

## Theory Questions

# Atomic Structure & the Periodic Table

Elements, Compounds & Mixtures / Atomic Structure / Electronic Configuration / Isotopes

Easy (7 questions)	/47
Medium (11 questions)	/91
Hard (5 questions)	/47
<b>Total Marks</b>	<b>/185</b>

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# Easy Questions

1 (a) Cobalt is an element in Period 4 of the Periodic Table.

Use your copy of the Periodic Table to help you complete the table below.

particle	number of protons	number of neutrons	number of electrons
Co			
Co <sup>2+</sup>			

(2 marks)

## (b) Extended Only

<sup>60</sup>Co is an isotope.

i) Explain the term isotope.

[2]

ii) Explain why two isotopes of the same element have identical chemical properties.

[1]

(3 marks)

2 (a) Substances can be classified as:

elements   mixtures   compounds

Elements can be divided into:

metals   non-metals

Define each of the following terms.

i) element

[2]

ii) compound

[2]

iii) mixture

[1]

.....

.....

.....

.....

.....

**(5 marks)**

**(b)** Classify each of the following as either an element, compound or mixture.

i) brass .....

[1]

ii) carbon dioxide .....

[1]

iii) copper .....

[1]

.....  
.....  
.....

**(3 marks)**

**(c)** Which physical property is used to distinguish between metals and non-metals?

It is possessed by all metals but by only one non-metal.

.....

**(1 mark)**

**3** Complete the following table which gives the number of protons, electrons and neutrons in each of the five particles.



4 (a) Define the term *isotope*.

.....

.....

(2 marks)

(b) The table gives information about four particles, **A**, **B**, **C** and **D**.

Complete the table.

The first line has been done for you.

particle	number of protons	number of electrons	number of neutrons	nucleon number	symbol or formula
<b>A</b>	6	6	6	12	C
<b>B</b>	11	10	12		
<b>C</b>	8		8		O <sup>2-</sup>
<b>D</b>		10		28	Al <sup>3+</sup>

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(7 marks)

5 (a) Magnesium, calcium and strontium are Group II elements.

Complete **Table 3.1** to show the electronic configuration of a calcium atom.

**Table 3.1**

shell	1st	2nd	3rd	4th
number of electrons				

.....  
(1 mark)

(b) Describe how the electronic configuration of a strontium atom is similar to the electronic configuration of a calcium atom.

.....  
(1 mark)

(c) Describe how the electronic configuration of a strontium atom is different from the electronic configuration of a calcium atom.

.....  
(1 mark)

6 (a) Complete the table to show the relative charge and approximate relative mass of a proton, a neutron and an electron.

type of particle	relative charge	approximate relative mass
proton		1
neutron		
electron	-1	

.....

.....

.....

.....

**(4 marks)**

(b) Deduce the number of electrons and neutrons in an atom of the isotope of potassium shown.



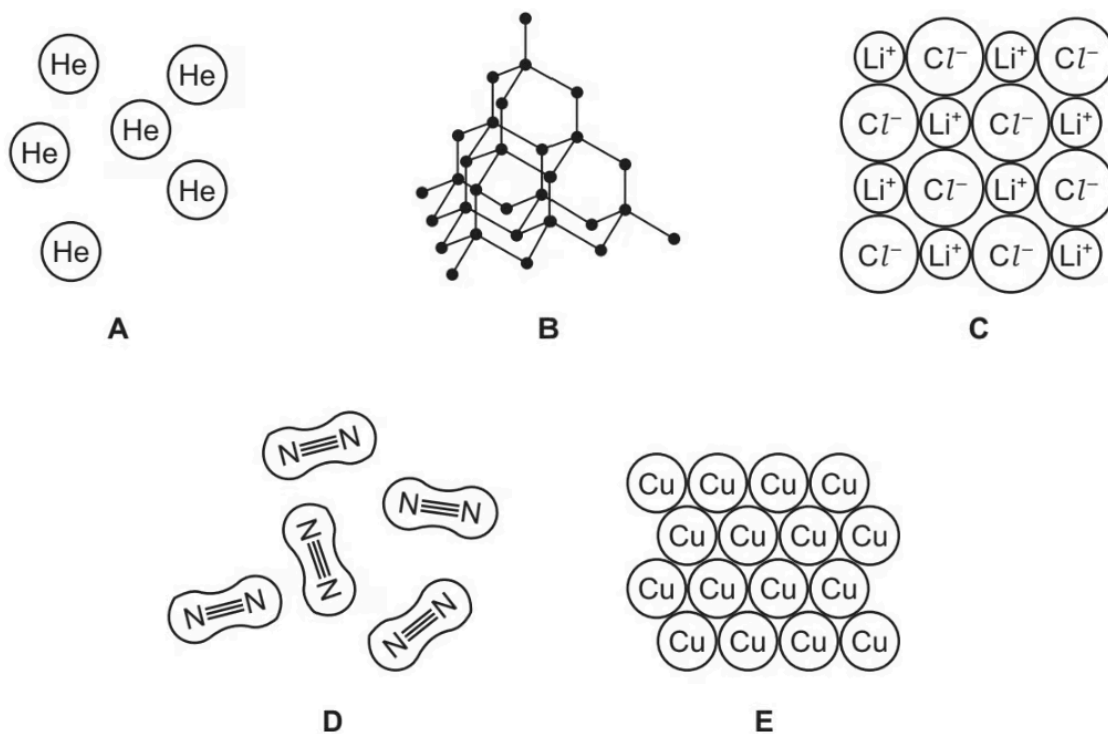
number of electrons:    number of neutrons:

