Atomic Structure Part 5

Q1.

Iron ore contains iron oxide.

(i) Calculate the relative formula mass of iron oxide, Fe_2O_3.

Relative atomic masses: O = 16; Fe = 56.

_____

_____

Answer = _____

(2)

(ii) Calculate the percentage by mass of iron in iron oxide.

_____

Percentage of iron = _____ %

(2)

(iii) Calculate the mass of iron that could be extracted from 1000 kg of iron oxide.

Use your answer to part (c) (ii) to help you with this calculation.

_____

Mass of iron = _____ kg

(1)

(Total 5 marks)

Q2.

The table shown below was devised by John Newlands in 1864. He arranged the elements in order of their relative atomic masses. He found a repeating pattern, with elements having similar properties in the vertical columns (Groups). He called this pattern the 'Law of Octaves', because elements with similar properties seemed to be repeated every eighth element.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co/Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce/La	Zr	Di/Mo	Ro/Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba/V	Ta	W	Nb	Au
Pt/Ir	Tl	Pb	Th	Hg	Bi	Os

(a) Many scientists were critical of Newlands' Law of Octaves.
Suggest why other scientists were critical of the Law of Octaves.

You should give examples from the table and use your knowledge of the chemistry of the elements.

_____

_____

_____

_____

_____

_____

(3)

(b) The diagram below shows a version of Mendeleev's Periodic Table of 1871. Mendeleev placed most of the elements in order of relative atomic mass.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	? ?	Ti ?	V As	Cr Se	Mn Br	Fe Co Ni
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	? I	Ru Rh Pd

This table became accepted by other scientists.

Give **two** ways in which Mendeleev's table improved on Newlands' table.

1 _____

_____

2 _____

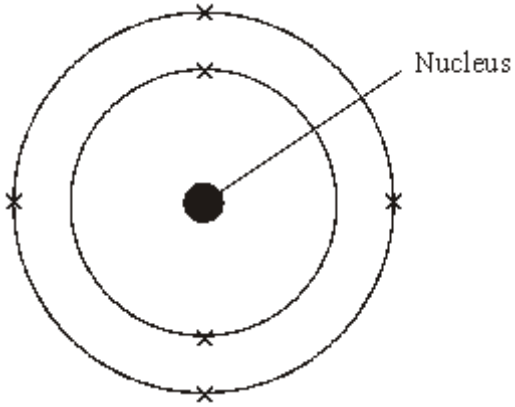
_____

(2)

(Total 5 marks)

Q3.

The diagram represents the electronic structure of an atom of an element.



The periodic table on the Data Sheet may help you with this question.

(a) Name this element.

_____

(1)

(b) Complete this sentence.

The nucleus of an atom contains neutrons and _____

(1)

(Total 2 marks)

Q4.

Niobium is a typical transition metal.

Put a tick (✓) next to each of the **four** properties in the table that you would expect for Niobium.

Property	
brittle	
conducts heat	
dull	
forms coloured compounds	
high melting point	
low boiling point	
strong	
very reactive	

(Total 4 marks)

Q5.

The periodic table on the Data Sheet may help you to answer this question.

(a) Newlands and Mendeleev both designed periodic tables in which the elements were put in the order of their relative atomic masses.

When the elements are put in this order a few of them are placed incorrectly when compared with a modern periodic table.

(i) Give **one** example of a pair of elements that would be placed incorrectly if they were in the order of their relative atomic masses.

_____ and _____

(1)

(ii) Explain why placing these two elements in the order of their relative atomic masses would **not** be correct.

_____

_____

(1)

(b) In the modern periodic table the elements are put in order of their atomic (proton) numbers.

Explain how the positions of the elements in the periodic table are linked to the electronic structure of their atoms.

_____

_____

_____

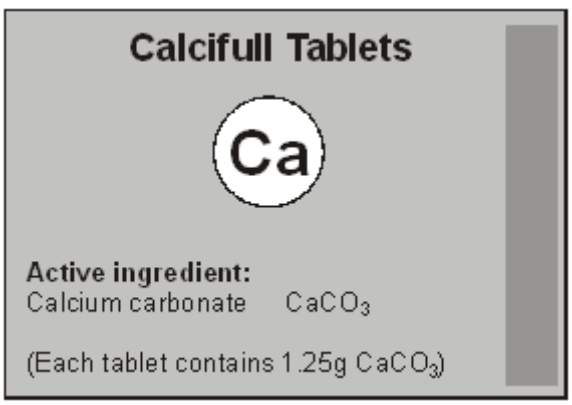
_____

(2)

(Total 4 marks)

Q6.

Calcium carbonate tablets are used to treat people with calcium deficiency.



(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

_____

_____

Relative formula mass = _____

(2)

(b) Calculate the percentage of calcium in calcium carbonate, $CaCO_3$.

_____

_____

Percentage of calcium = _____ %

(2)

(c) Calculate the mass of calcium in each tablet.

_____

_____

Mass of calcium = _____ g

(2)

(d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).

$$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (l) + CO_2\ (g)$$

Suggest why the patient may suffer from 'wind'.

_____

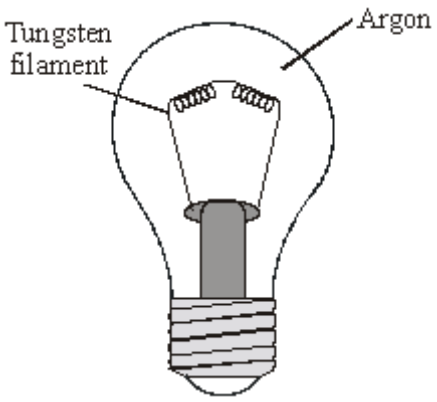
_____

(1)

(Total 7 marks)

Q7.

The diagram shows an electric light bulb.



When electricity is passed through the tungsten filament it gets very hot and gives out light.

(a) What reaction would take place if the hot tungsten was surrounded by air?

_____

_____

_____

(1)

(b) State why argon is used in the light bulb. Explain your answer in terms of the electronic structure of an argon atom.

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

Q8.

Silicon is an important element used in the electronics industry.

(a) Silicon can be made by heating a mixture of sand (silicon dioxide) with magnesium powder.

The equation for this reaction is shown below.

$$SiO_2\ (s) + 2Mg\ (s) \rightarrow 2MgO\ (s) + Si\ (s)$$

Calculate the mass of silicon dioxide needed to make 1 g of silicon.

Relative atomic masses: O = 16; Si = 28

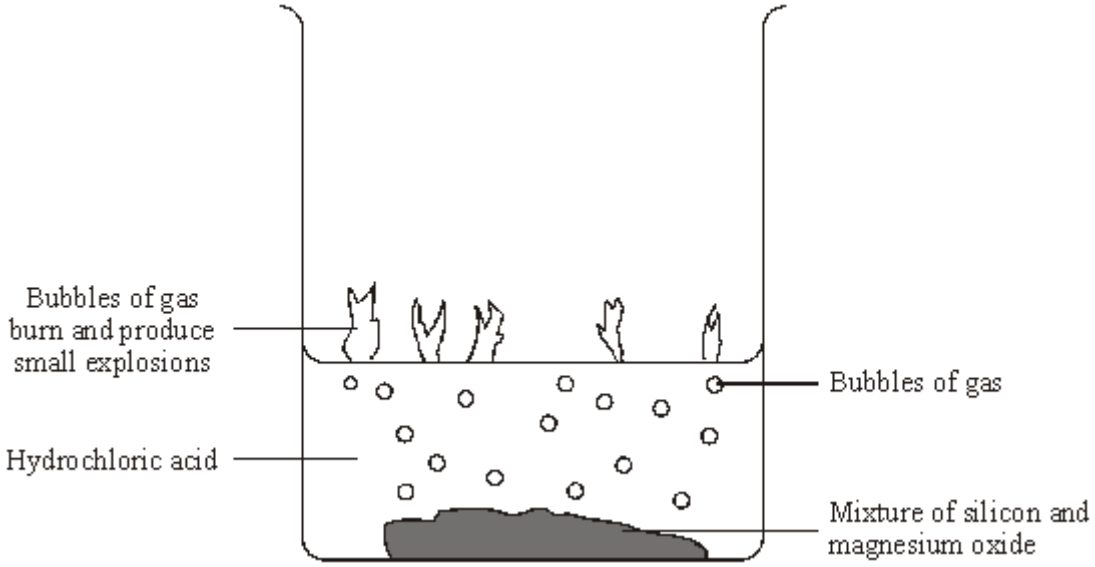
_____

_____

Mass = _____g

(3)

(b) The resulting mixture of magnesium oxide and silicon is added to a beaker containing hydrochloric acid. The silicon is then filtered from the solution.



(i) The magnesium oxide reacts with the hydrochloric acid and forms magnesium chloride ($MgCl_2$) solution and water.

magnesium oxide + hydrochloric acid → magnesium chloride solution + water

Write a balanced symbol equation for this reaction, including state symbols.

