

Atomic Structure Part 7

Q1.

The drawing shows a container of a compound called magnesium chloride.



- (i) How many elements are joined together to form magnesium chloride?

_____ (1)

- (ii) Magnesium chloride is an ionic compound. What are the names of its ions?

_____ ions and _____ ions (1)

- (iii) How many **negative** ions are there in the formula for magnesium chloride?

_____ (1)

- (iv) Complete the sentence.

Ions are atoms, or groups of atoms, which have lost or gained

_____ . (1)

- (v) Suggest **three** properties which magnesium chloride has because it is an ionic compound.

Property 1 _____

Property 2 _____

Property 3 _____

(3)
(Total 7 marks)

Q2.

Ammonium nitrate and ammonium sulphate are used as fertilisers.



- (i) Which acid reacts with ammonia to form ammonium nitrate?

_____ (1)

- (ii) Which acid reacts with ammonia to form ammonium sulphate?

_____ (1)

- (iii) The reactions in (i) and (ii) are both exothermic. How can you tell that a reaction is exothermic?

_____ (1)

- (iv) The reactions in (i) and (ii) are both examples of acid + base reactions. What is the name of the chemical change which takes place in every acid + base reaction?

_____ (1)

(Total 4 marks)

Q3.

Potassium reacts violently with cold water.

It forms an alkaline solution of potassium hydroxide and hydrogen.



(a) In what physical state is hydrogen given off?

Choose your answer from the words in the box.

gas	liquid	solid	solution
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_____ (1)

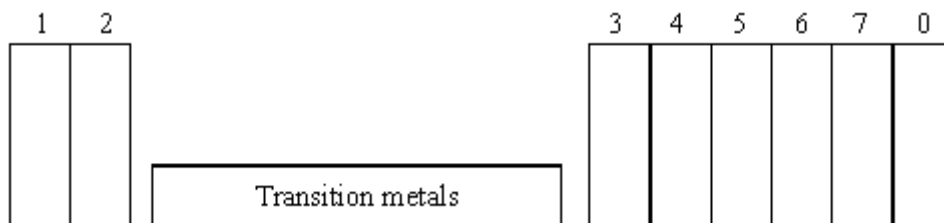
(b) (i) What type of substance will neutralise potassium hydroxide solution?

_____ (1)

(ii) What is the pH of the neutral solution?

_____ (1)

(c) In the Periodic Table there are eight main groups.



What is the number of the group that has potassium in it?

_____ (1)

(d) Sodium is in the same group as potassium.

(i) How does sodium react with cold water and what is formed?

_____ (2)

(ii) How can you prove that an alkaline solution is formed when sodium reacts with water?

_____ (2)

(e) Lithium reacts more slowly with cold water than sodium.

State **two** ways the reaction can be made to go faster.

Q4.

Part of the Periodic Table showing the symbols for the first twenty elements is given below.

			H						He
Li	Be			B	C	N	O	F	Ne
Na	Mg			Al	Si	P	S	Cl	Ar
K	Ca	Transition metals							

(a) Draw diagrams showing the arrangement of electrons (electronic structures) in:

(i) an aluminium atom;

(ii) a chlorine atom.

(2)

(b) (i) Use electronic structures to help you show why the formula of sodium oxide is Na_2O .

(3)

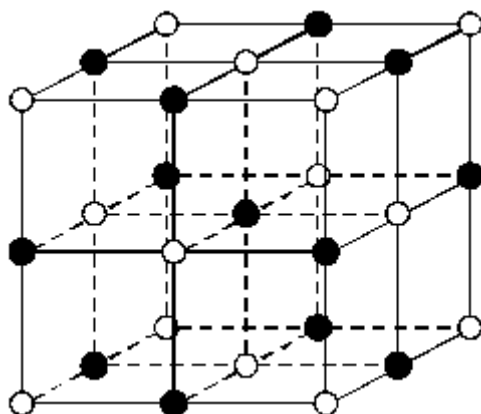
(ii) State why the formation of sodium ions is classified as an oxidation.

(1)

(Total 6 marks)

Q5.

(a) The diagram shows part of the ionic lattice of a sodium chloride crystal.