.....

.....

**(2 marks)**

7 (a) The diagrams show part of the structures of five substances, A, B, C, D and E.



Answer the following questions about these structures.

Each structure may be used once, more than once or not at all.

Which one of these structures, A, B, C, D or E, is a compound?

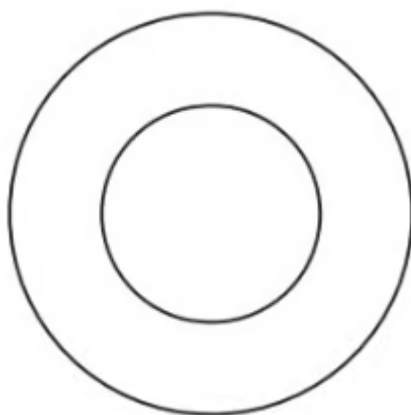
.....  
(1 mark)

(b) Substance B is an element.

What is meant by the term *element*?

.....  
(1 mark)

(c) Complete the diagram to show the electron arrangement in an oxygen atom.



(1 mark)

(d) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and copper ion shown.

	number of electrons	number of neutrons	number of protons
${}^{34}_{16}\text{S}$			
${}^{63}_{29}\text{Cu}^{2+}$			29

(4 marks)

# Medium Questions

1 (a) The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
<b>A</b>	15	15	16
<b>B</b>	15	15	16
<b>C</b>	15	15	17

What is the evidence in the table for each of the following?

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

[1]

ii) **A**, **B** and **C** are all particles of the same element.

[1]

iii) Particles **A** and **C** are isotopes of the same element.

[2]

.....

.....

.....

.....

(4 marks)

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

[1]

ii) Is element **A**, a metal or a non-metal? Give a reason for your choice.

[1]

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**(2 marks)**

2 (a) Protons, neutrons and electrons are subatomic particles.

Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

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

[3]

(3 marks)

(b) **Extended Only**

Bromine has two isotopes.

i) Define the term isotope.

[2]

ii) Explain why the two isotopes of bromine have the same chemical properties.

[2]

(4 marks)

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
${}^7_3\text{Li}$			
${}^{34}_{16}\text{S}^{2-}$			
	19	22	18

(5 marks)

3 (a) i) Define the term atomic number.

[1]

ii) Define the term nucleon number.

[2]

.....

.....

.....

**(3 marks)**

(b) The table shows the number of protons, neutrons and electrons in some atoms or ions.

Complete the table. The first line is given as an example.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	6	6	6	$^{12}_6\text{C}$
B	12	12	12	
C	8			$^{16}_8\text{O}^{2-}$
D	11	10	13	

.....

.....

.....

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**(5 marks)**

4 (a) The table below gives information about particles.

Complete the table. The first line has been done for you.

particle	number of protons	number of electrons	electronic configuration	charge on particle
A	12	10	2,8	2+
B		18	2,8,8	1-
C	18		2,8,8	0
D	8	10		

.....

.....

.....

.....

(4 marks)

(b) Gallium is a Group III element.

Define the term *element*.

.....

(1 mark)

(c) The following are gallium atoms.



Complete the following table.

atom	number of protons	number of neutrons	number of electrons
${}^{69}_{31}\text{Ga}$			
${}^{71}_{31}\text{Ga}$			

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**(3 marks)**

5 (a) The table below gives the composition of six particles which are either atoms or ions.

Particle	number of protons	number of neutrons	number of electrons
<b>A</b>	33	40	33
<b>B</b>	19	20	18
<b>C</b>	34	45	36
<b>D</b>	33	42	33
<b>E</b>	13	14	13
<b>F</b>	24	28	21

Which particles are atoms? Explain your choice.

