**Nuffield Advanced Chemistry Special Study: *Food science***
**Sample examination questions**

**Q1** ***[Adapted from Edexcel Chemistry (Nuffield) 1996]***

(a) (i) Explain why water is classified as a nutrient. (1)
(ii) Describe THREE functions of water in the human body. (3)
(iii) Describe THREE ways in which water is held within a food substance. (3)
(iv) Explain why fresh strawberries are more crisp than defrosted strawberries. (1)

(b) (i) State the THREE main types of micro-organisms found in food and indicate their relative sizes. State which type causes the majority of food spoilage. (3)

(ii) Sketch and fully label a bacterial growth curve using, for the vertical axis, *lg (number of cells*) and for the. horizontal axis *time.*
Explain the meanings of all the phases. (4)

(iii) Undesirable bacteria can be divided into two groups: the spoilage organisms and the pathogens. Explain the meaning of each of these classifications and give one practical example of each. (4)

(iv) Two pieces of freshly-cut apple were treated as follows: the first was dipped into phenol solution and the other was dipped into water. Both pieces were then treated with 1,2-dehydroxybenzene solution and left exposed to the air. What is the expected outcome of this experiment, and what explanation can be offered? (2)

(c) (i) The average milk consumption in the U.K. is 0.4 $dm^3$ per person per day. 1236 mg of calcium are contained in 1 $dm^3$ of milk. If the average woman's daily calcium requirement is 500 mg, what percentage of her daily calcium requirement is provided by 0.4 $dm^3$ of milk? (1)

(ii) Give TWO reasons why calcium is needed in the human diet. (2)

(iii) Triglycerides occur in large quantities in cream. Draw the structural formula of a triglyceride, showing alkyl groups as R′, R″ etc. (1)

(iv) In recent years the quantity of skimmed milk drunk has increased.
State TWO advantages and TWO disadvantages of drinking skimmed milk rather than whole milk (do not include taste). (4)

(v) Why is it inadvisable to drink milk from a cow which is being treated with antibiotics for an udder infection? (1)

**Total 30 marks**

**Q2** ***[Adapted from Edexcel Chemistry (Nuffield) 1997]***

(a) Protein molecules consist of 2-amino acids linked together with peptide groups. Some proteins are enzymes.

(i) Draw the general structure of a 2-amino acid, representing an alkyl group by R. (1)

(ii) Describe what is meant by the primary, secondary and tertiary structure of a protein. (3)

(iii) Explain TWO ways by which the tertiary structure is maintained. (2)

(iv) Sketch graphs to indicate the change in the rate of enzyme activity with
• temperature.
• pH.
Give reasons in each case for the shape of the graph, and indicate the area of optimum enzyme activity in each case. (6)

(b) The browning of potatoes is a food spoilage process which is enzyme-catalysed. In experiments to illustrate the nature and prevention of browning, slices of potato are freshly cut and treated in various ways. The slices may then be treated with 1,2-dihydroxybenzene solution and observed over a period of time.

(i) What is the purpose of using the 1,2-dihydroxybenzene solution, and why is its use appropriate? (2)

(ii) What control experiments should accompany experiments such as these, and why should they be carried out? (2)

(iii) The browning of apples may be retarded by the use of:
• ascorbic acid
• salt
In each case, explain why the treatment is effective. (4)

(iv) Suggest ONE dietary advantage of using ascorbic acid to retard browning, and ONE disadvantage of using salt. (2)

(c) Flour for bread manufacture must be of a particular quality, and must be harvested and subsequently treated in ways which make it suitable for the purpose.

(i) State **TWO** disadvantages of harvesting wheat with a high moisture content. (2)

(ii) What happens when wheat is passed through **break rolls** and **reduction rolls?** (2)

(iii) What advantage is there in storing flour for a time before use, and how may the same effect be achieved more quickly? (2)

(iv) What is a **strong flour,** and why is it more suitable for bread-making than other types of flour? (2)

**TOTAL 30 marks**

**Q3** ***[Adapted from Edexcel Chemistry (Nuffield) 1998]***

(a) Fats, proteins, carbohydrates and water are four of the six types of nutrients that must be present in a healthy diet. Fats (triglycerides) are esters of propane-1,2,3-triol.