_____

(2)

(ii) The gases produced are a mixture of several silicon hydrides.

One of the gases produced in the reaction is the silicon hydride with the formula SiH_4. The structure of this molecule is similar to methane, CH_4.

Draw a diagram to show the bonding in a molecule of SiH_4. Represent the electrons as dots and crosses and only show the outer shell (energy level) electrons.

(1)

(iii) A sample of a different silicon hydride was found to contain 1.4 g of silicon and 0.15 g of hydrogen.

Calculate the formula of this silicon hydride. You must show all your working to gain full marks.

Relative atomic masses: H = 1; Si = 28

_____

_____

_____

_____

_____

_____

_____

(4)

(iv) The silicon hydrides react immediately they come into contact with oxygen in the air. They burst into flames with a small explosion and give out energy.

Which letter, **A** to **H**, best describes this reaction?

Energy involved in breaking and forming bonds	**Activation energy**	**Rate of reaction**	**Letter**
The energy released from forming new bonds is greater than the energy needed to break existing bonds	high	fast	**A**
		slow	**B**
	low	fast	**C**
		slow	**D**
The energy needed to break existing bonds is greater than the energy released from forming new bonds	high	fast	**E**
		slow	**F**
	low	fast	**G**
		slow	**H**

Letter _____

(1)

(c) The structure of silicon is similar to the structure of diamond.

Describe the structure of silicon and explain why it has a high melting point. You may draw a diagram if this helps.

_____

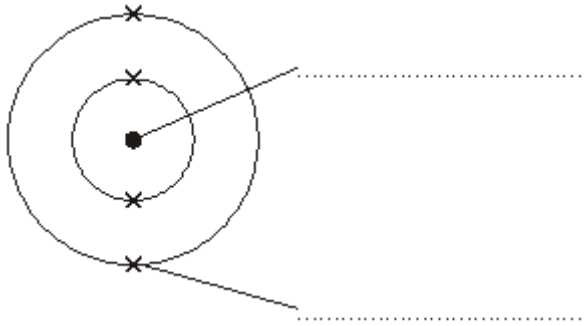
(4)

(Total 15 marks)

Q9.

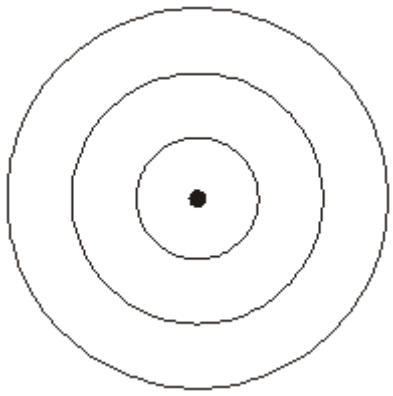
(a) The diagram represents an atom of beryllium. Use words from the box to label the diagram.

electron	**ion**	**isotope**	**molecule**	**nucleus**



(2)

(b) Use crosses (*x*) to complete the diagram to show the electronic structure of a magnesium atom. The atomic (proton) number of magnesium is 12.

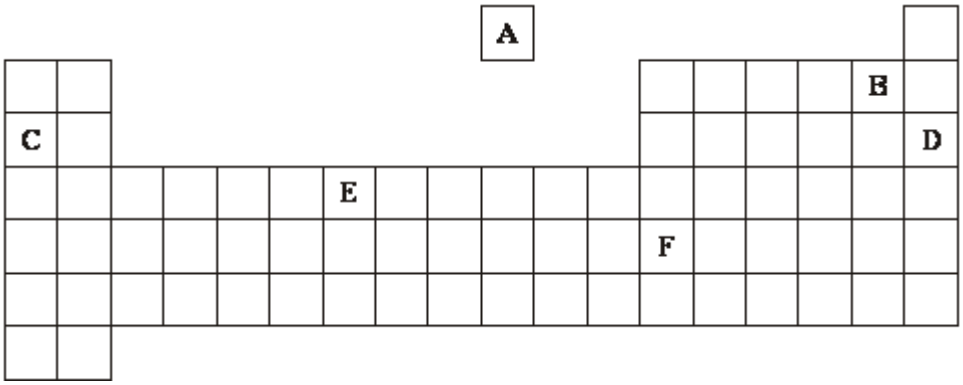


(2)

(Total 4 marks)

Q10.

The diagram shows an outline of the periodic table.



Choose your answers **only** from the letters shown on the table above.

The periodic table on the Data Sheet may help you to answer this question.

Which element, **A** to **F**:

(a) is in Group 3;

_____

(1)

(b) is a metal which floats on water and reacts violently to make an alkaline solution and hydrogen gas;

_____

(1)

(c) is a gas which burns with a squeaky pop?

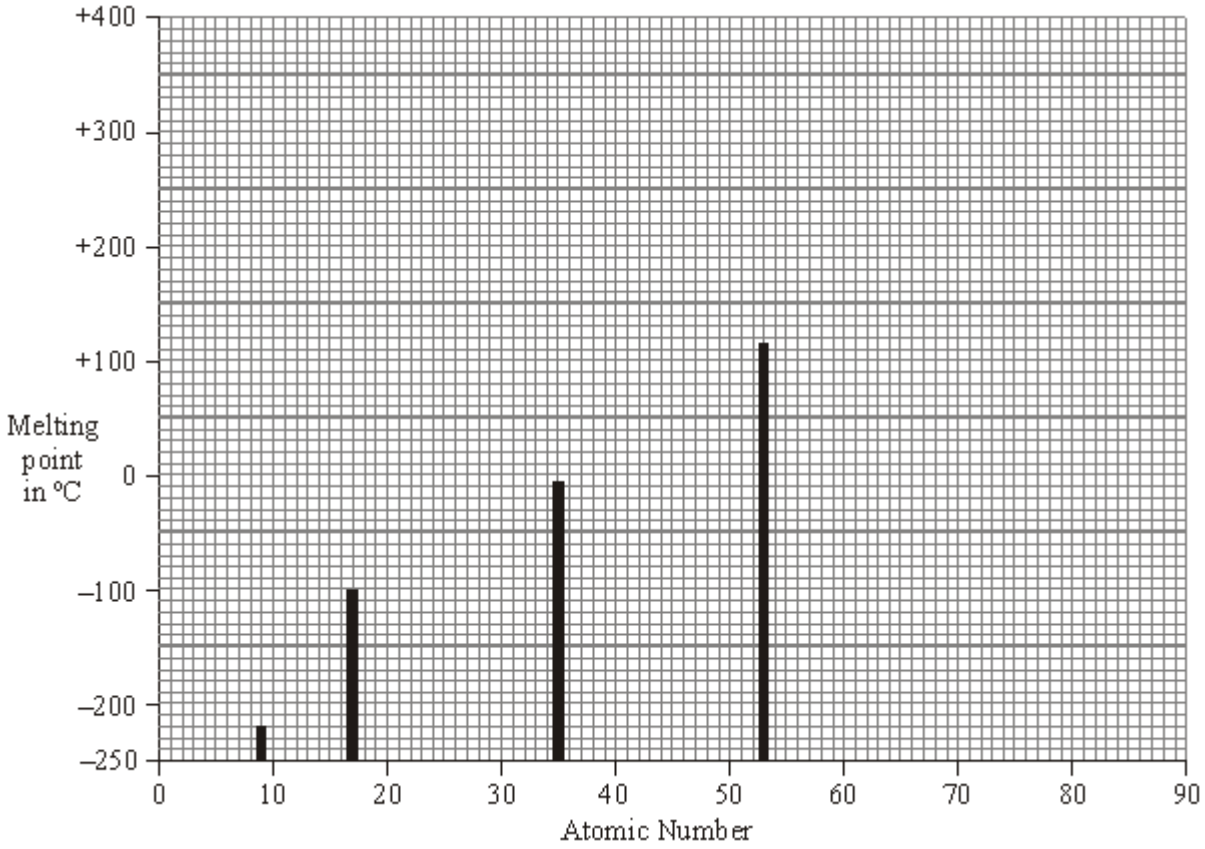
_____

(1)

(Total 3 marks)

Q11.

(a) The bar graph shows the melting points of the elements in Group 7 plotted against their atomic numbers.



(i) How do the melting points of the Group 7 elements change as the atomic number increases?

_____

_____

(1)

(ii) The melting point of astatine (atomic number = 85) is not shown on the bar graph. Estimate the melting point of astatine.

_____ °C

(1)

Draw a bar for this value on the bar graph.

(1)

(b) The water from wells in Japan contains bromide ions.

Bromine is extracted from this water. The bromine is displaced by adding another Group 7 element.

(i) Place a tick (✓) next to the name of **one** Group 7 element that could be used to displace bromine from this water.

Most reactive

Least reactive

Group 7	(✓)
Fluorine	
Chlorine	
Bromine	
Iodine	
Astatine	

(1)

(ii) State why you have chosen this element.

