Nuffield Advanced Chemistry Special Study: *Food science*
Sample examination questions: answers and marking guide

1a	(i)	Water is one of the six nutrients required to maintain health/lack of water results in illness (1)	(1)
	(ii)	transport of nutrients (1) taking part in reactions (1) maintaining rigidity in tissues (1)	(3)
	(iii)	hydrogen bonded to proteins and carbohydrates (1) hydration of ions (1) held in meshwork of proteins and carbohydrates (1)	(3)
	(iv)	frozen: cell walls broken by ice-crystals (1)	(1)
b	(i)	moulds, yeasts, bacteria (1) moulds>yeasts>bacteria correct order of size	(1)
		bacteria cause most food spoilage (1)	(3)
	(ii)	graph as fig 4.3 shape (1) lag phase (1) growth and stationary (1) death (1)	(4)
	(iii)	spoilage: make food unpalatable/reduce nutritional value (1) pathogen: cause disease (1) examples: spoilage: lactobacillus/ lactococeus/ other (1) pathogen: salmonella/ camphylobacter/ listeria/ other (1)	(4)
	(iv)	both go brown/ same rate of browning (1) phenol kills bacteria but these do not cause browning (1)	(2)
c	(i)	98.9% (1)	(1)
	(ii)	healthy teeth (1) bones (1)	(2)
	(iii)	$CH_2O\ CO\ R^1$ | $CH\ O\ CO\ R^{11}$ | $CH\ O\ CO\ R^{111}$ (1)	(1)
	(iv)	Advantages: less fat so …. less risk of heart disease (1) obesity (1) Disadvantages: less fat-soluble vitamins (1) thermal insulation (1)	(4)
	(v)	Antibiotics kill even beneficial bacteria/bacteria may become resistant to antibiotics (1)	(1)

TOTAL: 30 marks

2 a (i) NH_2-CH-CO_2H (1) (1)

R

(ii) primary – the amino acids in the protein and the order they are in (1)
secondary – the helical parts of the protein (1)
tertiary – the overall shape of the whole molecule (1) (3)

(iii) hydrogen bonding (1) ionic attraction (1) (2)

(iv) Diagrams as Fig 2.7 and 2.8
temperature: shape (1) rise due to increased rate (1) decrease due to denaturation of enzyme (1)
pH: shape (1) protons lost or gained from active site (1)
attractions weakened to substrate (1) (6)
'shape' to include area of optimum activity

b (i) It accelerates browning (1) it is the substrate naturally present in potato (1) (2)

(ii) Repeat experiments with water and dihydroxybenzene only (1)
To ensure that observed effects would not have happened without treatment (1) (2)

(iii) ascorbic acid: is a reducing agent (1) prevents oxidation of apple (1)
salt: ions attach themselves to active site (1) inhibit enzyme (1) (4)

(iv) Ascorbic acid promotes resistance to disease, etc (1)
Soft: strong taste/taste difficult to remove (1) (2)

c (i) high moisture means lower % protein and carbohydrates, therefore lower price (1)
high moisture means susceptibility to germination and moulds (1)
high moisture means poor separation during milling (1) *any two* (2)

(ii) break rolls crush grains and liberate contents (1)
reduction rolls crush the endosperm into fine powder (1) (2)

(iii) the flour becomes oxidised and bleaches to a lighter colour (1)
bleaching by the use of, eg, chlorine (1) (2)

(iv) strong flour has a high gluten/protein content (1)
gluten retains gas bubbles giving appropriate texture (1) (2)

TOTAL: 30 marks

3	a (i)	vitamins (1) minerals (1)	(2)
	(ii)	CH_2-O-CO-R^1 | CH-O-CO-R^{11} | CH_2-O-CO-R^{111} (1)	(1)
	(iii)	the absence of these causes deficiency disease (1)	(1)
	(iv)	energy (1) growth and repair (1) enzymes (1) *any two*	(2)
	(v)	the others can be obtained in metabolism (1)	(1)
	(vi)	cannot be digested (1) acts as 'roughage' to aid passage of material through the gut (1)	(2)
	(vii)	transport of nutrients (1) required for (hydrolysis) reactions (1) maintains tissue rigidity (1)	(3)
	b (i)	temperature (1) mixing routine (1)	(2)
	(ii)	insoluble protein swells (1) volume is a measure of protein quality (1)	(2)
	(iii)	'stronger' means higher gluten content (1) gluten is protein (1)	(2)
	(iv)	during 'proving' gas is liberated forming bubbles (1) gluten contains these bubbles / prevents escape of gas (1)	(2)
	c (i)	because consumers brought locally, direct from producers (1)	(1)
	(ii)	rendering food injurious to health (1) selling unsafe food (1) selling food not of the nature, quality or substance demanded (1) falsely describing / presenting food (1)	(4)
	(iii)	name (1) ingredients (1) sell by / best before date (1) storage conditions (1) manufacturer (1) origin (1) *any two*	(2)
	(iv)	destroys spoilage organisms (1) radiation can decompose proteins (1) public resistance (1)	(3)