(i) Name the TWO other types (in addition to the ones named above) of nutrients necessary for a healthy diet. (2)

(ii) Draw the structural formula of a triglyceride using R′, R″ etc to represent alkyl groups. (1)

(iii) Certain fats provide essential fatty acids. What is an **essential** fatty acid? (2)

(iv) State TWO functions of proteins in the human system. (2)

(v) Hydrolysis of proteins results in a maximum of 21 different amino acids. Explain why only 8 of these amino acids are essential for the human diet.

(vi) Cellulose is a carbohydrate, made from approximately 10,000 glucose units. Explain why it is not classed as a nutrient, but is acknowledged as of value in the human diet. (2)

(vii) Outline THREE main functions of water in the human body. (3)

(b) The following experiment can be used to estimate the amount of protein in a flour.

A 6-g sample of flour A was weighed into a dry weighing bottle.
50 $cm^3$ of pure water was placed in a stoppered 100 $cm^3$ measuring cylinder.
50 $cm^3$ of a standard sodium dodecyl sulphate/lactic acid solution was placed in a 50-$cm^3$ measuring cylinder.
The 6 g sample was carefully added to the water in the 100-$cm^3$ measuring cylinder.

The timing was started, and the stoppered cylinder was subjected to a standardised mixing and shaking routine, during which the solution of sodium dodecylsulphate was added.

When the mixing and shaking routine was finished, the cylinder was placed upright and allowed to stand.

After 30 minutes, the volume of sediment in the measuring cylinder was measured.

The experiment was repeated for flour sample B.

(i) Describe TWO factors which would need to be strictly controlled for this experiment to give a fair comparison of the different flours. (2)

(ii) Explain what is happening to the flour, and how this is related to the sedimentation volume. (2)

(iii) A is a **stronger** flour than B. What is meant by this statement, and how would the experiment show this to be the case? (2)

(iv) Describe the role of the flour protein in the making of bread. (2)

(c) This section is concerned with food legislation.

(i) Why was there no need for food legislation in the UK until the 19th century? (1)

(ii) The 1990 Food Safety Act created four principal criminal offences, two relating to food safety and two relating to consumer protection. What are these FOUR offences? (4)

(iii) Labelling has become an important issue in consumer protection.
All foods are required to be labelled with seven specific descriptors.
Give TWO of these descriptors. (2)

(iv) In what way does irradiation help to preserve food from deterioration?
What disadvantage results from the excessive use of radiation?
Why is so little irradiated food actually on sale? (3)

**TOTAL 30 marks**

**Q4** ***[Adapted from Edexcel Chemistry (Nuffield) 1999]***

(a) A fresh apple contains valuable nutrients and is a good source of vitamin C. It also has structural and chemical characteristics that make it an attractive food.

(i) State TWO chemical characteristics which affect the eating quality of an apple. (2)

(ij) Texture is an important structural characteristic: an apple should be firm and crisp.
Describe THREE factors which contribute to the firmness and crispness of an apple. (3)

(iii) Explain how an apple becomes soft:
(A) during storage;
(B) as it ripens on the tree;
(C) when it is cooked. (3)

(iv) State TWO functions of vitamin C in the body. (2)

(v) State TWO ways in which vitamin C is lost when apples are cooked in water. (2)

(b) (i) Two of the primary tastes are sweetness and saltiness. What are the other two primary tastes? (2)

(ii) Suggest TWO important safety precautions which should be taken when carrying out an experiment to find out the regions of the mouth which can detect the primary tastes. (2)

(iii) Describe, by diagram or in words, where, in the mouth, sweetness and saltiness are detected. (2)

(c) An experiment was carried out to convert whey solution into glucose solution using an immobilised enzyme. Beads of the immobilised enzyme were placed in a 10-$cm^3$ plastic syringe body fitted with a stop-tap in place of the needle. 50 $cm^3$ of 8% whey solution were allowed to percolate at a steady rate through the enzyme, and the glucose concentration was determined using glucose test strips at regular time intervals. The procedure was carried on until the glucose concentration was very low.