_____

_____

(1)

(iii) One sample of this water contained 2 g of bromine per litre of water.

How many litres of this water would be needed to make 1 kg of bromine?
(1 kg = 1000 g)

_____

_____ litres

(1)

(Total 6 marks)

Q12.

A student investigated some instant soup.

(a) Instant soup contains a food additive which has the formula:

NaH_2PO_4

Give the names of all the elements in this compound.

The periodic table on the Data Sheet may help you to answer this question.

_____

_____

(2)

(b) The student investigated the reaction which takes place when soup powder is added to cold water.

The student thought that the reaction might be *exothermic.*

(i) What is meant by the term *exothermic* reaction?

_____

_____

(2)

(ii) Describe an experiment that the student could do to prove that this reaction is exothermic.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 8 marks)

Q13.

Mendeleev constructed a periodic table in 1869.

In his periodic table:

- most of the elements were put in order of increasing relative atomic mass;
- elements with similar properties were put into groups;
- Mendeleev changed the order of some elements to put them with similar elements;
- spaces were left for elements that Mendeleev thought would be discovered in the future.

One space was in Group 3 between the elements aluminium and indium.

Group 3
Boron
Aluminium
?
Indium
Thallium

Mendeleev called this undiscovered element ‘eka-aluminium’. This element is now known

as gallium. In 1871, he also predicted some of the properties of gallium.

The table shows the properties of aluminium and indium, along with some of the predictions made by Mendeleev for gallium.

	Appearance	Metal or non-metal	Boiling point in °C	Density in g per cm3	Relative atomic mass
Aluminium	silvery white	metal	2467	2.7	27
Predicted properties of gallium	silvery white	metal	?	?	68
Indium	silvery white	metal	2080	7.31	115

(i) Suggest **two** reasons why other scientists in 1871 did not accept Mendeleev's periodic table.

Reason 1 _____

_____

Reason 2 _____

_____

(2)

(ii) Suggest why the discovery of gallium in 1875 convinced other scientists that Mendeleev's table was correct.

_____

_____

_____

(1)

(Total 3 marks)

Q14.

Transition elements and their compounds have many uses.

Iron oxide and cobalt oxide have been added to the glazes on pottery for hundreds of years.

(a) State why transition metal oxides are added to pottery glazes.

_____

(1)

(b) Use the table of ions on the Data Sheet to help you work out the formula of iron(III) oxide.

_____

(1)

(c) Cobalt oxide is reacted with hydrogen to form cobalt.

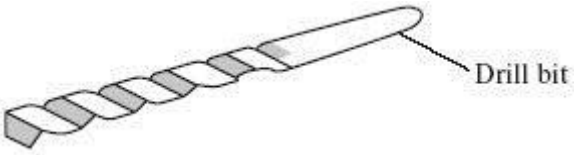
(i) Balance the equation for this reaction.

$$Co_3O_4 + \ldots\ldots\ldots H_2 \rightarrow 3\,Co + \ldots\ldots\ldots H_2O$$

(1)

(ii) Cobalt is mixed with other transition metals to make alloys.

These alloys are used to make cutting tools which remain sharp at very high temperatures. They can cut through other metals.



Suggest **two** properties of transition metals that make them suitable for making cutting tools.

1. _____

_____

2. _____

_____

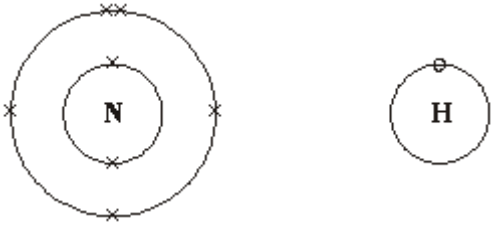
(2)

(Total 5 marks)

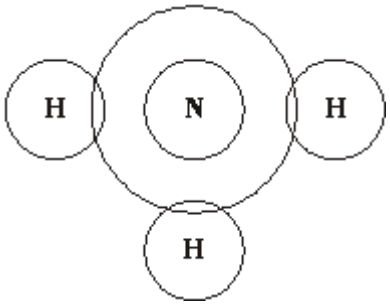
Q15.

Ammonia (NH_3) is an important chemical which is used to make fertilisers. Ammonia is made from nitrogen and hydrogen,

(a) The diagrams represent the electron arrangements in atoms of nitrogen and hydrogen.



Complete the diagram showing the arrangement of electrons in a molecule of ammonia.



(1)

(b) Name the type of bonding which holds the nitrogen and hydrogen atoms together in an ammonia molecule.

_____

(1)

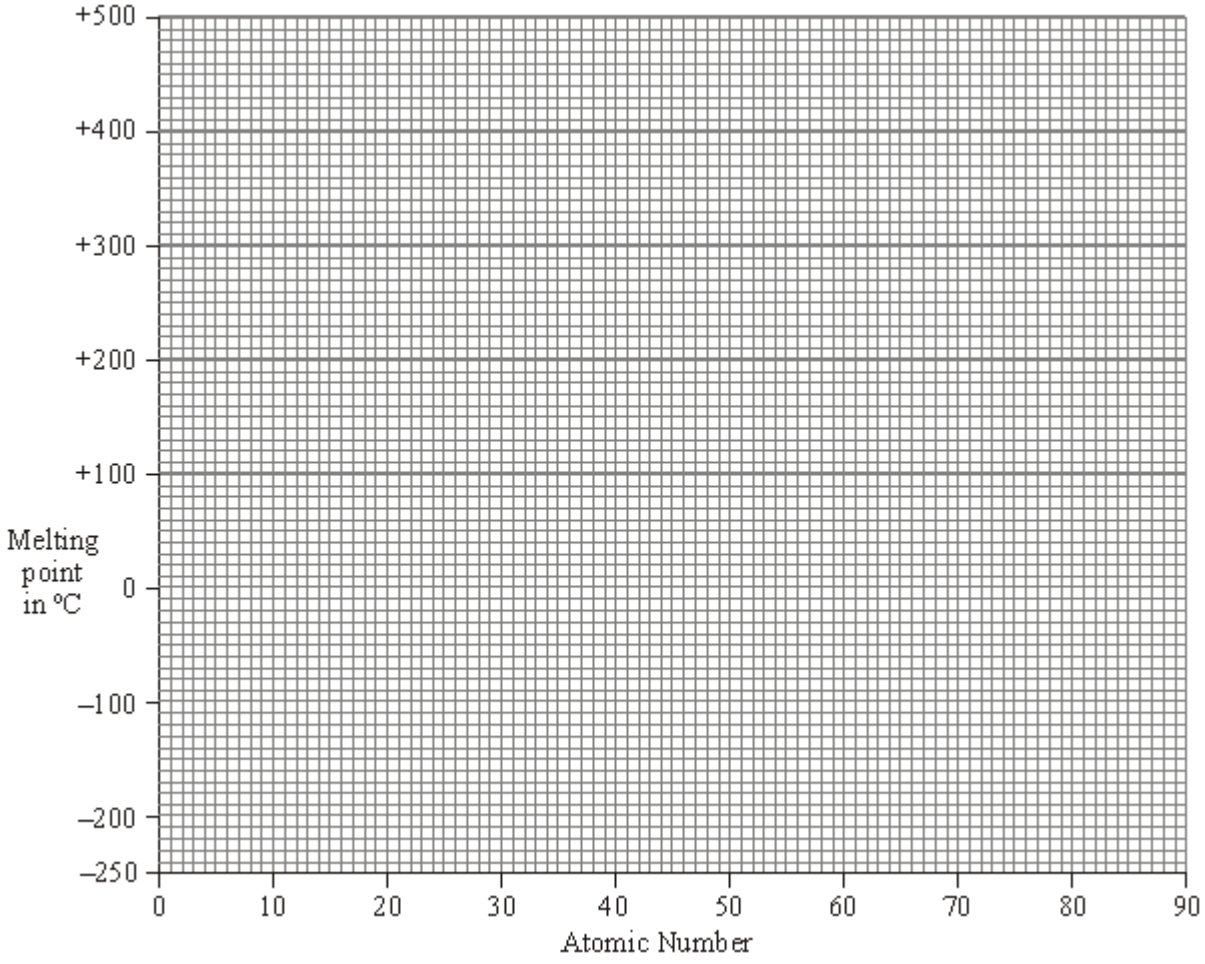
(Total 2 marks)

Q16.

(a) The table gives the melting points of some of the elements of Group 7.

Element	Atomic number	Melting point in ºC
Fluorine	9	–220
Chlorine	17	–101
Bromine	35	–7
Iodine	53	114
Astatine	85	?

(i) Plot a graph of the melting point against atomic number.



Draw a line of best fit.
Extend your line to estimate a value for the melting point of astatine.

(2)

(ii) Estimate the melting point of astatine. _____ °C

(1)

(iii) Which of the Group 7 elements are solids at 20 °C?

