Version 1.0

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Design and Technology: Food Technology 5541/6541

FTY6

Mark Scheme

2005 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Section A

1 (a) Explain what is meant by the following terms.

Criteria for Marks Awarded	Mark Range
A weak answer, which may only outline the term. There will be little or no explanation of the term and only slight mention of the underlying chemical principles and / or structures	0-1
A good answer, which may not include all the relevant chemical details and terminology, but demonstrates a sound understanding of the term	2-3
A full answer, which takes account of chemical principles and molecular structure and makes use of all the correct terminology in describing the term.	4

(i) Fatty acids

There are about 40 different fatty acids found in foods and of these there are basically two types: *saturated fatty acids* and *unsaturated fatty acids.*

In saturated fatty acids, the hydrocarbon chain is saturated with hydrogen, but in unsaturated fatty acids the hydrocarbon chain is not saturated with hydrocarbon and therefore has one or more double bonds.

Unsaturated fatty acids may be either *monosaturated* (containing one double bond) or *polysaturated* (containing more than one double bond).

Saturated fatty acids include *butyric, palmitic and stearic* (found in milk fat, butter). Monounsaturated fatty acids include *oleic* (found in cooking fats and oils). Polyunsaturated fatty acids include *linoleic and linolenic* (found in vegetable and fish oils).

(4 marks)

(ii) Triglycerides

Fats are esters of glycerol and fatty acids. Each OH group of the glycerol reacts with the – COOH of a fatty acid to form a molecule of fat or oil. This is an example of a condensation reaction. Fats and oils are a mixture of triglycerides, which consists of one molecule of glycerol combined with three fatty acids (Diglycerides combine with two fatty acid molecules and monoglycerides combine with one).

The simplest type of triglyceride is one in which all three fatty acids are the same, though they usually contain two or three different fatty acids and are known as mixed triglycerides. Naturally occurring fats and oils are mixtures of different mixed triglycerides and therefore contain a number of different fatty acids.

(4 marks)

(iii) Rancidity

This is the term used to describe the spoilage of fats and oils. There are two types:

(a) Oxidative Rancidity (which occurs as a result of the reaction between unsaturated triglycerides and oxygen from the air)

(b) Hydrolytic rancidity (where the enzymes known as lipases hydrolyse fats, breaking them down into glycerol and fatty acids).

Oxidative rancidity can be accelerated by heat, light and copper or iron traces. Lipases occur naturally in fats and oils or can be produced by micro-organisms present in fatty foods. Heat processing can inactivate lipases.

(4 marks)

(b) Describe the process of hydrogenation in the manufacture of margarine.

Margarine is an emulsion of water in fat. A portion of the vegetable fat used in margarine is hardened by hydrogenation to produce the required plasticity in the final product before it is blended with the water.

Hydrogenation (hardening) is undertaken to remove some of the double bonds in the fatty acids and effectively to make them more saturated. It turns a liquid into a solid by adding hydrogen across the double bonds in the unsaturated fatty acid molecules. It is carried out by heating the oil in large sealed vessels under pressure. Hydrogen is bubbled into the oil with finely divided nickel (which acts as a catalyst and is subsequently removed by filtration). The oil blend is mixed with the water phase, which is skimmed milk, soured under controlled conditions to give the right flavour to the product. Salt, vitamins A and D and artificial colouring are then added. The mixture is then mixed to achieve an emulsion and cooled.

Hard margarines are more hydrogenated (i.e. saturated) than soft margarines.

Criteria for Marks Awarded	Mark Range
A weak answer. The candidate understands little about the process of hydrogenation	0-3
A good answer in which the candidate describes, reasonably accurately, the process involved.	4-6
A full and detailed answer. The candidate demonstrates a sound understanding of hydrogenation	7-8

(8 marks)

(c) Why are trans fatty acids considered to be harmful to health?

Trans fatty acids are unsaturated fats that have been hydrogenated, usually in food processing, and become hard at room temperature. They then become like saturated fats in the manner in which they act in the body. Evidence is emerging that trans fatty acids may be more damaging for the body than saturated fats because they not only raise levels of LDL blood cholesterol but also lower levels of the good (HDL) cholesterol. There are more sinister associations with trans fats possibly triggering some cancers.