(i) What is meant by an **immobilised** enzyme? (1)

(ii) How might a whey solution be obtained from milk? (2)

(d) This part of the question is about microbial and biochemical changes in food.

(i) Explain the difference between a pathogen and a spoilage organism. (2)

(ii) Name ONE pathogen. (2)

(iii) Explain the principles involved in each of the following processes, which are used to preserve meat:
(A) Freezing
(B) Canning (6)

TOTAL 30 marks

**Q5** ***[Adapted from Edexcel Chemistry (Nuffield) 2000]***

(a) The following nutritional information appeared on a box of cornflakes.

| | *Typical value /100 g* |
|---|---|
| Energy | 1550 kJ |
| Protein | 8 g |
| Carbohydrates | 83 g |
| (of which sugars) | 8 g |
| Fat | 1.2 g |
| (of which saturates) | 1.3 g |
| Sodium | 1.1 g |
| Fibre | 3 g |
| Vitamins | |
| Thiamin(B1) | 1.2 mg |
| Riboflavin (B2) | 1.3 mg |
| Niacin | 15 mg |
| Vitamin B6 | 1.7 mg |
| Folic acid | 333 μg |
| Vitamin B12 | 0.85 μg |
| Iron | 7.9 mg |

(i) What chemical substance will provide the majority of the carbohydrate content of the cornflakes? (1)

(ii) Under European Union Law, all foods must be labelled by seven descriptors. Name TWO of these descriptors. (2)

(iii) State the function of each of the following substances in the human body:
Sodium
Thiamin (B1)
Iron (3)

(iv) Cornflakes are usually eaten with milk. Name TWO other important mineral elements (not given in the above table) that would be provided by the milk. (2)

(v) State TWO functions of fats in our bodies. (2)

(vi) Explain the difference between a saturated and an unsaturated fat. (1)

(vii) Vegetable oils are generally unsaturated. Describe the chemistry of the process by which these oils can be hardened to produce margarine. (2)

(b) When apples are prepared for eating, spoilage rapidly occurs due to enzyme reactions and the tissue turns brown.

(i) In an experiment, three cut apple segments were treated as follows.
Segment A: immersed in a water bath at 100 °C for 1 minute.
Segment B: immersed in a water bath at 40 °C for 1 minute.
Segment C: immersed in pure water at room temperature for 1 minute.
The slices were removed and left exposed to the air.

State and explain the relative rates of browning. (3)

(ii) A recipe for home-made fruit salad requires slices of raw apple to be prepared some time before being eaten. Describe and explain THREE ways in which the browning reaction could be controlled so that the slices do not spoil. (6)

(c) Milk can be bought in many different forms in a supermarket. For instance, it can be purchased as pasteurised, evaporated, dried, UHT, skimmed or semi-skimmed milk.

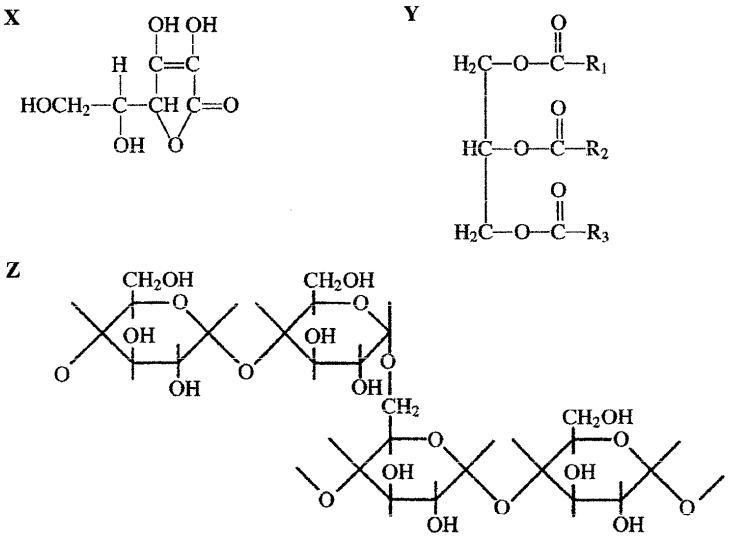
(i) Describe, commenting on how the durability and taste of the milk is affected, the processes of producing milk in the forms:
(A) UHT
(B) pasteurized. (6)