_____

(1)

(b) (i) Draw a diagram to show the arrangement of electrons in an atom of fluorine.

(1)

(ii) The elements of Group 7 have similar chemical properties.

Explain, in terms of electrons, why they have similar chemical properties.

_____

_____

(1)

(c) Xenon is a very unreactive element.

(i) Explain, in terms of electrons, why xenon is so unreactive.

_____

_____

_____

_____

(2)

(ii) Fluorine reacts with xenon but iodine does not.

Explain, in terms of atomic structure, why fluorine is more reactive than iodine.

_____

_____

_____

_____

_____

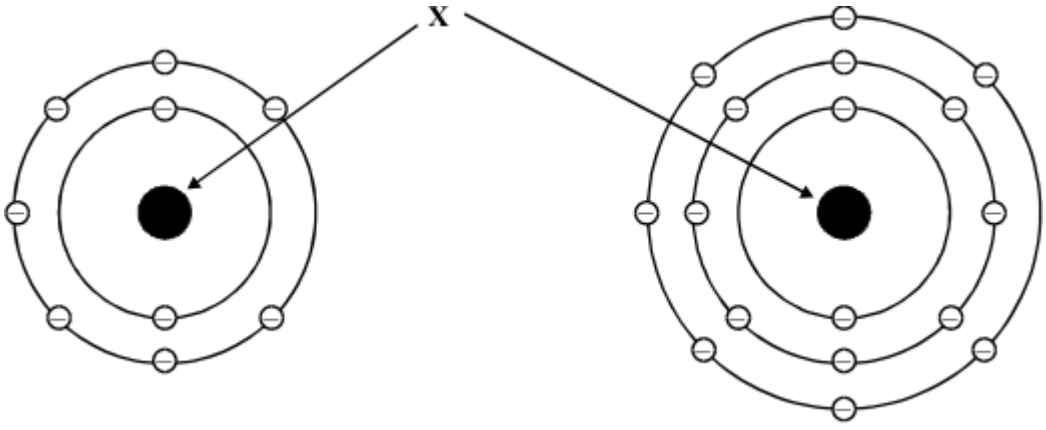
_____

(3)

(Total 11 marks)

Q17.

The diagrams show the electronic arrangement of the atoms of two elements.



(i) Name the part of the atoms labelled **X**.

_____

(1)

(ii) Why are these two elements in the same group of the Periodic Table?

_____

_____

(1)

(Total 2 marks)

Q18.

Fluorine is more reactive than chlorine. Fluorine reacts with most elements in the Periodic Table. However, fluorine does not react with argon.

Atomic numbers: F 9; Cl 17; Ar 18.

(a) To which group of the Periodic Table do fluorine and chlorine belong?

_____

(1)

(b) (i) Give **one** use for argon.

_____

(1)

(ii) Explain why the noble gas argon is unreactive.

_____

_____

_____

_____

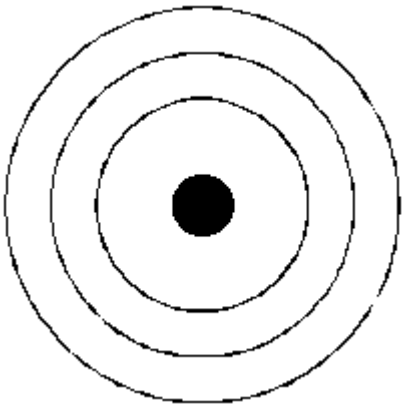
(2)

(c) (i) Give **one** use for chlorine.

_____

(1)

(ii) Draw the electron arrangement of a chlorine atom.



(2)

(iii) Explain why fluorine is more reactive than chlorine.

(3)

(Total 10 marks)

Q19.

There is molten rock below the Earth's solid outer crust. The rock remains molten because the radioactive decay of isotopes such as uranium, thorium and potassium releases heat energy.

(i) Explain how this released heat energy is thought to cause the recycling of rocks.

(4)

(ii) Two *isotopes* of potassium are shown.

$^{39}_{19}\mathrm{K}$ $^{49}_{19}\mathrm{K}$

Explain what is meant by *isotopes.* You must include numbers of electrons, neutrons and protons in your explanation.

_____

_____

_____

(4)

(Total 8 marks)

Q20.

The chemical equation for the formation of iron is:

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

Calculate the relative formula mass of iron oxide, Fe_2O_3.

Relative atomic masses: O 16; Fe 56.

_____

_____

_____

Relative formula mass Fe_2O_3 = _____

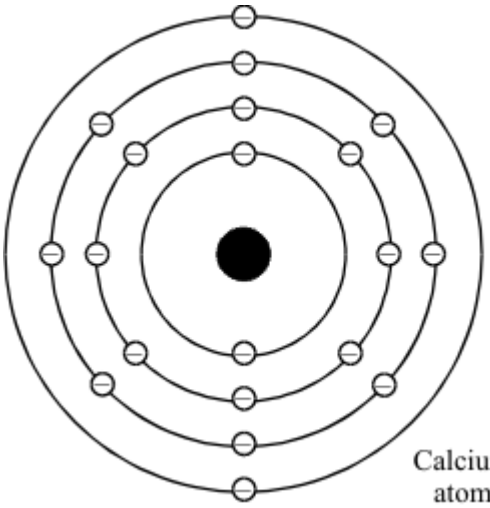
(Total 2 marks)

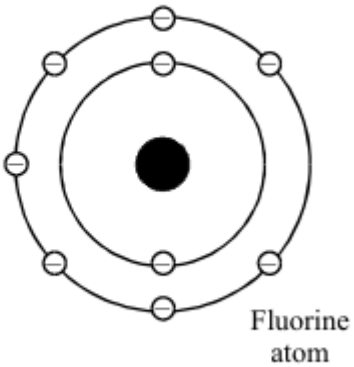
Q21.

Uranium metal can be produced by reacting uranium hexafluoride with calcium.

$UF_6 + 3Ca \rightarrow 3CaF_2 + U$

(a) Describe how calcium and fluorine bond together to form calcium fluoride. The electron arrangement of each atom is shown.





_____

_____

_____

_____

_____

(5)

(b) Uranium has two main isotopes, $^{235}_{92}U$ and $^{238}_{92}U$. Use these as examples to explain what is meant by the word isotope.

_____

_____

_____

_____

_____

(4)

(c) At the start of a reaction there was 174.5 g of uranium hexafluoride, UF_6.

Relative atomic masses: F 19; U 235

(i) Calculate the relative formula mass of uranium hexafluoride, UF_6.

_____

_____

_____

Relative formula mass UF_6 = _____ g

(1)

(ii) Calculate the mass of uranium that would be produced from 134.5 g of uranium hexafluoride.

_____

_____

_____

_____

_____

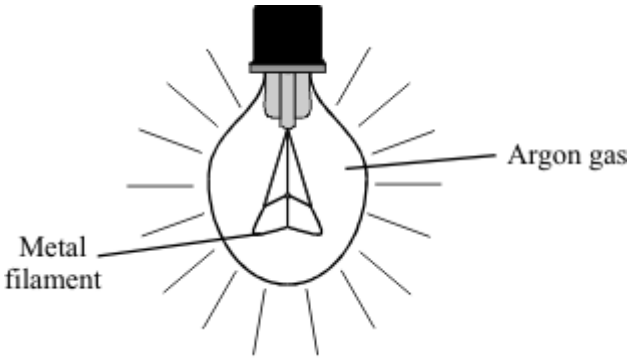
Mass of uranium = _____ g

(2)

(Total 12 marks)

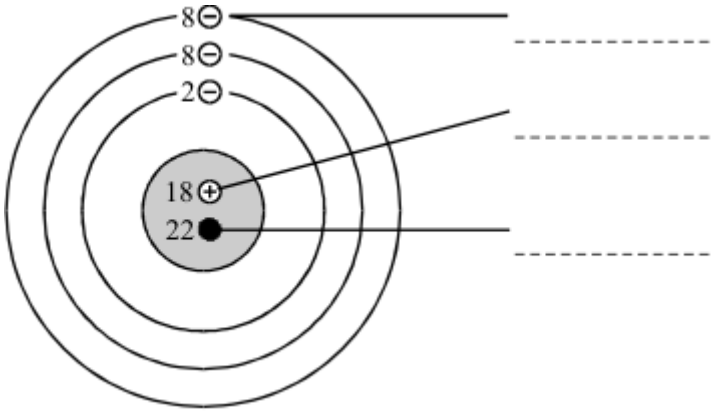
Q22.

The diagram shows a light bulb.



(a) (i) An argon atom has the structure shown. Use the words in the box to label the particles in the atom. Each word should only be used **once.**

electron	neutron	proton



(2)

(ii) Argon is unreactive. Why?

_____

_____

(1)

(b) Oxygen would **not** be a suitable gas to use in a light bulb. Explain why.