Criteria for Marks Awarded	Mark Range
The candidate has little or no knowledge or understanding of trans fatty acids.	0-1
A reasonable attempt at describing the term. There are some gaps in the candidate's knowledge however	2-3
A detailed and thorough knowledge and understanding is shown.	4

(4 marks)

2 (a) Explain why the following would be used in the manufacture of a sauce-based product that contains fish.

Criteria for Marks Awarded	Mark Range
A weak answer, which may only outline the term. Little or no meaningful explanation is evident.	0-1
A good answer, which covers the most obvious points. Some use of technical terms is evident.	2-3
A full answer. The candidate has a sound knowledge and understanding of the additives and provides a detailed explanation of why they would be used.	4

(i) Preservatives

Preservatives will be used to help keep the product safe for longer than it would normally last. Fish is a high risk food, high in protein and moisture and susceptible to microbial contamination and growth. Preservatives will extend the shelf life and inhibit the growth of micro-organisms that cause food spoilage and lead to food poisoning.

(4 marks)

(ii) Modified starch

Modified starch will be used to prevent the weeping of water from the starch-based sauce upon standing (syneresis). The process is the opposite of gelatinisation and is known as retrogradation. Modified starches are widely used by food manufacturers to prevent syneresis from occurring. The starches used have been altered by a process known as *stabilisation.* High amylopectin starches e.g. waxy corn starches are used, especially for freeze-thaw processes because it does not retrograde easily. They are useful for cold temperature storage of processed foods, including sauce-based products.

(4 marks)

(iii) Antioxidants

Anti-oxidants will be used to prevent the fat in the food combining with oxygen and becoming rancid, through oxidation. This would give the food an unpleasant flavour and smell. Anti-oxidants are often used in fish products (oily fish having a high fat content). Typical ones include:
Tocopherol (vitamin E) and sulphur dioxide.

(4 marks)

(b) **Why do some cuts of meat require different cooking methods than others? Make reference to the structure of meat in your answer.**

Meat is the flesh or muscle of animals. It is composed of microscopic fibres that are held together by connective tissue to form bundles. Fatty deposits and blood vessels are also found between bundles of fibres. The cells of the muscle fibres contain two soluble proteins **actin** and **myosin**, which are responsible for the contraction of muscles. Connective tissue contains the proteins **collagen, elastin** and **reticulin.** Collagen is found in skin and tendons as well as around muscle fibres. During cooking it is gradually converted into gelatine. Elastin is a tough, insoluble protein and neither elastin nor reticulin is affectedby cooking. Elastin is commonly known as gristle.

The tenderness of meat is dependent upon the following:

1. Size of muscle fibres
2. Amount of connective tissue
3. Activity of the animal before death
4. Length of hanging

Cooking makes meat more tender, palatable and digestible. Around 80 – 100°C the collagen is softened and converted to gelatine, in the presence of water. Gelatine is soluble. This increases the tenderness of the meat as the muscle fibres separate more easily.

Cuts of meat that have long muscle fibres and contain large amounts of connective tissue will not be tender unless they are cooked by the correct method. Cuts with only small amounts of connective tissue can be cooked by dry heat methods (roasting, grilling, frying) as the meat contains enough water itself to soften the collagen. If large amounts of connective tissue are present, long, slow, moist methods are necessary (pot roasting or braising, using steam or stewing and boiling, using boiling liquid).

Knowledge of the cuts of meat will be credited. Candidates are not expected to discuss tenderising methods other than cooking methods in this question.