(i) Complete the spaces in the table to give information about **both** of the ions in this lattice.

Name of ion	Charge
_____	_____
_____	_____

(2)

(ii) When it is solid, sodium chloride will not conduct electricity. However, molten sodium chloride will conduct electricity. Explain this difference.

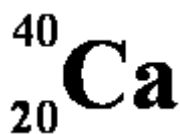
(2)

(iii) Complete the sentence.

Sodium chloride conducts electricity when it is molten and when it is

(1)

(b) The symbol for a calcium atom can be shown like this:



(i) What is the mass number of this atom?

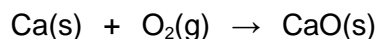
(1)

(ii) What information is given by the mass number?

(1)

(c) Calcium burns in oxygen with a brick-red flame. The product is a white solid. It is calcium oxide and its formula is CaO.

(i) Balance the chemical equation for the reaction.



(1)

(ii) Describe, in terms of electrons, what happens to a calcium atom when it becomes a calcium ion.

(2)

(Total 10 marks)

Q6.

Part of the Periodic Table is shown below. The symbol for helium is given.

						He

transition metals

(a) (i) What name is given to the group that contains helium?

(1)

(ii) Give **one** use for helium and explain why it is used.

(2)

(iii) What is the name of another element in the same group as helium?

(1)

(iv) Write the symbol for this element.

(1)

(b) Give the names of **two** other elements not in Group 0 that are gases at room temperature.

_____ and _____

(2)

(c) The alkali metals are in Group I of the Periodic Table.

Give the name and the symbol of **one** alkali metal.

Name _____ Symbol _____

(2)

(d) Alkali metals have low melting points.

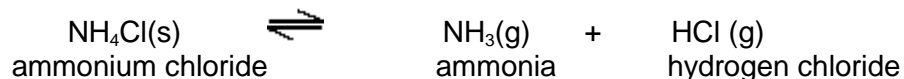
Give another physical property of the alkali metals.

(1)

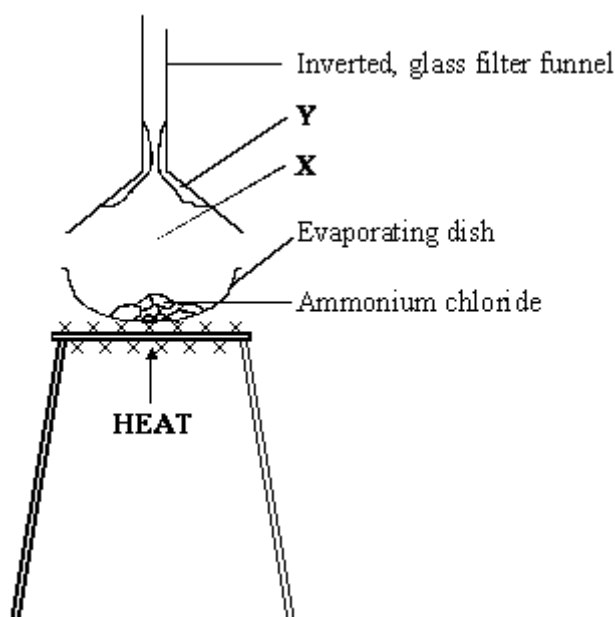
(Total 10 marks)

Q7.

(a) The equation for the reaction that takes place when ammonium chloride is heated is:



The diagram shows how a teacher demonstrated this reaction. The demonstration was carried out in a fume cupboard.



(i) Apart from the gases normally in the atmosphere, which two gases would be at X?

_____ and _____

(1)

(ii) Name the white solid that has formed at **Y**.

(1)

(iii) Why was the demonstration carried out in a fume cupboard?

(1)

(iv) Complete the **four** spaces in the passage.

The chemical formula of ammonia is NH_3 . This shows that there is one atom of _____ and three atoms of _____ in each _____ of ammonia. These atoms are joined by bonds that are formed by sharing pairs of electrons. This type of bond is called a _____ bond.

(4)

(b) Electrons, neutrons and protons are sub-atomic particles.

(i) Complete the **three** spaces in the table.