_____

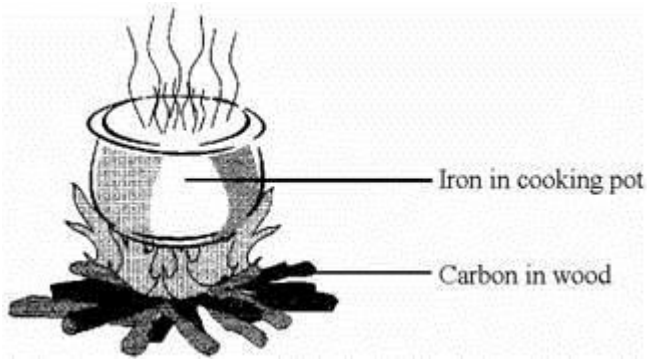
_____

(2)

(Total 5 marks)

Q23.

The uses of *elements* depend on their properties.



(a) Carbon and iron are both *elements.* What is an *element?*

_____

_____

(1)

(b) Complete the sentences by crossing out the words that are wrong. The first one has been done for you.

~~Non-Metals~~	Metals	can be hammered into shape.
Non-Metals	Metals	often have low melting point.
Non-Metals	Metals	are good conductors of heat.

(2)

(c) In the box are the names of three metals.

copper	iron	sodium

Which **one** of these is **not** a good metal for making the cooking pot? Give a reason for your answer.

Metal _____

Reason _____

_____

_____

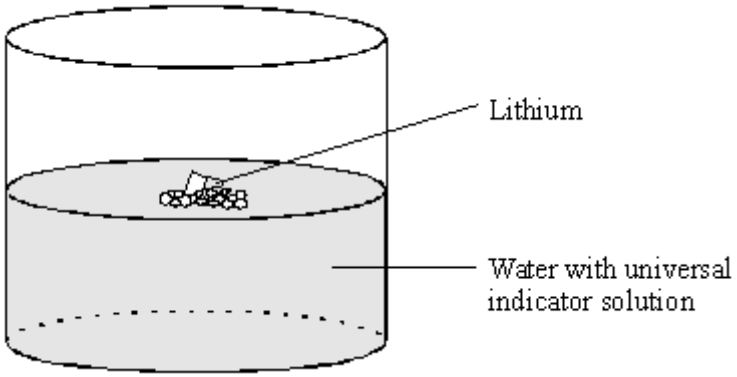
(2)

(Total 5 marks)

Q24.

Lithium is a very reactive metal.

(a) Lithium reacts with cold water.



(i) Which **physical** property of lithium is seen during this reaction?

_____

(1)

(ii) Which **chemical** property of lithium will be shown by the universal indicator?

_____

(1)

(b) Complete the sentence by writing in the missing numbers.

Lithium has an atomic number of 3 and a mass number of 7.

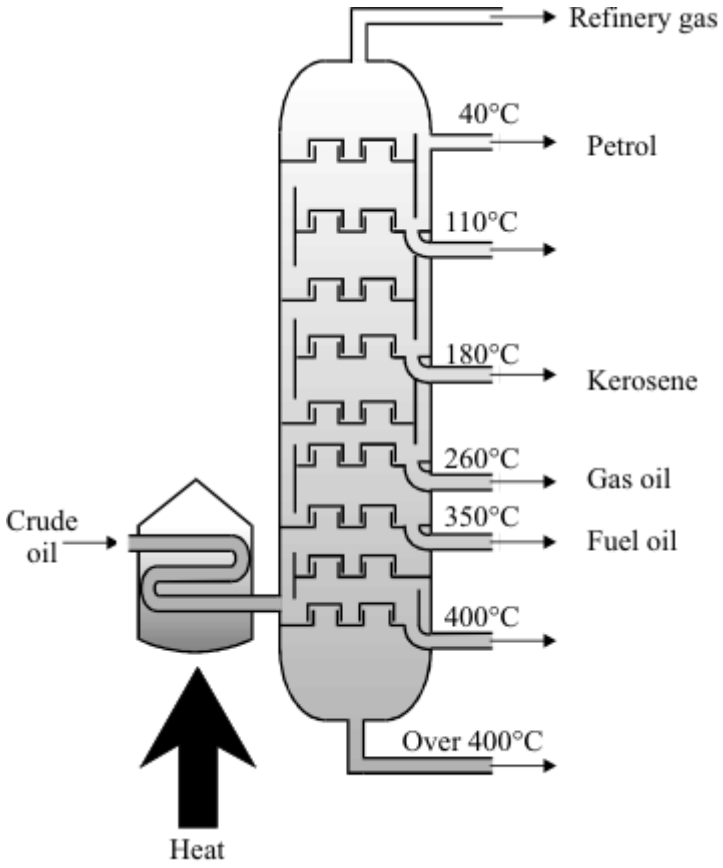
This means that an atom of lithium has _____ protons _____ electrons and _____ neutrons.

(3)

(Total 5 marks)

Q25.

To make crude oil more useful it is separated into different fractions.



(a) Complete the gaps in the following sentences.

Crude oil is separated into different fractions by a process called _____

_____ . Each fraction has a different _____ .

(2)

(b) Each fraction is a mixture of compounds. Most of these compounds are hydrocarbons, made up of the elements hydrogen and carbon.

(i) Explain the difference between a mixture and a compound.

_____

_____

_____

(2)

(ii) Explain the difference between a compound and an element.

_____

_____

_____

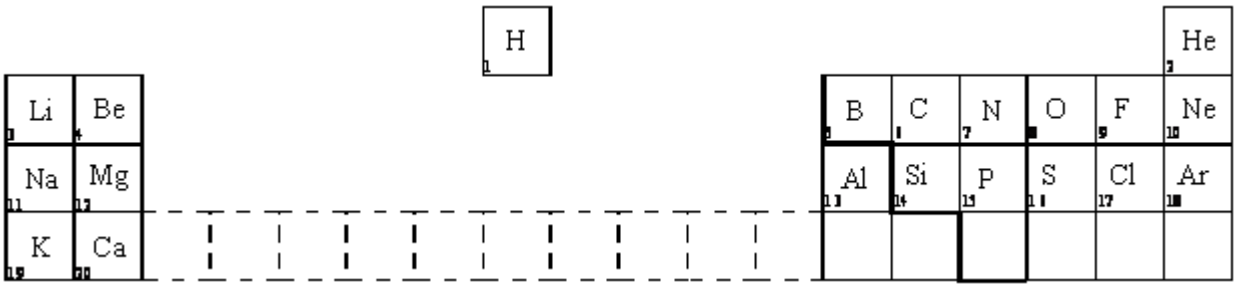
(2)

(Total 6 marks)

Q26.

The elements in Mendeleev's periodic table were arranged in order of increasing atomic

mass. Part of the modem Periodic Table is shown.



(a) Complete the sentence by writing in the missing words.

The modem Periodic Table is arranged in order of increasing

_____ _____ .

(1)

(b) (i) Name a metal in the same group as lithium.

_____

(1)

(ii) Name a non-metal in the same period as magnesium.

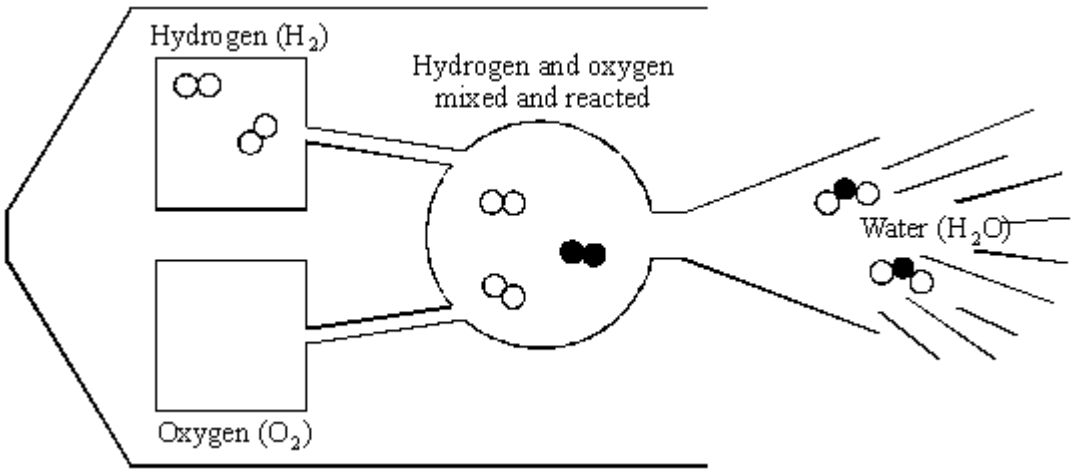
_____

(1)

(Total 3 marks)

Q27.

The diagram shows the reaction of hydrogen molecules with oxygen molecules to form water molecules.



(i) In the empty box draw **one** oxygen molecule.

(1)

(ii) Why are hydrogen and oxygen called elements?

