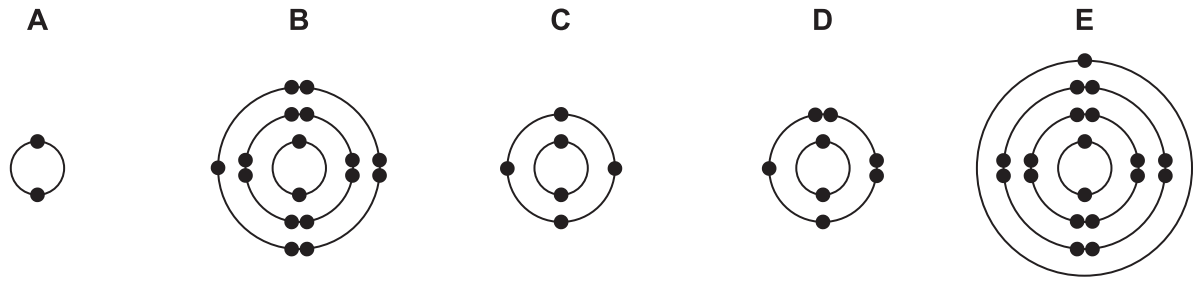
Protons, neutrons, electrons and electronic configuration Click for more variations

Reduced to 77% to fit the page (wider than A4).

4(a)	**M1** 11 **M2** 18 **M3** 2.8.8 **M4** –1	**4**
4(b)	A **and** B	**1**
4(c)	Li / Lithium	**1**
4(d)	it has a complete **or** full **or** 8 electrons in the outer shell	**1**

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5 **(a)** The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(i) an atom of an element in Group VI of the Periodic Table

..... [1]

(ii) an atom of a reactive metal

..... [1]

(iii) an atom with a proton number of 17

..... [1]

(iv) an atom that forms a stable ion with a charge of 2–

..... [1]

(v) an atom of oxygen.

..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the bromine atom and fluoride ion shown.

	number of electrons	number of neutrons	number of protons
$^{81}_{35}Br$	35		
$^{19}_{9}F^-$		10	

[3]

[Total: 8]

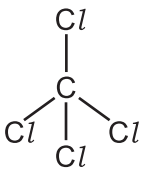
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Protons, neutrons, electrons and electronic configuration Click for more variations

5(a)(i)	D	1
5(a)(ii)	E	1
5(a)(iii)	B	1
5(a)(iv)	D	1
5(a)(v)	D	1
5(b)	number of electrons in F ion = 10 (1) number of neutrons in Br = 46 (1) number of protons in Br = 35 **AND** number of protons in F ion = 9 (1)	3

6 The structures of some substances containing chlorine are shown.

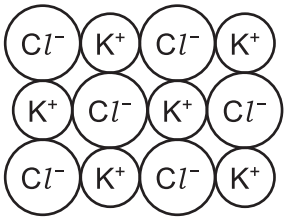
A



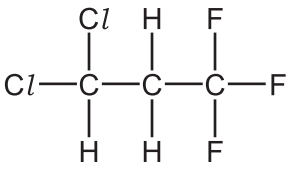
B



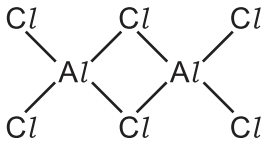
C



D



E



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

..... [1]

(ii) Which substance represents part of an ionic structure?

..... [1]

(iii) Which substance is an element?

Explain your answer.

.....

..... [2]

(iv) Determine the simplest formula for substance **D**.

..... [1]

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(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

(i) How do these two isotopes differ in their atomic structure?

..... [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{35}_{17}Cl$.

..... [1]

(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.

[2]

[Total: 9]

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Elements, compounds and mixtures Click for more variations

6(a)(i)	B / chlorine / Cl_2;	**1**
6(a)(ii)	C / KCl / potassium chloride;	**1**
6(a)(iii)	B; has only one type of atom;	**2** 1 1
6(a)(iv)	$C_3H_3F_3Cl_2$;	**1**
6(b)(i)	different number of neutrons / different mass numbers / different numbers of nucleons;	**1**
6(b)(ii)	18;	**1**
6(b)(iii)	7 electrons in the outer shell; first shell has 2 electrons and second shell has 8 electrons;	**2** 1 1

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7 **(a)** $^{32}_{16}S$ and $^{33}_{16}S$ are isotopes of sulfur.

Use your knowledge of protons, neutrons and electrons to answer the following questions.

(i) Describe how these isotopes of sulfur are the same and how they are different.

same .....

.....

different .....

.....

[3]

(ii) Explain why each of these isotopes have an overall charge of zero.

.....

..... [1]

(iii) Explain why both isotopes have the same chemical properties.

.....

..... [1]

(b) Sulfide ions, S^{2-}, have the electronic structure 2,8,8.

(i) Explain why sulfide ions have a charge of 2–.

.....

..... [1]

(ii) Give the formula of:

- an anion which has the same electronic structure as S^{2-}

.....

- a cation which has the same electronic structure as S^{2-}.

.....