Name of sub-atomic particle	Relative mass	Relative charge
_____	1	+1
_____	1	0
_____	$\frac{1}{1840}$	-1

(2)

(ii) Which **two** sub-atomic particles are in the nucleus of an atom?

_____ and _____

(1)

(Total 10 marks)

Q8.

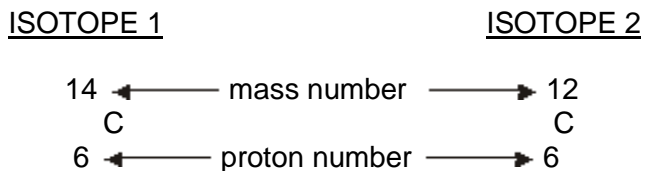
Choose words from this list to complete the sentences below.

carbonate chloride compound mixture oxide solution

- (a) When two elements react, the new substance formed is called a _____ . (1)
- (b) The white powder formed when zinc reacts with oxygen is called zinc _____ . (1)
- (Total 2 marks)

Q9.

The two carbon atoms represented below are isotopes.



- (a) Describe **two** ways in which the isotopes are similar.

(2)

- (b) Describe as fully as you can **one** way in which they are different.

(2)

(Total 4 marks)

Q10.

- (a) The diagram shows the electronic structure of a particular element.



In a similar way, show the electronic structure of another element from the same group in the periodic table and name the element you select.

Name of element selected _____

(4)

- (b) The element lithium gives a moderate reaction with cold water, releasing hydrogen and forming a solution of lithium hydroxide.

Describe how sodium is similar to and how it is different from lithium in its chemical reaction with cold water.

Explain any similarity or difference in terms of their atomic structure.

Similarity. _____

Reason. _____

Difference. _____

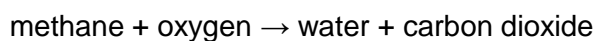
Reason. _____

(5)

(Total 9 marks)

Q11.

Here is the word equation for a chemical reaction.



Write down everything that the word equation tells you about the reaction.

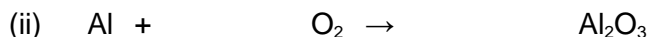
(Total 4 marks)

Q12.

- (a) Balance these chemical equations.



(1)



(1)

- (b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

(2)

(Total 4 marks)

Q13.

Sodium carbonate reacts with acids.

- (i) Complete the word equation.

sodium carbonate + hydrochloric acid \rightarrow sodium chloride + _____ + water

(1)

- (ii) Name the salt produced if sodium carbonate reacts with dilute nitric acid.

(1)

(Total 2 marks)

Q14.

The table shows the properties of four elements from Group VII of the Periodic Table.

Element	Proton Number	Electronic structure	Boiling point (°C)	Melting point (°C)	State at 20°C	Reaction with hydrogen	
						Ease	Product
Fluorine		2.7	-188	-218	gas	Explosive reaction in dull light	hydrogen fluoride
Chlorine	17		-34	-101		Explosive reaction in sunlight	hydrogen chloride
Bromine	35	2.8.18.7	+59	-7		React if heated	hydrogen bromide
Iodine	53	2.8.18.18.7	+185	+114	solid	React if heated strongly	hydrogen iodide

- (a) Complete the spaces in the table.

(4)

- (b) Comment briefly on the trend in melting points for these four elements.

(1)

(c) Explain, in as much detail as you can:

(i) why the reactions of these elements with hydrogen are similar.

(ii) why their reactivity with hydrogen decreases from fluorine to iodine.

(4)

(Total 9 marks)

Q15.

(a) The formula for ammonia is NH_3 . What does the formula tell you about each molecule of ammonia?

(3)

(b) Ammonia is used to make nitric acid (HNO_3). Calculate the formula mass (Mr) for nitric acid. (Show your working).

(3)

(Total 6 marks)

Q16.

(a) Balance these chemical equations.



(1)

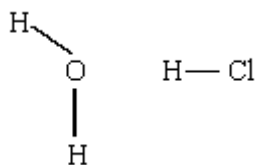


(1)

- (b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

(2)

- (c) Explain, as fully as you can, why a water molecule contains two hydrogen atoms but a hydrogen chloride molecule contains only one.



(You may use a diagram in your answer if you wish).

