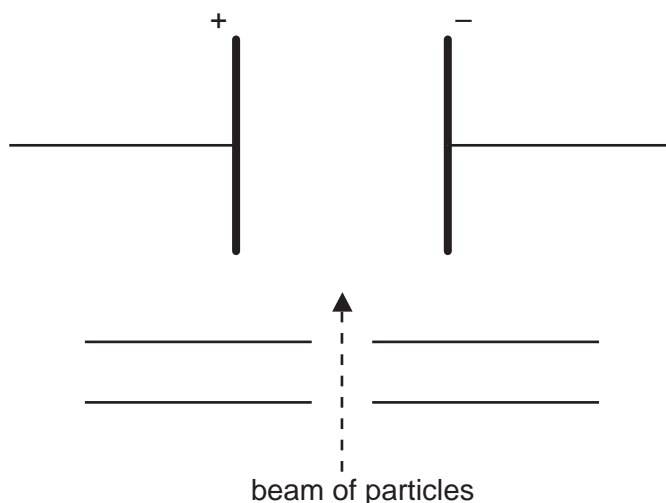


Answer **all** the questions in the spaces provided.

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- 1 In the 19th and 20th centuries, scientists established the atomic theory and showed that three sub-atomic particles, electron, neutron and proton, exist. The masses and charges of these three particles were subsequently determined.

When separate beams of electrons, neutrons or protons are passed through an electric field in the apparatus below, they behave differently.



- (a) (i) Which of these three particles will be deflected the most by the electric field?

.....

- (ii) In which direction will this particle be deflected?

.....

- (iii) Explain your answer.

.....

.....

[4]

- (b) (i) Define the term *proton number*.

.....

.....

- (ii) Why is the proton number of an atom of an element usually different from the nucleon number of an atom of the element?

.....

.....

[2]

- (c) Protons and neutrons have been used in nuclear reactions which result in the formation of artificial elements. In such processes, protons or neutrons are accelerated to high speeds and then fired like 'bullets' at the nucleus of an atom of an element.

Suggest why neutrons are more effective than protons as 'nuclear bullets'.

.....
..... [2]

- (d) In some cases, when neutrons are fired at atoms of an element, the neutrons become part of the nucleus of those atoms.

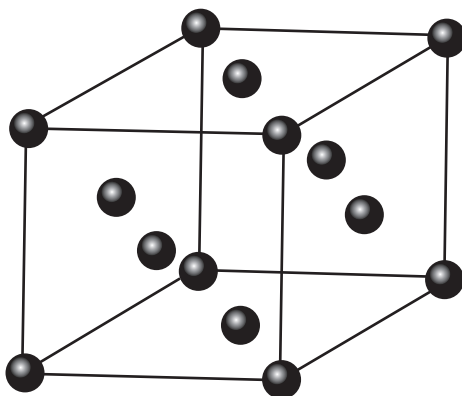
What effect does the presence of an extra neutron have on the chemical properties of the new atoms formed? Explain your answer.


.....
.....
..... [2]

[Total: 10]

- 2 Copper and iodine are both solids which have different physical and chemical properties. Each element has the same face-centred crystal structure which is shown below.

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The particles present in such a crystal may be atoms, molecules, anions or cations. In the diagram above, the particles present are represented by .

- (a) Which type of particles are present in the iodine crystal? Give their formula.

particle

formula

[2]

- (b) When separate samples of copper or iodine are heated to 50°C , the copper remains as a solid while the iodine turns into a vapour.

- (i) Explain, in terms of the forces present in the solid structure, why copper remains a solid at 50°C .

.....

- (ii) Explain, in terms of the forces present in the solid structure, why iodine turns into a vapour when heated to 50°C .

.....

[4]

- (c) (i) Although copper is a relatively unreactive metal, when it is heated to a high temperature in an excess of chlorine, copper(II) chloride is formed.

How does chlorine behave in this reaction?

.....

- (ii) When a mixture of copper and iodine is heated to a high temperature, no reaction occurs.

Suggest a reason for this difference.

.....

.....

[2]

[Total: 8]

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(b) Use the elements shown opposite to answer the following questions.

- (i) Give the formulae of **two** acidic oxides formed by the same element.

..... and

- (ii) Give the name or formula of an oxide that is amphoteric.

.....

- (iii) Identify an element whose oxide dissolves readily in water to give a strongly alkaline solution.

.....

- (iv) Identify an element in Period 3 (Na to Ar) whose chloride dissolves in water to give a neutral solution.

.....