.....  
.....

**(2 marks)**

(b) Which particle is a negative ion and why has this particle got a negative charge?

.....  
.....

**(2 marks)**

(c) Which particles are positive ions?

.....

**(1 mark)**

(d) Explain why particle **A** and particle **D** are isotopes.

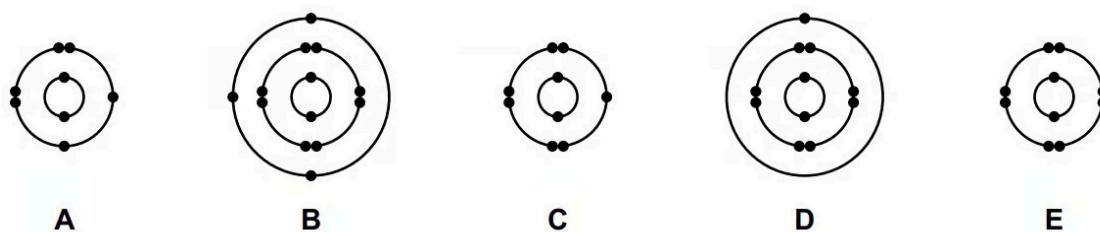
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(2 marks)

6 (a) Figure 1.1 shows the electronic configurations of five atoms, A, B, C, D and E.

Figure 1.1



Each letter may be used once, more than once or not at all.

Give the letter of the atom, A, B, C, D or E, that is in Group III of the Periodic Table.

.....  
(1 mark)

(b) Give the letter of the atom, A, B, C, D or E, that has 13 protons.

.....  
(1 mark)

(c) Give the letter of the atom, A, B, C, D or E, that is a noble gas.

.....  
(1 mark)

(d) Give the letter of the atom, A, B, C, D or E, that forms a stable ion with a single negative charge.

.....  
(1 mark)

7 (a) Sulfuric acid is a compound.

Define the term compound.

.....  
(1 mark)

(b) Complete **Table 2.1** to show the number of electrons, neutrons and protons in the sulfur atom and oxide ion.

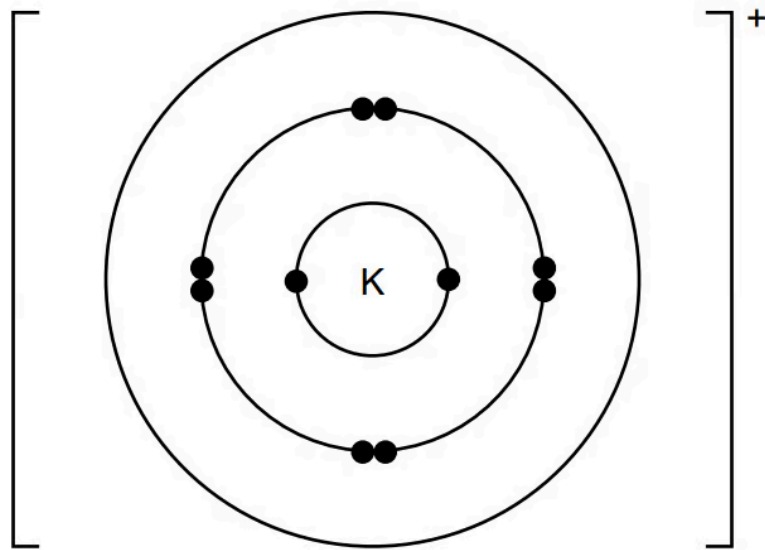
**Table 2.1**

	number of electrons	number of neutrons	number of protons
${}_{16}^{34}\text{S}$	16		
${}_{8}^{18}\text{O}^{2-}$		10	

.....  
.....  
.....  
(3 marks)

(c) Complete **Figure 2.2** to show the electronic configuration of a potassium ion.

Figure 2.2



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(1 mark)

**8 (a)** This question is about elements **X**, **Y** and **Z**.

An atom of element **X** is represented as  ${}_{16}^{34}\text{X}$

Name the different types of particles found in the nucleus of this atom of **X**.

.....  
.....

**(2 marks)**

**(b)** What is the term for the total number of particles in the nucleus of an atom?

.....

**(1 mark)**

**(c)** What is the total number of particles in the nucleus of an atom of  ${}_{16}^{34}\text{X}$  ?

.....

**(1 mark)**

**(d)** What is the electronic structure of the ion  $\text{X}^{2-}$ ?

.....

**(1 mark)**

**(e)** What term is used to describe atoms of the same element with different numbers of particles in the nucleus?

.....