(3)

(Total 7 marks)

Q17.

You will find it helpful to use the information on the Data Sheet when answering this question.

In the nucleus of an aluminium atom are:

13 protons
and 14 neutrons.

- (a) Complete these sentences.

- (i) The mass number of the aluminium atom is _____ .
(ii) In an atom of aluminium there are _____ electrons.

(2)

- (b) Why is an aluminium atom electrically neutral?

(2)

(c) Complete the table for the element fluorine.

PARTICLE	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
Fluorine atom	9		9
Fluoride atom		10	

(3)

(Total 7 marks)

Q18.

The formula for the compound hydrogen peroxide is H_2O_2 .

Write down everything that the formula tells you about each molecule of hydrogen peroxide.

(Total 4 marks)

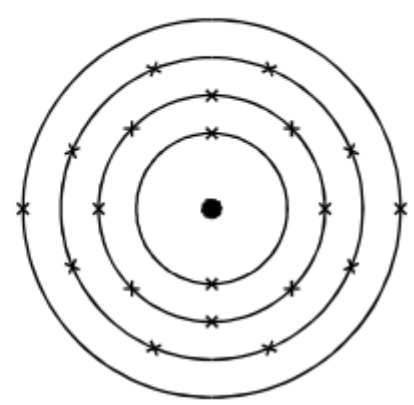
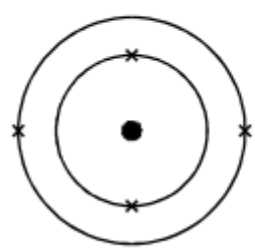
Q19.

Three elements in Group 2 of the periodic table are beryllium (Be), magnesium (Mg) and calcium (Ca). Their mass numbers and proton numbers are shown below. The electronic structure is shown for beryllium and calcium.

9
Be
4

24
Mg
12

40
Ca
20



(a) In a similar way, draw the electronic structure for magnesium.

(3)

- (b)
- The three elements have similar chemical properties
 - The reactivity of these elements with non-metals, increases from beryllium to magnesium to calcium.

Explain these two statements in terms of atomic structure.

(6)

(Total 9 marks)

Q20.

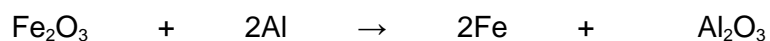
The information on the Data Sheet will be helpful in answering this question.

- (a) Calculate the formula mass (M_r) of the compound iron (III) oxide, Fe_2O_3 .
(Show your working.)

(3)

- (b) Calculate the mass of iron produced when 32g of iron (III) oxide is completely reduced by aluminium.

The reaction is shown in the symbol equation:



(Show your working.)

Answer = _____ grams

Q21.

Atoms of calcium, phosphorus and fluorine are represented below, each with its mass number and proton number.

40	31	19	← mass numbers
Ca	P	F	
20	15	9	← proton numbers

(a) Use this information to complete the table.

	CALCIUM	PHOSPHORUS	FLUORINE
Number of protons in the nucleus	20		9
Number of neutrons in the nucleus	20	16	
Number of electrons		15	9

(3)

(b) Calcium and fluorine atoms can combine to form the compound calcium fluoride, CaF_2 .

The fluoride ion is represented by F^- .

(i) Explain how the fluorine atom forms a fluoride ion.

(2)

(ii) How is the calcium ion represented?

(2)

(c) Phosphorus and fluorine form a covalent compound, phosphorus trifluoride.

Complete the sentences below which are about this compound.

Phosphorus trifluoride is made up of phosphorus and fluorine _____

These are joined together by sharing pairs of _____ to form

phosphorus trifluoride _____ .

(3)

(d) (i) Sodium chloride, an ionic compound, has a high melting point whereas paraffin wax, a molecular compound, melts easily.

Explain why.

(2)

- (ii) Molten ionic compounds conduct electricity but molecular compounds are non-conductors, even when liquid.

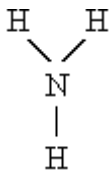
Explain why.

(2)

(Total 14 marks)

Q22.

The diagram shows one molecule of the compound ammonia.



Write down everything that the diagram tells you about each molecule of ammonia.

(Total 4 marks)

Q23.