Criteria for Marks Awarded	Mark Range
A weak answer. The candidate has a limited knowledge and understanding of the structure of meat and is unclear about why different cooking methods are required.	0-3
A good answer. The candidate has made an effort to describe the structure of meat and may have illustrated the answer with examples of cuts of meat and relevant cooking methods. There will be some omissions in this answer.	4-6
A full and detailed answer. The candidate is able to explain the need for the different types of cooking method in relation to the structure of meat and the various cuts.	7-8

(8 marks)

(c) **Explain what is meant by the Maillard reaction (non-enzymic browning).**

The Maillard Reaction is also known as 'non-enzymic browning'. This is a browning reaction that occurs during the roasting, baking, grilling and frying of many foods. A chemical reaction takes place between the amino group of a free amino acid or a free amino group on a protein chain and the carbonyl group of a reducing sugar, e.g. glucose. Brown-coloured compounds are formed which are responsible for the deeper colour of products such as chips, baked biscuits and cakes, bread crusts and roasted meat. These compounds also improve the flavour of such products.

Criteria for Marks Awarded	Mark Range
A weak answer. The candidate shows a limited understanding of the term. Vague explanation of the underlying chemical reaction.	0-1
The candidate has attempted to explain the term. There may be some confusion. Some reference to chemical reactions taking place.	2-3
A good answer. The candidate demonstrates a full understanding of the reaction. Good use of chemical terminology.	4

(4 marks)

Section B

3 **Describe how CAD and CAM are used in the design and manufacture of food products. Give examples to support your answer.**

CAD packages are used to:

- Produce drawings to use images in such things as product profiles and design ideas
- Nutritional analysis
- Packaging nets
- Food labels
- HACCP design and system design
- Estimation of microbial growth
- Market research data

CAM is used because it saves time and it is an integral part of automated production. Computers can be used to control individual machines and/ or the whole system. Some uses of CAM are as follows:

- Standardising production
- Increasing speed and efficiency of production
- Enabling multi-tasking to take place e.g. icing many cakes simultaneously, rather than just one
- Monitoring the production system (CCPs, designated tolerances for temperature, pH, moisture content, weight etc.)
- Increases reliability of the finished product
- Reduces the need for storage (e.g. the 'just-in-time' system)
- Increases productivity
- Increases safety by using machines to carry out potentially dangerous tasks
- Data Handling: dealing with large amounts of information needed to set processes up and monitor them (e.g. HACCP, stock control etc.)
- Risk assessment

N.B. Marks will be awarded for each distinct usage of CAD / CAM. Additional marks will be awarded for explanation and examples.

Criteria for Marks Awarded	Mark Range
The candidate is able to distinguish between CAD and CAM and shows a limited knowledge and understanding of each. The explanation of each use may lack depth and detail however. Examples to support the answer may not always be provided. Candidates may discuss few distinct uses.	0-8
The candidate demonstrates a reasonable knowledge and understanding of the terms and is able to provide a range of examples for each (a minimum of six different uses are required to achieve marks in this section).	9-16
The candidate has a sound knowledge and understanding of the question and is able to describe fully the ways in which CAD and CAM are used in design and manufacture. A significant number of different uses are given, with sound examples and thorough explanation of each use.	17-24

(24 marks)

4 **"Manufacturers are keen to respond to the increased demand from customers for meal and snack products."**

Discuss this statement making reference to the following.

(a) Healthy eating
(b) Life-stage products
(c) Ambient meals
(d) Ethnic foods

Healthy eating:

- The desire to be healthy, but lack of time or inclination to cook.
- Feelings of guilt / working parents wanting to buy good pre-prepared food for their families.
- Heavy advertising on T.V. and within stores.
- Use of colours associated with 'healthy' foods such as green and orange, to attract customers.
- Influence of T.V. chefs – green pepper / red tomato, Jamie and fresh herbs etc.
- Getting someone else to do the thinking for you. It says on the packet that it is healthy or 'good for you', therefore it must be.

Life-stage products:

- The concept of product design for people at different stages of life. A niche market e.g. targeting retired people, toddlers or teenagers.
- An American idea
- Use of fortification as a means of promoting products for specific groups, e.g. energy drinks for teenagers, calcium-enriched water for middle-aged women.
- Vegetarian products, Functional foods, Proactive and cholesterol-reducing products.

Ambient Meals:

- Making good use of modern packaging techniques such as vacuum packing, MAP etc. and the traditional methods such as canning. Catering for the familiar and the new.
- Cutting costs: producing very cheap meals that have a long shelf life.
- Heavy use of additives such as MSG to produce a tasty end product.
- Novelty factor- targeting products such as noodles, which are popular, easy to reconstitute and inexpensive yet easy to flavour.
- Tapping into the ethnic ranges, providing cheaper alternatives to more expensive products.
- Easy storage, easy to prepare – boil a kettle, open a tin, no need to refrigerate.