(ii) State and explain which form of milk you would recommend for someone going on a back-packing holiday. (2)

**TOTAL 30 marks**

**Q6** ***[Adapted from Edexcel Chemistry (Nuffield) 2001]***

(a) (i) Identify the TYPES of nutrients represented by the formulae X, Y and Z, and state ONE function of each.




(6)

(ii) In foods of animal origin, the texture is due mainly to proteins, such as collagen, which are made from amino acids. Draw the general displayed formula of an amino acid representing an alkyl group by R. (1)

(iii) Draw the structure of a dipeptide that can be formed by condensing two amino acids. Represent the alkyl groups by R′ and R″. The peptide linkage should be fully displayed. (2)

(iv) Explain what is meant by the **tertiary** structure of a protein. (1)

(v) How does collagen change in physical properties as it becomes older? What structural changes are responsible for this? (2)

(vi) What happens to collagen on cooking? (1)

(b) A grain of wheat consists of starch contained in the endosperm surrounded by a tough skin collectively called the bran. In the production of white flour the bran is removed, which means that important vitamins are lost. Ascorbic acid and iron ions are two flour improvers that are added to flour used for bread-making.

(i) When a mixture of starch and water is gently heated, the starch gelatinises. Describe what happens to the starch grains and the water molecules when this happens. (3)

(ii) How can the point of gelatinisation be recognised? (1)

(iii) Explain why ascorbic acid is added to the flour. (2)

(iv) Why are iron ions added to flour? (1)

(v) Describe what is meant by a **strong** flour. Why is strong flour preferred for bread-making? (2)

(c) (i) State TWO problems associated with the preservation of food by freezing. (2)

(ii) Describe TWO advantages of freeze dehydration over heat dehydration. (2)

(iii) State and explain TWO ways in which packaging can increase the shelf life of foods. (2)

(iv) State TWO factors which must be taken into account when selecting materials for use in food packaging. (2)

**TOTAL 30 marks**

**Q7** ***[Adapted from Edexcel Chemistry (Nuffield) January 2002]***

(a) In the diet of many people, potatoes are a source of the following:
• vitamin C
• starch
• cellulose
• water.

(i) Explain the importance of each of these four substances in our diet. (8)

(ii) State THREE ways in which water is held within potato cells. (3)

(b) (i) What factors affect the:
• moisture content
• protein content
in flour from different wheat crops? (4)

(ii) Ascorbic acid is a commonly used flour improver. Its presence in flour may be detected by pouring a little dilute iodine solution over a wet sample of flour in a petri dish.
A What would you expect to SEE happening if ascorbic acid is present?
B What is the essential chemistry involved ? (You are not expected to write an equation) (3)

(iii) Iron compounds are sometimes added to flour. The presence of such compounds can be detected by adding acidified potassium thiocyanate to a dry sample of flour, and observing the result after about 10 minutes.
A What would you expect to SEE happening if iron compounds are present?
B The observed change is due to the formation of a complex ion involving iron(III) ions and thiocyanate ions, $CNS^-$. What is the formula for this complex ion? (2)

(c) Many vegetables are preserved by canning. The vegetables are blanched before being placed in cans which are then filled with steam and sealed. The cans are then heated by steam and cooled in sterile cold water.

(i) What is meant by 'blanching' and why is this process necessary? (3)
(ii) Explain why the cans are filled with steam before sealing. (2)
(iii) Give TWO disadvantages of heating the cans in steam. (2)
(iv) Explain why less heat treatment is needed for fruit than for vegetables (3)

**TOTAL 30 marks**