_____

_____

(1)

(iii) Why is water called a compound?

_____

_____

(2)

(Total 4 marks)

Q28.

This question is about the Periodic Table.

(a) Dimitri Mendeleev was a Russian scientist who, in 1869, helped to develop the Periodic Table. He made his table with the known elements arranged in order of increasing atomic mass. He started new rows so that elements with similar chemical properties would be in the same column. Mendeleev sometimes had to leave gaps in his table.

(i) Complete the sentences.

The Periodic Table is now the arrangement of the elements in order

of increasing atomic _____ . The rows are called _____

and the columns are called _____ .

(3)

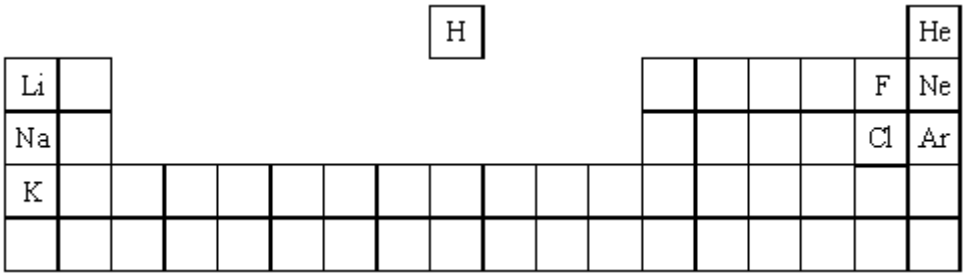
(ii) Suggest why Mendeleev had to leave gaps in his table.

_____

_____

(1)

(b) This section of the Periodic Table shows the positions of some elements.



(i) Give the chemical symbol for **one** of the noble gases.

_____

(1)

(ii) Draw the arrangement of electrons around the nucleus for the noble gas that you chose in (i).

Nucleus

(1)

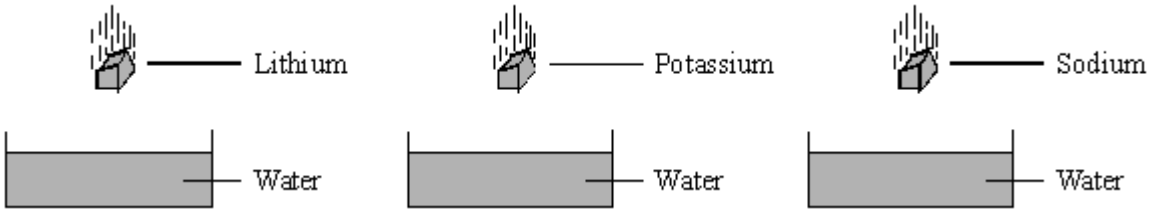
(iii) Why do the electron arrangements of lithium, sodium and potassium make them react in a similar way?

_____

_____

(1)

(iv) Small pieces of lithium, potassium and sodium are added to water.



What is the order of reactivity for these three metals? Put the most reactive metal first.

_____

_____

(1)

(v) Complete and balance the chemical equation for the reaction of sodium with water.

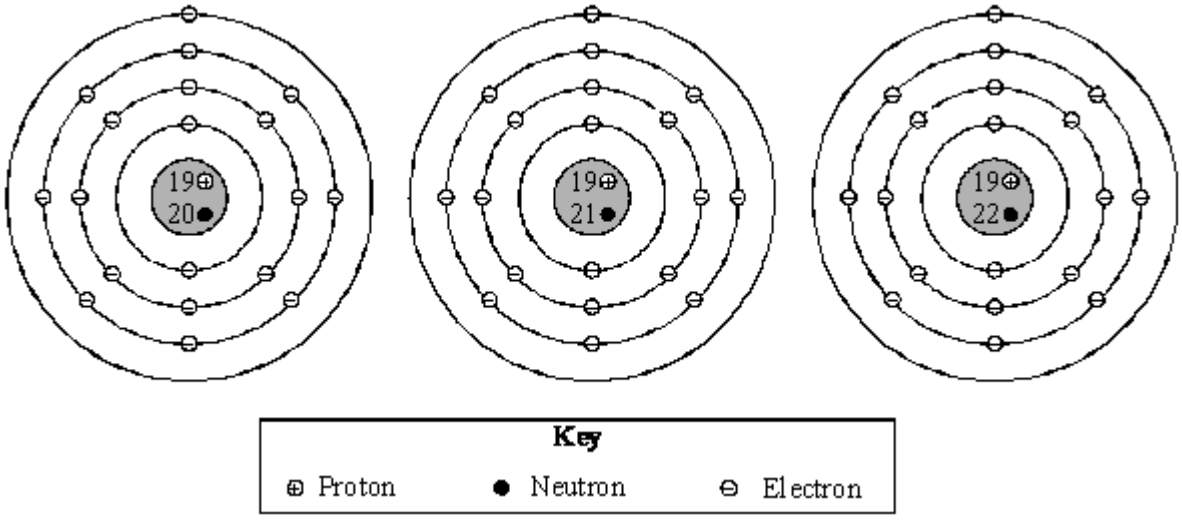
$2Na(s) + 2H_2O(l) \rightarrow$ _____$NaOH(aq) +$ _____(g)

(2)

(Total 10 marks)

Q29.

The diagrams show three *isotopes* of potassium.



(i) In what way does the atomic structure show you that they are all **atoms**?

_____

_____

(1)

(ii) Explain why these three atoms are called *isotopes* of potassium.

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

Q30.

Many everyday substances can be classified as acids, bases or salts. For example, car batteries contain sulphuric acid, oven cleaners contain sodium hydroxide and table salt contains sodium chloride.

(a) A solution of each of these substances was tested with universal indicator.

Solution	Colour of universal indicator
Sulphuric acid (H_2SO_4)	red
Sodium hydroxide (NaOH)	purple
Sodium chloride (NaCl)	green

(i) Explain how these universal indicator colours and the corresponding pH values could be used to identify each of these solutions.

_____

_____

_____

_____

_____

(3)

(ii) Name and give the formula of the ion which causes the solution to be acidic.

Name of ion _____

Formula of ion _____

(2)

(b) Sodium chloride can be made by reacting sodium hydroxide with hydrochloric acid in the presence of an indicator.

(i) What is the name of this type of reaction?

_____

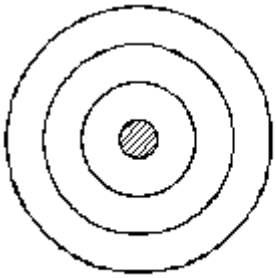
(1)

(ii) Write a balanced chemical equation for this reaction.

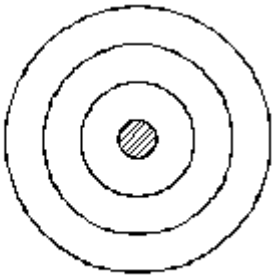
_____(aq) + _____(aq) → _____(aq) + _____(l)

(2)

(c) The atomic number for sodium is 11 and for chlorine is 17.



Sodium atom



Chlorine atom

(i) Complete the diagrams to show the electron arrangements for a sodium atom and a chlorine atom.

(2)

(ii) These atoms form different particles by one electron transferring from the sodium atom to the chlorine atom. What is the name given to the particles formed?

_____

(1)

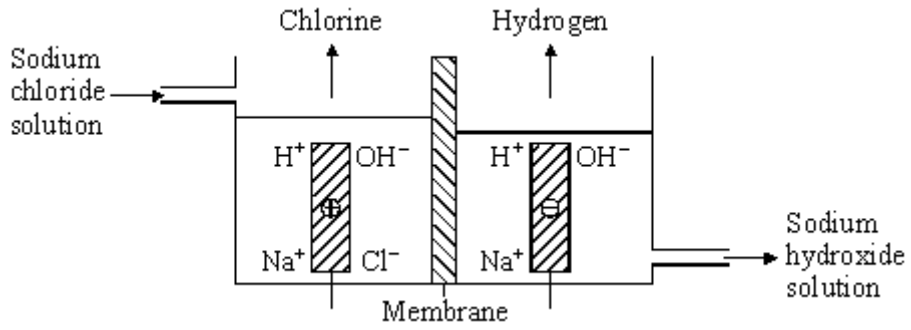
(iii) Why do these sodium and chloride particles bond?

_____

_____

(1)

(d) Sodium chloride solution is electrolysed to form three products, hydrogen, chlorine and sodium hydroxide.



Describe how each of these products are formed.