Here is a symbol equation, with state symbols, for a chemical reaction between solutions of lead nitrate and potassium chloride.



The equation tells you the formulae of the two products of the reaction.

- (a) What are the names of the **two** products?

1. _____

2. _____

(2)

(b) What else does the equation tell you about these products?

(2)

(Total 4 marks)

Q24.

The electronic structures of five elements, V, W, X, Y and Z are shown below.

$\frac{V}{2.1}$	$\frac{W}{2.6}$	$\frac{X}{2.8.4}$	$\frac{Y}{2.5}$	$\frac{Z}{2.8.6}$
-----------------	-----------------	-------------------	-----------------	-------------------

(a) (i) Write the letters of the **two** elements which belong to the same group in the Periodic Table _____

(ii) To which group do they belong? _____

(2)

(b) Write the letters of **two** elements that are gases _____

(1)

(c) Lithium, sodium and potassium are the first three elements in Group 1 of the Periodic Table.

(i) Lithium reacts with cold water to produce lithium hydroxide and hydrogen.

Describe how the reaction between sodium and water is

(A) similar and **(B)** different to that between lithium and water.

(A) Similar _____

(B) Different _____

(3)

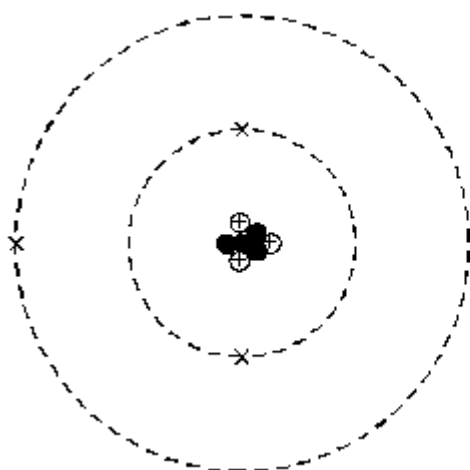
(ii) Potassium is much more reactive than lithium.

Explain this in terms of their electronic structures.

(3)
(Total 9 marks)

Q25.

The diagram shows the structure of a lithium atom.



KEY

⊕ = proton

x = electron

(a) (i) What is represented by ● _____

(ii) What is represented by  _____

(2)

(b) What is the symbol for lithium? _____

(1)

(Total 3 marks)

Q26.

The diagram shows part of the periodic table.

Group 1		Group 2					Group 3		Group 4	Group 5	Group 6	Group 7	Group 0
23 sodium 11	24 magnesium 12			27 aluminium 13	28 silicon 14	31 phosphorous 15	32 sulphur 16	35 chlorine 17	40 argon 18				

Choose from the elements shown in the table:

- (a) one metal _____ (1)
- (b) a noble gas _____ (1)
- (c) a coloured gas _____ (1)
- (Total 3 marks)**

Q27.

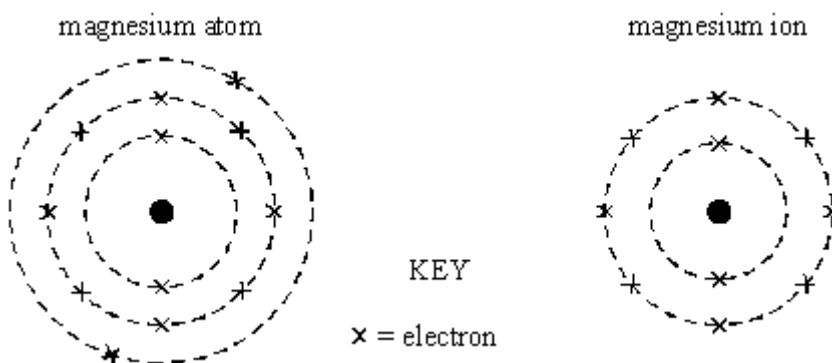
Sodium reacts with water to produce hydrogen gas and a solution of sodium hydroxide.

Complete the **word** equation for this reaction (do **not** use symbols or formulae).

_____ + _____ _____ + _____
(Total 3 marks)

Q28.

- (a) The diagrams below show the electronic structure of a magnesium atom and a magnesium ion.



