

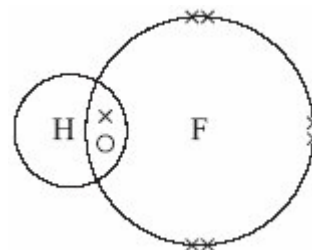
**Atomic structure, analysis and quantitative chemistry**

1. This question is about fluorine and some of its compounds.

(a) The diagram represents a molecule of hydrogen fluoride.

Draw a ring around the type of bonding that holds the hydrogen and fluorine atoms together in this molecule.

**covalent                  ionic                  metallic**



(1)

(b) Fluorine is made in industry by the electrolysis of a mixture of potassium fluoride and hydrogen fluoride.

(i) Use **one** word from the box to complete the sentence.

|            |               |              |
|------------|---------------|--------------|
| <b>gas</b> | <b>liquid</b> | <b>solid</b> |
|------------|---------------|--------------|

To allow electrolysis to take place the mixture of potassium fluoride and hydrogen fluoride must be .....

(1)

(ii) The mixture of potassium fluoride and hydrogen fluoride contains fluoride ions (F<sup>-</sup>), hydrogen ions (H<sup>+</sup>) and potassium ions (K<sup>+</sup>).

Use **one** word from the box to complete the sentence.

|                 |                 |                  |
|-----------------|-----------------|------------------|
| <b>fluorine</b> | <b>hydrogen</b> | <b>potassium</b> |
|-----------------|-----------------|------------------|

During electrolysis the element formed at the **positive** electrode is .....

(1)

(c) Fluoride ions are sometimes added to drinking water. It is thought that these ions help to reduce tooth decay.

(i) Tick (✓) **one** question that **cannot** be answered by scientific investigation alone.

| Question   | Tick (✓) |
|--|----------|
| Do fluoride ions in drinking water reduce tooth decay? |          |
| Are fluoride ions in drinking water harmful to health? |          |
| Should fluoride ions be added to drinking water?       |          |

(1)

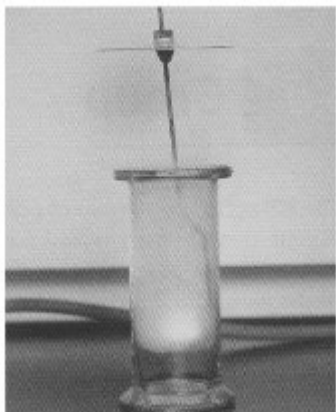
(ii) Explain why you have chosen this question.

.....  
 .....

(1)

**(Total 5 marks)**

2. The picture shows sodium reacting with chlorine. The reaction forms sodium chloride.



(a) Use words from the box to answer the questions.

|          |         |             |         |
|----------|---------|-------------|---------|
| compound | element | hydrocarbon | mixture |
|----------|---------|-------------|---------|

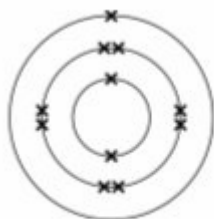
Which word best describes:

(i) sodium ..... (1)

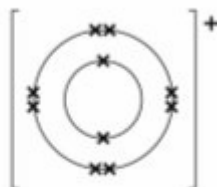
(ii) sodium chloride? ..... (1)

(b) When sodium reacts with chlorine the sodium atoms change into sodium ions.

The diagrams below represent a sodium atom and a sodium ion.



Sodium atom (Na)



Sodium ion (Na<sup>+</sup>)

Use the diagrams to help you explain how a sodium atom turns into a sodium ion.

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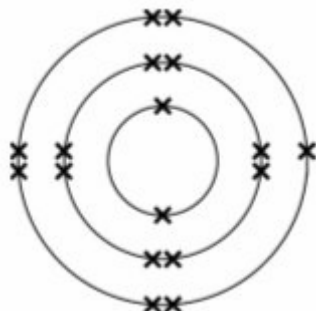
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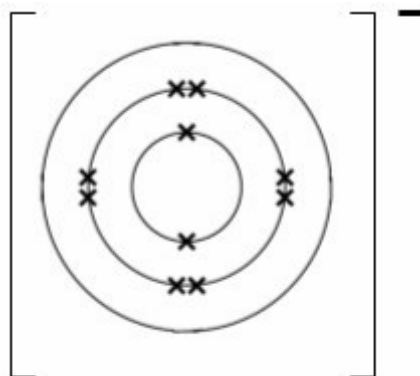
(2)

(c) (i) The diagram below represents a chlorine atom.