Ethnic Foods:

- Capitalising upon the fact that people travel abroad a lot and bring back with them the desire for foreign flavours.
- Cutting the cost for the consumer in that they can have authentic flavours without having the expense of buying all the flavourings.
- Catering for the person who likes ethnic recipes but can't or won't cook.
- Keeping the consumer interested by constantly by developing new recipes and ranges.
- Promoting new products on T.V. and producing and producing attractive packages.
- The 'eat-in-the-pot' cooking containers, timesaving, energy-saving.
- Manufacturers who research thoroughly and employ authentic ethnic cooks to develop high quality products using authentic recipes, ingredients and cooking methods.

N.B. Marks will be awarded for the quality of the discussion and the number of varied and substantiated points the candidates make. Candidates will be rewarded for making reference to current market research findings and market trends.

Criteria for Marks Awarded	Mark Range
A weak answer. The candidate attempts to answer the question but may not be able to discuss each point effectively. The answer lacks depth and detail and examples may not be given. There may be some confusion about the types of food products listed. Discussion may be at a superficial level.	0-8
A good answer. The candidate has attempted to discuss the question and has supported the discussion with examples, based upon a reasonable knowledge and understanding of market trends. Some of the points made may lack depth and detail however and there may be some confusion.	9-16
A full and well- articulated answer. The candidate has fully understood the question and supports the response with detailed argument and relevant examples. Some original thought is evident and good use is made of specialist terminology. The candidate has a very good understanding of current market trends.	17-24

(24 Marks)

Section C

5 **Manufacturers should be aware of the three types of hazard in food production.**

(a) Physical
(b) Microbiological
(c) Chemical

For each point above, explain the steps taken in designing and monitoring food production systems to ensure that risks are minimised.

Physical:

- Establishing a strict QA system, which is enforced by QA Manager and adhered to by all employees, to cover such issues as protective clothing, personal hygiene, first aid procedures, blue plasters etc.
- Use of metal detectors on the production line to search for metal shavings, coins, nuts screws, bolts etc. that may have entered the food from the production line.
- Regular maintenance programmes to ensure that moving parts on machinery are secure.
- Visual checks inbuilt into the system to check for any physical contaminants that may enter the food, such as soil particles, bits of unwanted packaging materials. Effective systems in place for disposing of rubbish at the input stage of production.
- Making use of consumer complaints and company quality control records to assess the type and frequency of the occurrence of physical contaminants.

Chemical:

- Use of the QA system to ensure that workers do not wear strong perfumes or deodorants.
- Periodic testing of pH levels, taint testing of food samples.
- Frequent maintenance of machinery to check for oil leakage onto production lines etc.
- Testing for pesticides on fresh products as they enter the factory.
- Ensuring that all fresh produce is cleaned to remove pesticides or other agricultural / horticultural chemicals and that any chemical cleaning agents used, e.g. in salad production are thoroughly tested before use on food products.
- Ensuring that cleaning procedures on the factory floor do not take place whilst food is in production to minimise the risk of cross-contamination.
- Effective staff training, ensuring that all personnel work within the standards set by the QA Manager.

Microbiological:

- Ensuring that food is rejected if it enters the factory at an unsafe temperature level.
- Ensuring that high-risk products are purchased from a reputable supplier who meets the QA standards for the factory.
- Frequent testing of temperatures at CCPs.
- Feedback systems in place to deal with the various risk levels.
- Maintaining areas of low, medium and high risk within the factory. Staff to dress appropriately and maintain the standards set by the QA Manager.
- Monitoring of all control measures to ensure that safe temperatures are maintained.
- Periodic microbial testing to monitor pathogenic bacterial counts.
- Maintaining thorough records of tests carried out over a period of time and of consumer complaints.
- Thorough cleaning systems in place, including storage areas for raw and cooked foods.
- Ensuring that transportation to retailers is properly controlled and that lorries and retailers maintain the cold chain.