TOTAL: 30 marks

4	a	(i)	taste (1) colour (1) odour (1) *any two*	(2)
		(ii)	turgor pressure OWTTE (1) strength of cell wall (1) adhesion between cells (1)	(3)
		(iii)	A loss of water (1) B pectin degrades (1) C pectin dissolves (1) (3)	
		(iv)	blood and bone tissue building (1) resistance to infection (1) prevents scurvy (1) *any two*	(2)
		(v)	decomposes on heating (1) dissolves in water (1)	(2)
	b	(i)	sour (1) bitter (1)	(2)
		(ii)	conduct experiments away from the laboratory (1) use fresh 'cotton bud' for each test (1) use clean containers for solutions (1) *any two*	(2)
		(iii)	sweet: tip of tongue (1); salt: side(s) of tongue (1)	(2)
	c	(i)	an enzyme which has been fixed so that it cannot dissolve or be washed away (1)	(1)
		(ii)	precipitate curds using rennet (1) filter/decant, leaving liquid (1)	(2)
	d	(i)	spoilage: affects only palatability and/or nutritional value (1) pathogen: causes illness (1)	(2)
		(ii)	pathogens: salmonella (1) listeria (1) other (see text) (1) *any one*	(1)
		(iii)	A freezing: low temperature reduces bacterial (1) and enzyme (1) action and makes water unavailable for reaction (1) B canning: air replaced by steam (1) sterilised by heating (1) vacuum in can/excludes air (1)	(6)

TOTAL: 30 marks

5	a	(i)	cellulose (1)	(1)
		(ii)	name (1) ingredients (1) durability (1) storage conditions (1) manufacturer (1) packer/seller (1) origin (1) *any two*	(2)
		(iii)	sodium: fluid balance/body temperature maintenance (1) thiamin: regulates growth/appetite/nerves/liberation of energy (1) iron: constituent of blood (1)	(3)
		(iv)	calcium (1) phosphorus (1)	(2)
		(v)	energy source (1) essential fatty acids prevent deficiency disorders (1) convey fat-soluble vitamins (1) thermal and physical insulation (1) *any two*	(2)
		(vi)	saturated: only single C-C bonds; unsaturated: double bonds (1)	(1)
		(vii)	reacted with hydrogen at 180°C (1) nickel catalyst (1)	(2)
	b	(i)	A browns slowly if at all – enzymes denatured (1) B browns more quickly – optimum temperature (1) C browns more slowly than B (1)	(3)
		(ii)	use of vitamin C (1) reducing agent/reacts with oxygen (1) use of sugar (1) inhibits enzyme (1) use of lemon juice/citric acid (1) decreases pH (1)	(6)
	c	(i)	A UHT heated to high temperature (1) destroys activity of bacteria/enzymes therefore keep for a long time (1) gives characteristic taste (1) B pasteurisation heated briefly (1) kills bacteria but enzymes still function therefore delays deterioration (1) taste unaffected (1)	(6)
		(ii)	dried (1) much lighter to carry than other forms (1)	(2)

TOTAL: 30 marks

6 a (i) X: vitamin (1) control/regulation of body processes (1)
Y: fat/lipid/triglyceride (1) energy source/insulation/ etc see text (1)
Z: carbohydrate (1) energy source (1) (6)

(ii) Mt_2 -CHR-CO_2H (1) (1)

(iii) Mt_2 - CHR^{1}-C-N-CHR^{11}-CO_2H
|| |
O H 1 mark rest of molecule (1) (2)

(iv) overall shape of molecule (1) (1)

(v) becomes tougher (1) cross-linking between protein chains (1) (2)

(vi) converted to gelatin (1) (1)

b (i) water penetrates grains (1)
heat breaks hydrogen bonds in starch (1)
grains swell/burst (1) (3)

(ii) suddenly becomes more viscous (1) (1)

(iii) improves viscoelastic properties (1) by allowing gas bubbles to expand (1) (2)

(iv) iron is an important constituent of blood therefore improves nutritional value of bread (1) (1)

(v) strong flour has high gluten/protein content (1)
helps to prevent escape of gas from bubbles giving porous texture (1) (2)

c (i) disrupts cell walls giving poor texture on thawing (1)
some enzymes and bacteria remain active (1) (2)

(ii) avoids denaturing proteins (1)
avoids damage to cells (1) (2)

(iii) physical damage (1) dehydration (1) absorption of water (1)
oxidation (1) *any two* (2)

(iv) impermeability to air for meat (1)
allow air/water/gas to permeate for fruit and vegetables (1) (2)

TOTAL: 30 marks

7 a (i) Vitamin C: blood and bone formation (1)
resistance to infection (1)
iron absorption (1) *any two* (2)

Starch: source of energy (1) (1)

Cellulose: cannot be digested (1)
assists passage of waste through the intestine (1) (2)

Water: transport nutrients (1)
takes part in chemical changes (1)
temperature control (1)
tissue rigidity (1) *any three* (3)

(ii) hydrogen bonding to polar groups (1)
hydration of ions (1)
trapped in mesh (1) (3)

b (i) moisture: weather at harvest time (1) storage conditions (1) (2)
protein: amount of nitrogen fertiliser (1) climate (1) wheat variety (1) *any two* (2)

(ii) A yellow/brown to colourless (1)
B iodine molecules reduced (1) to colourless iodide ions (1) (3)

(iii) A colourless to red (1)
B $Fe(CNS)^{2+}$(1) (2)

c (i) immersion in boiling water (1)
inactivates enzymes/kills bacteria (1)
removes area from tissues (1) (3)

(ii) steam replaces air (1)
on cooling gives a vacuum so no oxidation can occur (1) (2)

(iii) difficult for heat to reach centre of contents (1)
over-processing of outer layers (1) (2)

(iv) amount of heat needed depends on pH of food (1)
low pH (most fruit) supports fewer micro-organisms (1)
higher pH can support more micro-organisms (1) (3)

TOTAL: 30 marks