When chlorine reacts with sodium the chlorine forms negative chloride ions.

Complete the diagram below to show how the outer electrons are arranged in a chloride ion ( $\text{Cl}^-$ ).



(1)

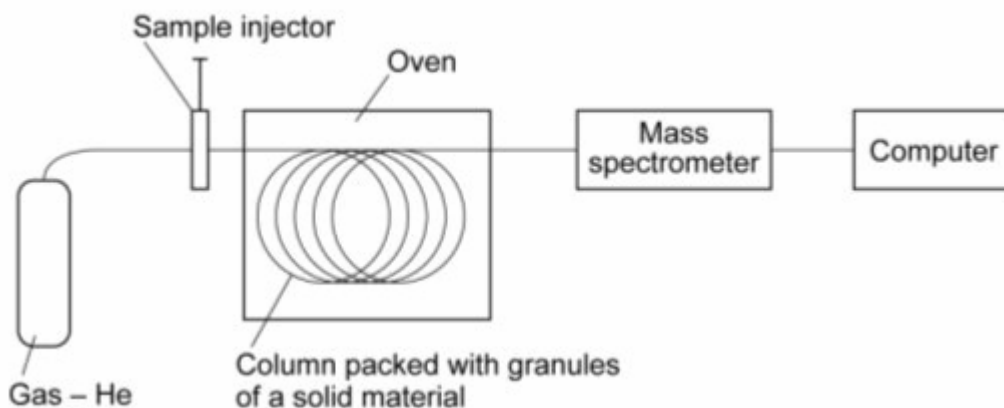
(ii) Chloride ions are strongly attracted to sodium ions in sodium chloride. Explain why.

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 .....

(1)

(Total 6 marks)

3. The diagram shows the main parts of an instrumental method called gas chromatography linked to mass spectroscopy (GC-MS).



This method separates a mixture of compounds and then helps to identify each of the compounds in the mixture.

(a) In which part of the apparatus:  
 (i) is the mixture separated? ..... (1)

(ii) is the relative molecular mass of each of the compounds in the mixture measured?  
 ..... (1)

(iii) are the results of the experiment recorded? ..... (1)

(b) (i) Athletes sometimes take drugs because the drugs improve their performance. One of these drugs is ephedrine.

Ephedrine has the formula: **C<sub>10</sub>H<sub>15</sub>NO**

What relative molecular mass (*Mr*) would be recorded by GC-MS if ephedrine was present in a blood sample taken from an athlete?

Show clearly how you work out your answer.

Relative atomic masses: H = 1; C = 12; N = 14; O = 16.

.....  
 .....

Relative molecular mass = ..... (2)

(ii) Another drug is amphetamine which has the formula: **C<sub>9</sub>H<sub>13</sub>N**

The relative molecular mass (*Mr*) of amphetamine is 135.

Calculate the percentage by mass of nitrogen in amphetamine.

Relative atomic mass: N = 14

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 .....

Percentage of nitrogen = ..... % (2)

(c) Athletes are regularly tested for drugs at international athletics events. An instrumental method such as GC-MS is better than methods such as titration.

Suggest why.

.....  
 .....

(2)

- (d) When a blood sample is taken from an athlete the sample is often split into two portions. Each portion is tested at a different laboratory.

Suggest why.

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(2)  
(Total 11 marks)

4. An advert for some crisps claims that they now contain only 30% saturated fat because they are cooked in sunflower oil. The crisp company used bromine water to compare percentage unsaturation of sunflower oil with four other vegetable oils, **A**, **B**, **C** and **D**.

| Oil       | Volume of bromine water added until the bromine colour just remains (cm <sup>3</sup> ) |        |        |         | Percentage unsaturation (%) |
|-----------|--|--------|--------|---------|-----------------------------|
|           | Test 1   | Test 2 | Test 3 | Average |                             |
| Sunflower | 25.4   | 28.0   | 27.0   | 26.8    |                             |
| <b>A</b>  | 13.0   | 14.0   | 15.0   | 14.0    | 35                          |
| <b>B</b>  | 23.2   | 11.2   | 24.0   | 23.6    | 59                          |
| <b>C</b>  | 19.9   | 21.1   | 20.2   | 20.4    | 51                          |
| <b>D</b>  | 9.5  | 8.8    | 9.3    | 9.2     | 23                          |

- (i) What is the range of percentage unsaturation for oils **A**, **B**, **C** and **D**?