What is the charge on the magnesium ion? _____ (2)

- (b) Calcium bromide has the formula CaBr_2 .

What does this tell you about the ions in this compound?

(Total 4 marks)

Q29.

The idea of a periodic table of the elements was started by John Newlands about 140 years ago.

He wrote down the elements he knew about in order, starting with the lightest atoms.

Then he arranged them into seven groups, like this:

1	2	3	4	5	6	7
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca				

- (a) Write down **three** differences between the groups in Newlands' periodic table and the groups in the modern periodic table (up to the element Ca, which is calcium).

(3)

- (b) Suggest one reason why this part of Newlands' table was different from the modern one.

(1)

(Total 4 marks)

Q30.

The idea of a periodic table of the elements was started by John Newlands about 140 years ago.

He wrote down the elements he knew about in order, starting with the lightest atoms.

Then he arranged them into seven groups, like this:

1	2	3	4	5	6	7
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca				

- (a) Write down **three** differences between the groups in Newlands' periodic table and the groups in the modern periodic table (up to the element Ca, which is calcium).

(3)

(b) Suggest **one** reason why this part of Newlands' table was different from the modern one.

(1)

(c) Dimitri Mendeleev later developed the periodic table of the elements. He arranged the elements according to their properties and their relative atomic masses.

The diagram shows where Mendeleev put tellurium (Te) and iodine (I) in his table because of their properties.

(The diagram uses present day symbols and the atomic numbers of the elements have been added to Mendeléev's table.)

	GROUP 6	GROUP 7	
	$^{16}_8\text{O}$	$^{19}_9\text{F}$	
	$^{32}_{16}\text{S}$	$^{35.5}_{17}\text{Cl}$	
		$^{80}_{35}\text{Br}$	
	$^{128}_{52}\text{Te}$	$^{127}_{53}\text{I}$	

(i) What is wrong with this arrangement of tellurium and iodine in terms of their relative atomic masses?

(1)

(ii) Explain why this is not a problem in the modern periodic table.

(2)
(Total 7 marks)

Q31.

These are the electronic structures of the atoms of three different elements.

2.8.1
element A

2.8.8
element B

2.8.8.1
element C

- (a) Identify elements A and B.

Element A is _____

Element B is _____

(2)

- (b) (i) Why is element C more reactive than element A?

(2)

- (ii) Why is element B unreactive?

(2)

(Total 6 marks)

Q32.

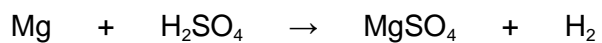
- (a) The formula for the chemical compound magnesium sulphate is MgSO_4 .

Calculate the relative formula mass (M_r) of this compound. (Show your working.)

(2)

- (b) Magnesium sulphate can be made from magnesium and dilute sulphuric acid.

This is the equation for the reaction.



Calculate the mass of magnesium sulphate that would be obtained from 4g of magnesium.
(Show your working.)

Answer _____ g

(2)

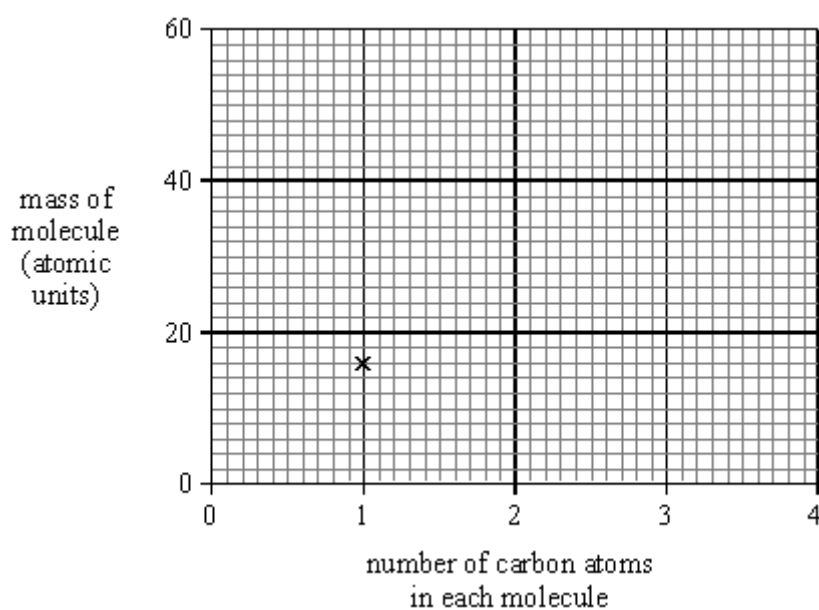
(Total 4 marks)

Q33.