**(1 mark)**

**(f) Separate: Chemistry and Extended Only**

Part of the definition of relative atomic mass is 'the average mass of naturally occurring atoms of an element'. Some relative atomic masses are not whole numbers. Element Y has only two different types of atom,  $^{69}\text{Y}$  and  $^{71}\text{Y}$ . The ratio of atoms present in element Y is shown.

$$^{69}\text{Y} : ^{71}\text{Y} = 3 : 2$$

- Calculate the relative atomic mass of element Y to one decimal place.

relative atomic mass: .....

- Identify element Y.
- element Y: .....

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**(3 marks)**

**(g)** Element Z is in Period 3 and Group V.

Explain in terms of electron transfer why Z behaves chemically as a non-metal.

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**(2 marks)**

### 9 (a) Extended Only

Chlorine is in Group VII of the Periodic Table. Two isotopes of chlorine are chlorine-35 and chlorine-37

State why these two isotopes of chlorine have the same chemical properties.

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**(2 marks)**

- (b)** Chlorine is in Group VII of the Periodic Table. Two isotopes of chlorine are chlorine-35 and chlorine-37.

Complete the table to show the number of electrons, neutrons and protons in each atom and ion.

	number of electrons	number of neutrons	number of protons
$^{35}_{17}\text{Cl}$			
$^{37}_{17}\text{Cl}^-$			

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**(3 marks)**

- (c)**  $^{22}_{11}\text{Na}$ ,  $^{23}_{11}\text{Na}$  and  $^{24}_{11}\text{Na}$  are isotopes of sodium.

Describe how these sodium isotopes are the same and how they are different in terms of the total number of protons, neutrons and electrons in each.

same:

different:

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**(3 marks)**

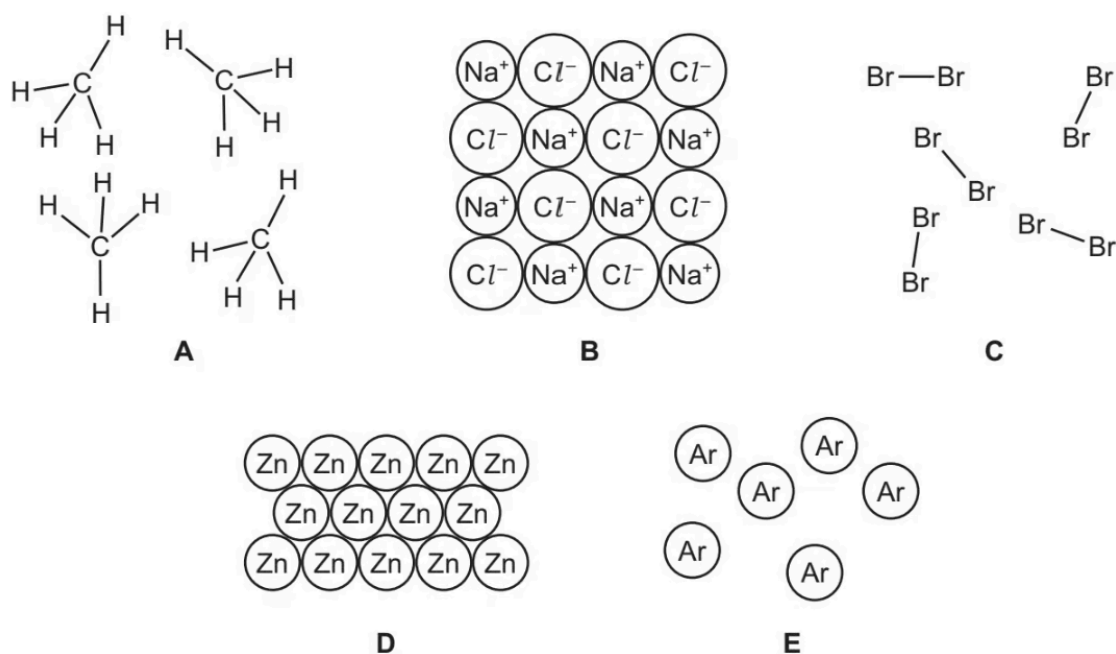
**(d)**  ${}_{11}^{22}\text{Na}$ ,  ${}_{11}^{23}\text{Na}$  and  ${}_{11}^{24}\text{Na}$  are isotopes of sodium.

Why do all three isotopes have an overall charge of zero?

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**(1 mark)**

10 (a) The diagram shows part of the structures of five substances, **A**, **B**, **C**, **D** and **E**.



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

Which two of these structures, **A**, **B**, **C**, **D** or **E**, are compounds?

.....

.....