_____

_____

_____

_____

_____

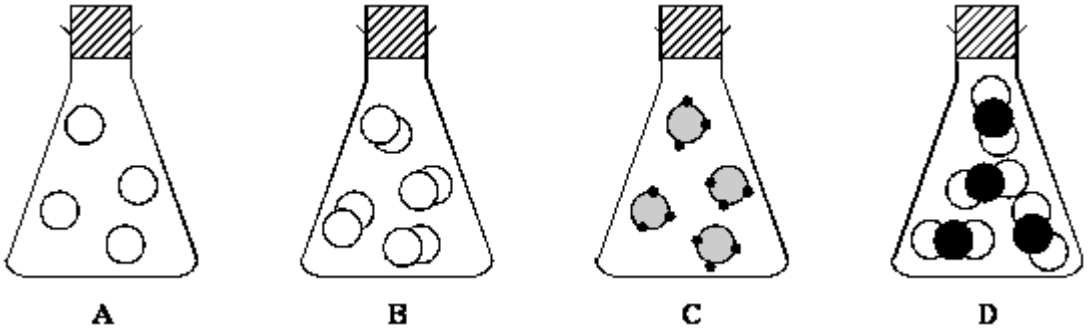
_____

(3)

(Total 15 marks)

Q31.

In the flasks are the particles of four different gases. (Each circle represents an atom.)



(a) Which diagram represents

(i) oxygen, O_2 _____

(1)

(ii) steam, H_2O _____

(1)

(b) The gases in **A** and **B** are elements and the gases in **C** and **D** are compounds. Explain why.

_____

_____

_____

_____

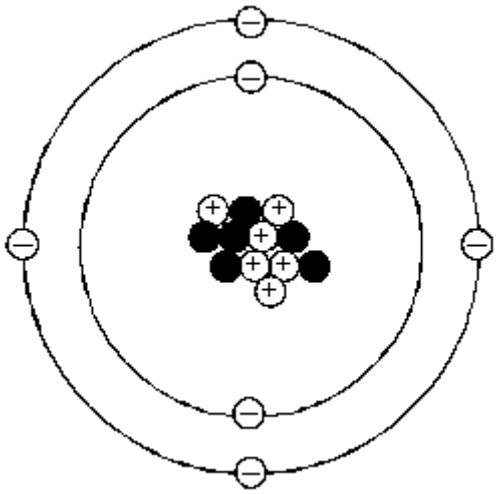
_____

(3)

(Total 5 marks)

Q32.

About 100 years ago a scientist called J. J. Thomson thought that an atom was a ball of positive charge with negative particles stuck inside. Today a different model is used. The diagram shows how an atom of carbon is represented by this model.



(a) The negative particles ⊖ are called electrons.

(i) What is the name of the positive particles ⊕?

_____

(1)

(ii) What particle is represented by ●?

_____

(1)

(iii) What is the central part of the atom called that contains both ⊕ and ●?

_____

(1)

(b) Use the model to explain why the six electrons are arranged as shown.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q33.

Follow the steps to find the percentage of iron in iron oxide.

Relative atomic masses: O 16; Fe 56.

(i) Step 1

Calculate the relative formula mass of iron oxide, Fe_2O_3.

_____

_____

(1)

(ii) Step 2

Calculate the total relative mass of just the iron atoms in the formula, Fe_2O_3.

_____

(1)

(iii) Step 3

Calculate the percentage (%) of iron in the iron oxide, Fe_2O_3.

_____

_____

Percentage of iron _____ %

(1)

(Total 3 marks)

Q34.

The Periodic Table contains groups of elements that have similar chemical properties.

(a) The halogens are in Group 7 of the Periodic Table.

(i) Complete the table. Iodine has been done for you.

Halogen	Colour of vapour
chlorine	
	red-brown
iodine	purple

(2)

(ii) Why do the halogens have similar chemical properties?

_____

_____

(1)

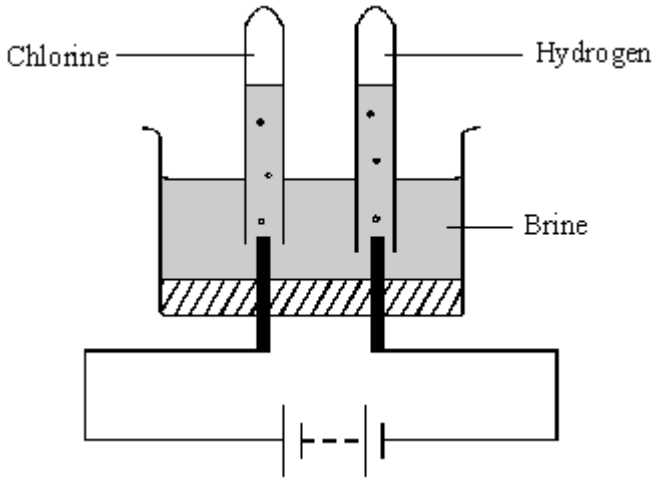
(b) The alkali metals are in Group 1 of the Periodic Table. State what is formed when any alkali metal reacts with water.

(2)

(Total 5 marks)

Q35.

Brine, a solution containing sodium chloride in water, can be used to manufacture chlorine, hydrogen and sodium hydroxide. A student sets up a simplified model of the industrial cell.



(a) The electron arrangements of some atoms are shown here.

H	1
O	2.6
Na	2.8.1
C1	2.8.7

(i) Use the relevant electron arrangements to describe the bonding in water.

(2)

(ii) Use the relevant electron arrangements to describe the bonding in sodium

chloride.

_____

_____

_____

_____

_____

_____

(3)

(b) Use the atomic structures of $^{35}_{17}Cl$ and $^{37}_{17}Cl$ to explain the meaning of the term *isotopes.*

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q36.

This question is about sodium chloride (common salt) which is an important chemical.

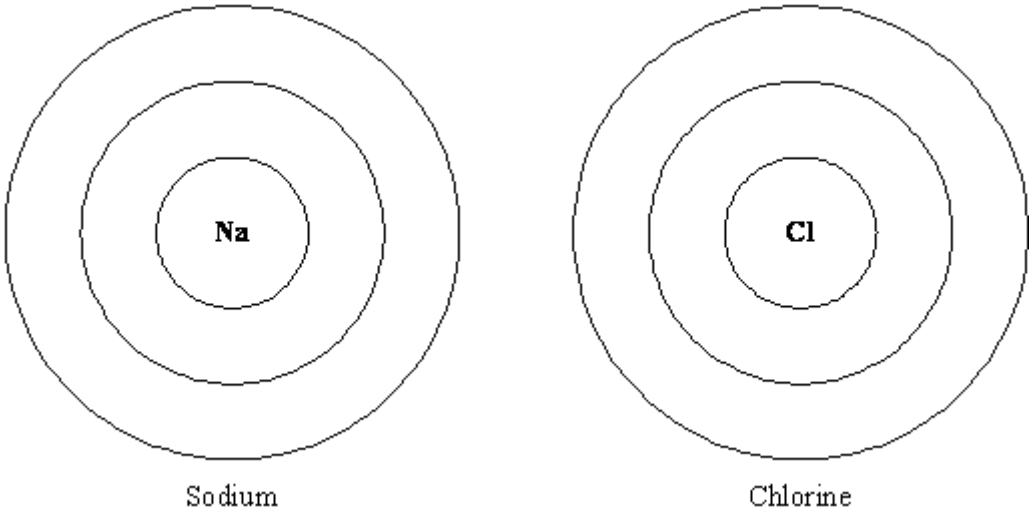
Sodium chloride can be made by burning sodium in chlorine gas.

(a) Balance the symbol equation for the reaction of sodium with chlorine.

$$Na_{(s)} + Cl_{2(g)} \rightarrow NaCl_{(s)}$$

(1)

(b) (i) Complete the diagrams below to show the electronic structures of a sodium and a chlorine atom. (Atomic number of sodium = 11 and chlorine = 17.)



(3)

(ii) When sodium reacts with chlorine the sodium atoms are changed into sodium ions (Na^+) and the chlorine atoms are changed into chlorine ions (Cl^-).

Explain how:

1. a sodium atom changes into a sodium ion;

_____

_____

(2)

2. a chlorine atom changes into a chloride ion.

_____

_____

(2)

(c) The element potassium is in the same group of the Periodic Table as sodium. Potassium reacts with chlorine to make potassium chloride which is sometimes used instead of common salt in cooking.

(i) Predict the formula of potassium chloride.

_____

(1)

By reference to the electronic structures of potassium and sodium explain:

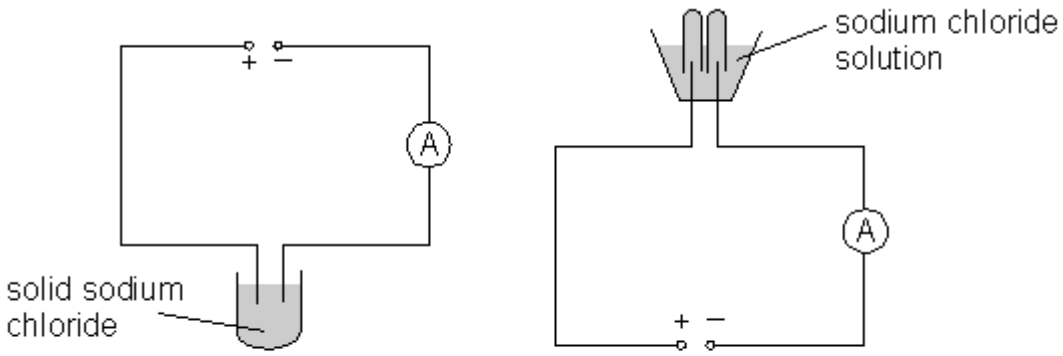
(ii) Why the reaction of potassium with chlorine is similar to the reaction of sodium with chlorine.