Range = ..... %

(1)

- (ii) Describe and explain what happens to the first drops of bromine water that are added to these oils.

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(2)

- (iii) The average for oil **B** is given as 23.6 cm<sup>3</sup>. Explain how this average has been calculated.

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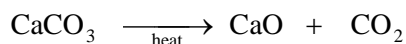
(1)

- (iv) The results did **not** show that sunflower oil contains 30% saturated fat.  
Explain why. (You will need to calculate the percentage unsaturation of sunflower oil.)

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 .....  
 .....

(2)  
(Total 6 marks)

5. Limestone (CaCO<sub>3</sub>) is a raw material. On strong heating it is converted to calcium oxide which is a very useful substance.



- (a) Calculate the formula mass (M<sub>r</sub>) of calcium carbonate.

.....  
 M<sub>r</sub> of calcium carbonate = .....

(2)

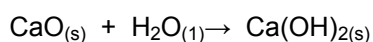
- (b) About 60 million tonnes of calcium oxide is made in Britain each year.  
Calculate the mass of calcium carbonate needed to make this amount of calcium oxide.

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

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.



- (i) Give the chemical name of Ca(OH)<sub>2</sub>.

.....

(1)

- (ii) What is the physical state of the Ca(OH)<sub>2</sub> formed in the reaction?

.....

(1)

(Total 8 marks)

6. Perfumes contain a mixture of chemicals.

The main ingredients of perfumes are a solvent and a mixture of fragrances.

(a) A sample of the solvent used in one perfume contained 0.60 g of carbon, 0.15 g of hydrogen and 0.40 g of oxygen.

Relative atomic masses: H = 1; C = 12; O = 16.

Calculate the empirical (simplest) formula of the solvent.

You must show all of your working to gain full marks for this question.



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(4)

(b) Solvent molecules evaporate easily.

Explain why substances made of simple molecules evaporate easily.

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(2)

(c) Most companies claim that their perfumes have been tested on skin. A study was made of the tests they used. The study found that each company used different tests.

The perfumes were tested in the companies' own laboratories and **not** by independent scientists. Some companies did not give any information about the tests that they had used.

(i) Suggest why companies test their perfumes on skin.

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(1)

(ii) Did the study show that the tests made by the different companies were valid and reliable? Explain your answer.

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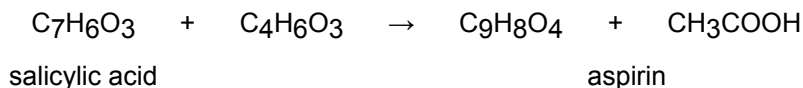
(2)

(Total 9 marks)

7. Aspirin tablets have important medical uses.

(a) Aspirin is made when salicylic acid reacts with ethanoic anhydride.

The equation for this reaction is:



Calculate the maximum mass of aspirin that could be made from 100 g of salicylic acid.

Show clearly how you work out your answer.

The relative formula mass ( $M_r$ ) of salicylic acid ( $\text{C}_7\text{H}_6\text{O}_3$ ) is 138.

The relative formula mass ( $M_r$ ) of aspirin ( $\text{C}_9\text{H}_8\text{O}_4$ ) is 180.



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Maximum mass of aspirin = ..... g

(2)

(b) (i) In an experiment a chemist calculated that the maximum yield of aspirin is 400g. The chemist did the experiment but only made 250g of aspirin. Calculate the percentage yield of aspirin for this experiment.

Show clearly how you work out your answer.

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.....

Percentage yield of aspirin = ..... %

(2)

(ii) Suggest **one** possible reason why the chemist did **not** have a percentage yield of 100%.

.....

.....

(1)

(c) The use of a catalyst might reduce costs in the industrial production of aspirin. Suggest how.

.....

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(1)

(Total 6 marks)