(2 marks)

(b) Substance **E** is present in air. Air is a mixture of different gases. Describe **two** characteristics of a mixture.

.....

.....

(2 marks)

(c) Complete the table to show the number of electrons, protons and neutrons in the sulfur atom and zinc ion shown.

	number of electrons	number of neutrons	number of protons
${}^{36}_{16}\text{S}$			
${}^{67}_{30}\text{Zn}^{2+}$			30

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(4 marks)

11 (a) This question is about the structures of atoms and ions.

Define the term *proton number*.

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(2 marks)

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

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

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(2 marks)

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

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(1 mark)

(d) **Extended Only**

Explain why the chemical properties of  ${}_{12}^{24}\text{Mg}$  and  ${}_{12}^{26}\text{Mg}$  are the same.

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(2 marks)

(e) 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
${}_{11}^{23}\text{Na}^+$	11	12	10
	4	5	4
	17	20	18

.....

.....

.....

.....

(4 marks)

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

Al:

$\text{S}^{2-}$ :

.....

.....

(2 marks)

# Hard Questions

1 (a) The symbols of six particles are shown below.

Na <sup>+</sup>	Ca <sup>2+</sup>	Kr	P	Si	O <sup>2-</sup>
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Select from the list of particles to answer the following questions. A particle may be selected once, more than once or not at all.

i) Which **two** ions have the same electronic structure?

[1]

ii) Which ion has the same electronic structure as an atom of argon?

[1]

iii) Which atom can form an ion of the type X<sup>3-</sup>?

[1]

iv) Which atom can form a hydride which has a formula of the type XH<sub>4</sub>?

[1]

.....

.....

.....

.....

**(4 marks)**

(b) i) How many protons, neutrons and electrons are there in one copper(II) ion  ${}^{64}_{29}\text{Cu}^{2+}$

[2]

ii)  ${}_{21}^{45}\text{Sc}$  represents an atom of scandium. How many nucleons and how many charged particles are there in one atom of scandium?

[2]

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**(4 marks)**

(c) Two different atoms of sodium are  ${}_{11}^{23}\text{Na}$  and  ${}_{11}^{24}\text{Na}$ .

i) Explain why these two atoms are isotopes.

[2]

ii)  ${}_{11}^{24}\text{Na}$  is radioactive. It changes into an atom of a different element which has one more proton. Identify this element.

[1]

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**(3 marks)**

2 (a) The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
<b>A</b>	15	15	16
<b>B</b>	15	18	16
<b>C</b>	15	15	17

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]

.....

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.....

.....

.....

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**(6 marks)**

**(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]

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**(3 marks)**

**3 (a)** Complete the table which gives the names, symbols, relative masses and relative charges of the three subatomic particles.

name	symbol	relative mass	relative charge
electron			
proton		1	
	n		0

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**(3 marks)**

**(b)** Use the information in the table to explain the following.

i) Atoms contain charged particles but they are electrically neutral because they have no overall charge.

[2]

ii) Atoms can form positive ions.

[2]

iii) Atoms of the same element can have different masses.

[2]

iv) Scientists are certain that there are no undiscovered elements missing from the Periodic Table from hydrogen to lawrencium.

[1]

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**(7 marks)**

4 (a) The table below gives the number of protons, neutrons and electrons in atoms or ions.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	9	10	10	${}^{19}_{9}\text{F}^{-}$
B	11	11	12	
C	18	18	22	
D	15	18	16	
E	13	10	14	

Complete the table. The first line is given as an example.

.....

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.....

.....

(6 marks)

(b) Which atom in the table is an isotope of the atom which has the composition 11p, 11e and 14n?

Give a reason for your choice.

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**(2 marks)**

5 (a) This question is concerned with the elements in Period 5, Rb to Xe.

The electron distributions of some of these elements are given in the following list.

- element A  $2 + 8 + 18 + 10$
- element B  $2 + 8 + 18 + 18 + 8$
- element C  $2 + 8 + 18 + 18 + 5$
- element D  $2 + 8 + 18 + 18 + 6$
- element E  $2 + 8 + 18 + 18 + 4$
- element F  $2 + 8 + 18 + 18 + 7$

i) Identify element C.

[1]

ii) Which element in the list does not form any compounds?

[1]

iii) Which element in the list forms a chloride of the type  $XCl_2$ ?

[1]

iv) Which two elements would react together to form a compound of the type  $XY_4$ ?

[1]

v) Which element in the list would react with cold water to form an alkaline solution and hydrogen?

[1]

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**(5 marks)**

**(b)** Predict two differences in physical properties and two differences in chemical properties between rubidium and the transition metal niobium.

physical .....

chemical .....

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**(4 marks)**