- (v) Identify an element that reacts with water to give a solution that can behave as an oxidising agent.

.....

[6]

[Total: 12]

- 4 Octadecane, $C_{18}H_{38}$, is a long chain hydrocarbon which is present in crude oil. Such long chain hydrocarbons are 'cracked' to produce alkanes and alkenes which have smaller molecules.

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- (a) Give **two** different conditions under which long chain molecules may be cracked.

.....

 [2]

- (b) Octadecane, $C_{18}H_{38}$, can be cracked to form hexane and an alkene.

Write a balanced equation for this reaction.

..... [1]

Alkenes are important industrially because the $C=C$ bond makes them very reactive.

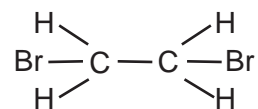
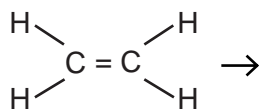
- (c) Ethene reacts with bromine to give 1,2-dibromoethane.

- (i) What type of reaction is this?

.....

- (ii) Outline the mechanism of this reaction, giving the structure of the intermediate.

Show clearly any relevant dipoles, charges and lone pairs of electrons.



[4]

The unsaturated hydrocarbon **Z** is obtained by cracking hexane and is important in the chemical industry.

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The standard enthalpy change of combustion of **Z** is $-2059 \text{ kJ mol}^{-1}$.

(d) Define the term *standard enthalpy change of combustion*.

.....
..... [2]

When 0.47 g of **Z** were completely burnt in air, the heat produced raised the temperature of 200 g of water by 27.5°C .

(e) (i) Calculate the amount of heat released in this experiment.

(ii) Use the data above and your answer to (i) to calculate the relative molecular mass of **Z**.

[4]

(f) Deduce the molecular formula of **Z**.

[1]

(g) The unsaturated hydrocarbon **Z** can be polymerised.

Draw the structure of the polymer of **Z** showing **two** repeat units.

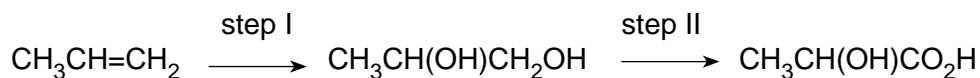
[1]

[Total: 15]

5 Lactic acid, 2-hydroxypropanoic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$, occurs in sour milk.

Glycollic acid, 2-hydroxyethanoic acid, $\text{HOCH}_2\text{CO}_2\text{H}$, occurs in sugar cane.

(a) Lactic acid may be synthesised from propene by the following sequence.



(i) What reagent(s) and condition(s) are used for step I?

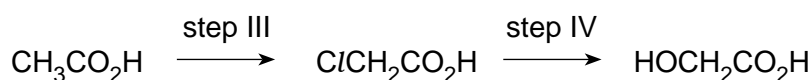
reagent(s)

condition(s)

(ii) What type of reaction is step II?

..... [3]

(b) Glycollic acid may be synthesised from ethanoic acid by the following sequence.



(i) Suggest the reagent(s) and condition(s) that are used for step III.

reagent(s)

condition(s)

(ii) What reagents and conditions are used in step IV?

reagent(s)

condition(s)

[4]

(c) Lactic acid and glycollic acid react differently when heated under reflux with acidified dichromate(VI) ions.

Draw the structural formula of the organic product in **each** case.

product from lactic acid

product from glycollic acid

[2]

- (d) Lactic acid is chiral. Draw displayed formulae of the two optical isomers of lactic acid clearly showing their three-dimensional structures. Indicate with an asterisk (*) the chiral carbon atom in each.

[2]

Glycollic acid and lactic acid each give the reactions of an alcohol group and of a carboxylic acid group. Each compound will react with the other to give an ester.

- (e) When one molecule of glycollic acid reacts with one molecule of lactic acid, it is possible to form two different esters.

Draw the structure of **each** of these esters.

[2]

Glycollic acid and lactic acid are reacted together to make the material for 'soluble stitches' (also known as 'soluble sutures') which are used in surgery.

In this material, many molecules of each acid have been reacted to form a long chain 'polyester' molecule which contains many ester groups.

This polyester is used in surgery to sew up wounds inside the body.

Over a period of time, the polyester undergoes a chemical reaction and breaks up to re-form the two individual hydroxy-acids.

- (f) (i) This reaction occurs where the pH of the body is about pH5 to pH6. Suggest what type of chemical reaction causes the polyester material to break up.

.....

- (ii) Suggest why the products of this reaction are soluble in water.

.....

.....

[2]

[Total: 15]

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