[2]

[Total: 8]

Isotopes and relative atomic mass Click for more variations

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7(a)(i)	number of protons (are the same) / 16 protons (1) number of electrons (are the same) / 16 electrons (1) number of neutrons (are different) / 16,17 neutrons (1)	**3**
7(a)(ii)	**number** of protons is the same as (the number of) electrons	**1**
7(a)(iii)	same **number** of (outer shell) electrons	**1**
7(b)(i)	(they have) **two** more electrons than protons	**1**
7(b)(ii)	P^{3-} **OR** Cl^- (1) K^+ **OR** Ca^{2+} (1)	**2**

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8 The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
A	15	15	16
B	15	18	16
C	15	15	17

(a) What is the evidence in the table for each of the following?

(i) Particle **A** is an atom.

.....

..... [1]

(ii) They are all particles of the same element.

.....

..... [1]

(iii) Particle **B** is a negative ion.

.....

..... [2]

(iv) Particles **A** and **C** are isotopes.

.....

..... [2]

(b) (i) What is the electronic structure of particle **A**?

..... [1]

(ii) What is the valency of the element?

..... [1]

(iii) Is the element a metal or a non-metal? Give a reason for your choice.

.....

..... [1]

[Total: 9]

Isotopes and relative atomic mass Click for more variations

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8 **(a)** **(i)** same number of protons and electrons [1]

(ii) all have the same number of protons / same proton number / same atomic number [1]

(iii) more electrons than protons [2]
number of protons and electrons not equal **ONLY** [1]

(iv) same number of protons (and electrons) / same proton number / same atomic number [1]
different number of neutrons / different mass number / nucleon number [1]

(b) **(i)** 2 + 8 + 5 [1]

(ii) 3 / 5 [1]

(iii) non-metal because it accepts electrons
/ needs 3e to complete outer energy level
/ because it is in Group V or 5e in outer shell [1]
note need both non-metal and reason for [1]

[Total: 9]

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9 Atoms are made of electrons, neutrons and protons.

(a) Complete Table 2.1.

Table 2.1

particle	relative charge	relative mass
electron		$\frac{1}{1840}$
neutron	0	
proton		

[2]

(b) Atoms of the same element are known as isotopes.

$^{39}_{19}K$ and $^{41}_{19}K$ are isotopes of potassium.

(i) Complete Table 2.2 to show the number of electrons, neutrons and protons in one atom or ion of these isotopes.

Table 2.2

isotope	electrons	neutrons	protons
$^{39}_{19}K$			
$^{41}_{19}K^{+}$			

[3]

(ii) Table 2.3 shows the relative masses and the percentage abundances of the two isotopes in a sample of potassium.

Table 2.3

relative mass of isotope	percentage abundance of isotope
39	90
41	10

Calculate the relative atomic mass of this sample of potassium to **one** decimal place.

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relative atomic mass = ... [2]

(iii) An isotope of aluminium has a nucleon number of 27.

Aluminium has a relative atomic mass of 27.

State what conclusion can be made from this information.

.....

..... [1]

(c) A calcium atom has the electronic configuration of 2,8,8,2.

Give the formula of one atom and one negative ion that has the same electronic configuration as Ca^{2+}.

- atom .....
- negative ion .....

[2]

[Total: 10]

Isotopes and relative atomic mass Click for more variations

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9(a)

M1 charge (1)	**M2** mass(1)
–1	
	1
+1	1

1 mark for each correct column

2

9(b)(i)

electron	neutron	proton
19	20	19
18	22	19

1 mark for each correct column

3

9(b)(ii) **M1** $(41 \times 10) + (39 \times 90) = 3920$ (1)

M2 $(3920 \div 100) = 39.2$(1)

2

9(b)(iii) aluminium has only 1 isotope which has nucleon number 27

1

9(c) **M1** Ar (1)

M2 P^{3-} or S^{2-} or Cl^- (1)

2

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10 This question is about the structures of atoms and ions.

(a) Define the term *proton number*.

.....

..... [2]

(b) (i) Complete the table to show the number of protons, neutrons and electrons present in atoms of $^{24}_{12}Mg$ and $^{26}_{12}Mg$.

	number of protons	number of neutrons	number of electrons
$^{24}_{12}Mg$			
$^{26}_{12}Mg$			

[2]

(ii) What term is used to describe atoms of the same element, such as $^{24}_{12}Mg$ and $^{26}_{12}Mg$?

..... [1]

(iii) Explain why the chemical properties of $^{24}_{12}Mg$ and $^{26}_{12}Mg$ are the same.

.....

..... [2]

(c) Complete the table to identify the atoms and ions which have the following numbers of protons, neutrons and electrons.

	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na^{+}$	11	12	10
	4	5	4
	17	20	18

[4]

(d) State the electronic structure of the following atom and ion.

Al .....

S^{2-} .....

[2]

[Total: 13]

Protons, neutrons, electrons and electronic configuration Click for more variations

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10(a)	number of protons (1) protons in the nucleus (of an atom) (1)	**2**
10(b)(i)	12p 12n 12e (1) 12p 14n 12e (1)	**2**
10(b)(ii)	isotope(s)	**1**
10(b)(iii)	same number of electrons (1) (same number) of electrons in the outer shell (1)	**2**
10(c)	$^{9}_{4}Be$ any element symbol with a single negative charge (1) use of C*l* (1) use of $^{37}_{17}$ (1)	**4**
10(d)	2 8 3 (1) 2 8 8 (1)	**2**

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