Criteria for Marks Awarded	Mark Range
The candidate has produced a basic answer, which lacks depth and detail. Explanation may be simplistic and the number of points made limited. Not all of the risk areas may have been addressed.	0-8
A good attempt. The candidate has tried to cover all three areas, thorough parts of the response may lack depth and detail. There may be some confusion in places and the need for more examples to be given.	9-16
A full and detailed answer. The candidate exhibits a sound knowledge and understanding of the issues and describes each of the three areas effectively, providing varied and relevant examples. Good use of technical terminology.	17-24

(3 x 8 marks)

6 **Once a food product has been designed it is the responsibility of the research and development team to prepare it for large-scale manufacture. With reference to the following manufacturing units describe this process and the factors that have to be taken into account.**

(a) Test Kitchen
(b) Pilot plant
(c) Laboratories

Test Kitchen:
This is where the initial ideas are tested to a specification. Home Economists often work in test kitchens to try out new ideas and prepare them for further development. The test kitchen is as it sounds – a well equipped, but small-scale kitchen where recipes are formulated for a product. The products are made up and then subjected to tests for consistency, taste and other aspects of the specification. The aim is to establish what the product ought to taste like and what it should look like. The aim is to prepare the way for larger scale manufacturing. Much of the groundwork in the development of a new idea takes place in the test kitchen. The team will be highly trained and skilled, not only as cooks, but also as sensory analysts, with a good understanding of the potential market and consumer demands. Food technologists will also work in the test kitchen, providing specialist support. The team will amend and modify the recipe and processing method until they are satisfied with the result. In this way, a reference point is developed which shows what the product must taste like and what it must look like.

Pilot Plant:
This is like a mini-factory. The formulated recipe from the test kitchen is prepared on a larger scale. Food Technologists test the formulation on machines that are scaled-down versions of the large-scale plant machinery. The work carried out in the pilot plant is to see what happens when the food is subjected to large-scale mixers, cutters, conveyor belts etc. Modifications will have to be made to the mix, shape etc. Additives such as anti-caking ingredients may need to be added to the mix to ensure that the flow is smooth through the machinery. The pilot plant will replicate the treatment the product will receive as it moves along the factory floor. This work is vital to ensure that the formulation is workable on a large scale. If it is not workable, it must be adjusted until it is. Technical problems associated with the formulation and adjustments to the machinery required are ironed out. A new line will not be allowed into production until it is perfected. The pilot plant therefore ensures that the new products are adequately developed prior to large-scale manufacture and that production runs will therefore be cost effective, minimising waste.

Laboratories:
The work of Food Scientists is vital in ensuring that food is safe and of a high quality. The laboratory provides information and results which confirm, or otherwise, whether a product meets the specification. This is a very important part of the quality system. Larger factories can support their own laboratory, but smaller factories may use the specialist services of a laboratory based elsewhere. The laboratory work is tested against a quality standard, e.g. EN45001, which states the general criteria for the operation of testing laboratories. Microbiologists play a vital role in the laboratory. They are responsible for testing products from the production line periodically to grow and count microbial cultures. This information can be used to predict shelf life and calculate use by dates. The microbiologist's work can also be used to detect the source of any food poisoning outbreak, establishing where and when a product or part of a product became contaminated. Laboratories are also responsible for working with food additives, testing them and utilising them to best effect within the design specification. They will test packaging materials, ensuring that they are suitable for storage and reheating. They may also develop new types of packaging e.g. 'Steam Cuisine'.

Criteria for Marks Awarded	Mark Range
The candidate has produced a basic response to the question, covering the most obvious points. There may be some confusion between the sections and the answer will lack depth and detail.	0-8
A good answer in which the answer the candidate distinguishes generally well between the three areas. The most significant points are covered, though the answer may lack depth and detail in places. There may be some confusion, though the candidate does provide some examples to support the answer.	9-16
A full and detailed answer. The candidate demonstrates a sound understanding of the topic and is able to illustrate the answer with reference to specific examples. Good use made of technical language and terms	17-24

(3 x 8 marks