_____

_____

(1)

(d) The electrolysis of sodium chloride solution is an important industrial process. The diagrams below show two experiments set up during an investigation of the electrolysis of sodium chloride.



Experiment 1 Experiment 2

(i) What would be the reading on the ammeter in experiment 1?

_____ A

(ii) Explain your answer.

_____

_____

_____

(3)

(e) The equations below show the reactions which take place in experiment 2.

$H_2O_{(1)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}$

$2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$

$2Cl^-_{(aq)} - 2e^- \rightarrow Cl_{2(g)}$

(i) Which substance provides hydrogen ions?

_____

(1)

(ii) Name the product formed at:

(A) the positive electrode;

_____

(B) the negative electrode.

_____

(1)

(Total 15 marks)

Q37.

Fluorine is a very useful element. It is placed in group 7 of the Periodic Table.

Use your knowledge of the elements in group 7 to help you answer these questions. You

may find that information in the Data Sheet may help you with this question.

(a) Name another element in group 7 of the Periodic Table.

_____

(1)

(b) Cylinders filled with fluorine molecules are commercially available. What would you expect the formula of a fluorine molecule to be?

_____

(1)

(c) Fluoride ions are added to drinking water to help prevent tooth decay. What is the charge on fluoride ions in the water?

_____

(1)

(d) Fluorine reacts with the non-metal sulphur to make sulphur hexafluoride (SF_6).

(i) What type of bonding would you expect in sulphur hexafluoride?

_____

(1)

(ii) Explain the reason for your answer to part (i).

_____

_____

_____

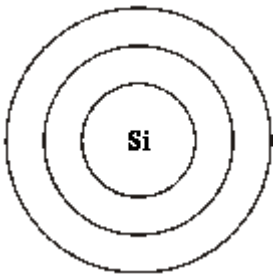
(1)

(Total 5 marks)

Q38.

Silicon is an extremely important element. More than a million tonnes of silicon are produced each year. Silicon is made by reducing silicon oxide (sand) with carbon (coke).

(a) (i) Complete the diagram below to show the arrangement of electrons in an atom of silicon. The Data Sheet may help you with this question.



(2)

(ii) Which electrons in the silicon atom take part in chemical reactions with other atoms?

_____

_____

(1)

(iii) What features of all the atoms of the elements in group 4 of the Periodic Table might give them similar chemical properties?

_____

_____

(1)

(b) Silicon is difficult to classify as a metal or a non-metal because it has properties which resemble both. Some of the properties of silicon are listed below.

- Silicon is a shiny blue/grey solid.
- Silicon is placed in Group 4 of the Periodic Table.
- Silicon has a relative atomic mass of 28.
- Silicon has a very high melting point (1410ºC).
- Silicon has a very high boiling point (2355ºC).
- Silicon conducts electricity.
- Silicon oxide will neutralise alkalis.
- Silicon forms compounds in which the silicon atoms are bonded to other atoms by covalent bonds.

(i) Select **two** properties from the list above in which silicon resembles a metal.

1. _____

2. _____

(2)

(ii) Select **two** properties from the list above in which silicon resembles a non-metal.

1. _____

2. _____

(2)

(Total 8 marks)

Q39.

Limestone ($CaCO_3$) is a raw material. On strong heating it is converted to calcium oxide which is a very useful substance.

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$$

(a) Calculate the formula mass (M_r) of calcium carbonate.

_____

M_r of calcium carbonate = _____

(2)

(b) About 60 million tonnes of calcium oxide is made in Britain each year.
Calculate the mass of calcium carbonate needed to make this amount of calcium oxide.

_____

Mass of calcium carbonate needed = _____ million tonnes

(4)

(c) Water is added to some of the calcium oxide produced in a process known as 'slaking'. The product of this reaction is used to make plaster.

$CaO_{(s)} + H_2O_{(1)} \rightarrow Ca(OH)_{2(s)}$

(i) Give the chemical name of $Ca(OH)_2$.

(1)

(ii) What is the physical state of the $Ca(OH)_2$ formed in the reaction?

(1)

(Total 8 marks)

Q40.

Fluorine is the most reactive element in group 7 of the Periodic Table.
Fluorine reacts with all the other elements in the Periodic Table except some of the noble gases. It does not react with helium, neon and argon, but it does react with xenon. Many substances burst into flames when exposed to fluorine.

(a) (i) The electronic structure of chlorine is 2.8.7. What is the electronic structure of fluorine?

(1)

(ii) What is the electronic structure of the chloride ion Cl^-?

(1)

(iii) Explain why fluorine is more reactive than chlorine.

(4)

(b) (i) What does the information at the start of this question suggest about the reactivity of the elements in group 0?

_____

_____

(1)

(ii) A chemist did an experiment to find out if fluorine reacts with xenon. The two gases were mixed in a glass container. The only product detected was silicon fluoride. Explain what happened.

_____

_____

_____

(2)

(iii) The experiment was repeated many years later but the gases were mixed in a different type of container. A white solid was obtained which was xenon fluoride.

Predict whether you think (1) krypton and (2) radon will react with fluorine. Explain the reasons for your predictions.

_____

_____

_____

_____

_____

_____

(5)

(Total 14 marks)

Q41.

There are millions of different substances that make up our world. All these substances are made from chemical elements.

(a) What is an element?

_____

_____

_____

_____

(1)

(b) Many substances are compounds. What is a compound?

_____

_____

_____

_____

(2)

(Total 3 marks)

Q42.

Use the Periodic Table on the Data Sheet to help you to answer this question.

(a) State **one** similarity and **one** difference in the electronic structure of the elements:

(i) across the Period from sodium to argon;

_____

_____

_____

(2)

(ii) down Group 7 from fluorine to astatine.

_____

_____

_____

(2)

(b) (i) State the trend in reactivity of the Group 1 elements.

_____

(1)

(ii) Explain this trend in terms of atomic structure.

_____

_____

_____

_____

_____

(3)

(c) Hydrogen is an element which is difficult to fit into a suitable position in the Periodic Table. Give reasons why hydrogen could be placed in either Group 1 or Group 7.

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

Q43.

The extract below was taken from a leaflet on the uses of platinum. One of the uses described was in making electrodes for spark plugs in car engines. The spark plug produces the spark which ignites the fuel in the engine.

Spark Plugs

The electrodes in a spark plug have to conduct electricity very well. Since they project into the combustion chamber of the engine, they must also be able to withstand extremely high temperatures in a very corrosive atmosphere.

Nickel-based plugs have been produced for many years. They only last a fairly short time. As the electrodes wear, combustion becomes less efficient and the petrol is not burnt completely.

Platinum and other precious metals can now be used in spark plugs. These last much longer and are more efficient. This can help to reduce air pollution.

The table below gives some information about platinum and nickel.

	MELTING POINT (° C)	BOILING POINT (° C)	POSITION IN REACTIVITY SERIES	COST (£/kg)
nickel	1455	2920	Higher than gold	2.5
platinum	1769	4107	below gold	6110

(a) Compare nickel and platinum for use in making the electrodes in spark plugs.

A good answer should give advantages and disadvantages of each metal linking these to the properties of the metals. Marks will be given for the way in which you organise your answer.

You will need a sheet of lined paper.

(8)

(b) (i) Describe the structure and bonding in metals.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain why metals such as nickel and platinum are good conductors of electricity.

_____

_____

_____

(2)

(Total 13 marks)

Q44.

One step in the manufacture of lead is the reduction of lead oxide with carbon. Lead and carbon dioxide are the products of this reaction.

(a) Write a word equation for this reaction.

_____

(1)

(b) What is meant by “reduction”?

_____

(1)

(Total 2 marks)

Q45.

Read the following information about an element X.

The element X melts above 600°C. It conducts electricity at room temperature. It burns in oxygen to form an oxide. When the oxide is mixed with water it turns Universal Indicator blue.

The oxide of X is a white solid at room temperature. It has the formula XO and contains the ion X^{2+}.

The element X reacts with chlorine to form a chloride with a high melting point. The chloride conducts electricity when molten and it is soluble in water.

(a) From the information give **three** pieces of evidence which suggest that X is a metal.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) In which Group of the Periodic Table should X be placed? Give a reason for your answer.

Group _____

Reason _____

_____

(2)

(c) Predict the formula for the chloride of X. _____

(1)

(Total 6 marks)