The table gives some information about a family of molecules in crude oil.

NUMBER OF CARBON ATOMS IN MOLECULE	MASS OF MOLECULE (atomic units)
1	16
2	30
4	58

(a) Show information from the table in the most appropriate way on the grid.



(3)

(b) What is the mass of a molecule with three carbon atoms?

_____ (1)

(c) The other atoms in each molecule are all hydrogen atoms.
What family of substances do all the molecules belong to?

_____ (1)

(d) The mass of a carbon atom is 12 atomic units.
The mass of a hydrogen atom is 1 atomic unit.

So the molecule with one carbon atom has four hydrogen atoms.
Its formula is CH₄.

Write down the formula:

(i) of the molecule with two carbon atoms _____

(ii) of a molecule from the same family with five carbon atoms _____

(2)

(Total 7 marks)

Q34.

This question is about the structure of atoms.

(a) Choose words from the list to complete the sentences below.

electrons ions neutrons protons

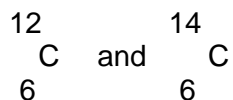
In an atom, the particles with a negative charge are called _____

Particles in the nucleus with no charge are called _____

An atom has no overall charge because it has the same number of electrons and _____

_____ (3)

(b) Two isotopes of the element carbon are:



Complete the table of information for these two isotopes.

	ATOMIC NUMBER	MASS NUMBER	NUMBER OF PROTONS	NUMBER OF NEUTRONS
$\begin{array}{c} ^{12} \\ \text{Isotope C} \\ 6 \end{array}$	6	12	6	6
$\begin{array}{c} ^{14} \\ \text{Isotope C} \\ 6 \end{array}$	6		6	

(2)
(Total 5 marks)

Q35.

(a) Write down the symbols for

lithium _____

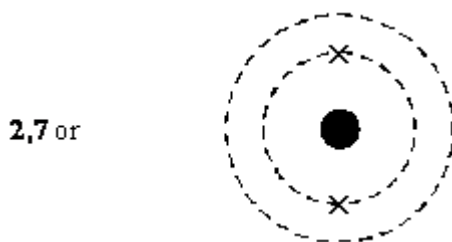
fluorine _____

(2)

(b) The electronic structure of a lithium atom can be shown like this:



In a similar way, complete this diagram to show the electronic structure of a fluorine atom.



(1)

(c) A lithium atom can lose one electron to form a lithium ion which can be written **(2)⁺**
A fluorine atom can gain one electron to form a fluoride ion.

Choose from the list the correct way to write the fluoride ion.

(2,6)⁺ **(2,7)⁺** **(2,7)⁻** **(2,8)⁺** **(2,8)⁻**

Answer _____

(2)
(Total 5 marks)

Q36.

The diagram shows some of the elements in Groups I and 7 of the Periodic Table.

Group							0
1	2	3	4	5	6	7	
Li						F	
Na						Cl	
K						Br	
						I	

- (a) The elements in Group 1 have similar chemical properties.

Describe **one** chemical reaction which shows that lithium, sodium and potassium react in the same sort of way.

You should say what you would react them with and what substances would be produced.

- What you would react them with

- Substances produced

(3)

- (b) All the elements in Group 7 react with hydrogen.

Fluorine reacts in the dark, explosively, at very low temperatures.

Chlorine reacts explosively in sunlight, at room temperature.

Bromine, in light, only reacts if heated to about 200°C.

Suggest the conditions needed for hydrogen and iodine to react.

Give reasons for your answer.

(2)

- (c) Hydrogen and chlorine react to produce hydrogen chloride.
Balance the symbol equation for the reaction.



(1)

- (d) Use your understanding of atomic structure to explain the trend in reactivity in the Group 7 elements.

(2)
(Total 8 marks)

