VCE CHEMISTRY 2006
FOOD CHEMISTRY
TEST UNIT 4

Time allowed: 50 minutes
Total marks: 40

SECTION A
Contains 12 multiple choice questions

SECTION B
4 Extended response questions

A data sheet and multiple choice answer sheet are provided. Answer extended response questions in the space provided. Use the marks and time allowed as a guide to how much time you should spend answering each question.

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						relative atomic number symbol name relative atomic mass	1 H Hydrogen 1.0										2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3											13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulfur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 44.9	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.6	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yittrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium 98.1	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (266)	107 Ns Neilsbohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (272)	111 Rg Roentgenium (272)	112 Uub Ununbium (277)		114 Uuq Ununquadium (289)				

Lanthanide series	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.3	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinide series	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.1	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (255)	103 Lr Lawrencium (256)

DATA SHEET

Physical Constants

F	= 96 500 C mol^{-1}	**Ideal gas equation**
R	= 8.31 JK^{-1} mol^{-1}	$pV = nRT$
V_m (STP)	= 22.4 L mol^{-1}	
V_m (SLC)	= 24.5 L mol^{-1}	

Specific heat of water = 4.184 J mL^{-1} $^{o}C^{-1}$

The Electrochemical Series

		$E°$ in volt
$F_2(g) + 2e^-$	$\rightarrow 2F^-(aq)$	+ 2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^-$	$\rightarrow 2H_2O(l)$	+ 1.77
$Au^+(aq) + e^-$	$\rightarrow Au(s)$	+ 1.68
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$	$\rightarrow Mn^{2+}(aq) + 4H_2O(l)$	+ 1.50
$Cl_2(g) + 2e^-$	$\rightarrow 2Cl^-(aq)$	+ 1.36
$O_2(g) + 4H^+(aq) + 4e^-$	$\rightarrow 2H_2O(l)$	+ 1.23
$Br_2(l) + 2e^-$	$\rightarrow 2Br^-(aq)$	+ 1.09
$Ag^+(aq) + e^-$	$\rightarrow Ag(s)$	+ 0.80
$Fe^{3+}(aq) + e^-$	$\rightarrow Fe^{2+}(aq)$	+ 0.77
$I_2(s) + 2e^-$	$\rightarrow 2I^-(aq)$	+ 0.54
$O_2(g) + 2H_2O(l) + 4e^-$	$\rightarrow 4OH^-(aq)$	+ 0.40
$Cu^{2+}(aq) + 2e^-$	$\rightarrow Cu(s)$	+ 0.34
$CO_2(g) + 8H^+(aq) + 8e^-$	$\rightarrow CH_4(g) + 2H_2O(l)$	+ 0.17
$S(s) + 2H^+(aq) + 2e^-$	$\rightarrow H_2S(g)$	+ 0.14
$2H^+(aq) + 2e^-$	$\rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^-$	$\rightarrow Pb(s)$	- 0.13
$Sn^{2+}(aq) + 2e^-$	$\rightarrow Sn(s)$	- 0.14
$Ni^{2+}(aq) + 2e^-$	$\rightarrow Ni(s)$	- 0.23
$Co^{2+}(aq) + 2e^-$	$\rightarrow Co(s)$	- 0.28
$Fe^{2+}(aq) + 2e^-$	$\rightarrow Fe(s)$	- 0.44
$Zn^{2+}(aq) + 2e^-$	$\rightarrow Zn(s)$	- 0.76
$2H_2O(l) + 2e^-$	$\rightarrow H_2(g) + 2OH^-(aq)$	- 0.83
$Mn^{2+}(aq) + 2e^-$	$\rightarrow Mn(s)$	- 1.03
$Al^{3+}(aq) + 3e^-$	$\rightarrow Al(s)$	- 1.67
$Mg^{2+}(aq) + 2e^-$	$\rightarrow Mg(s)$	- 2.34
$Na^+(aq) + e^-$	$\rightarrow Na(s)$	- 2.71
$Ca^{2+}(aq) + 2e^-$	$\rightarrow Ca(s)$	- 2.87
$K^+(aq) + e^-$	$\rightarrow K(s)$	- 2.93
$Li^+(aq) + e$	$\rightarrow Li(s)$	- 3.02

VCE Chemistry 2006 Food Chemistry Test Unit 4

SECTION A

MULTIPLE CHOICE ANSWER SHEET

Instructions:

For each question choose the response that is correct or best answers the question.
Circle the chosen response on this answer sheet.
Only circle **one** response for each question.

Question 1.	A	B	C	D
Question 2.	A	B	C	D
Question 3.	A	B	C	D
Question 4.	A	B	C	D
Question 5.	A	B	C	D
Question 6.	A	B	C	D
Question 7.	A	B	C	D
Question 8.	A	B	C	D
Question 9.	A	B	C	D
Question 10.	A	B	C	D
Question 11.	A	B	C	D
Question 12.	A	B	C	D

VCE Chemistry 2006 Unit 4 Food Test

SECTION A - [12 marks, 15 minutes]

This section contains 12 multiple choice questions.
For each question choose the response that is correct or best answers the question.
Indicate your answer on the answer sheet provided.
(Choose only ***one*** *answer for each question.)*

Question 1

Which one of the following is **least** effected when a protein is denatured?

A. The primary structure.
B. The secondary structure.
C. The tertiary structure.
D. The shape of the protein molecule.

Question 2

What is the molecular formula for a tripeptide that can be formed from the amino acid glycine, ($C_2H_5NO_2$)?

A. $C_8H_{14}N_4O_5$.
B. $C_6H_6N_3O_3$.
C. $C_6H_{11}N_3O_4$.
D. $C_8H_{16}N_4O_6$.

Question 3

What material does the body use to excrete nitrogen?

A. H_2NCONH_2.
B. NH_4^+.
C. NH_3.
D. $HCONH_2$.

Question 4

Under similar conditions a polyunsaturated fat will become rancid faster than a saturated fat because

A. the polyunsaturated fat will hydrolyses faster than the saturated fat.
B. the carbon-carbon double bonds in the polyunsaturated fat are more easily attacked by oxygen than the single carbon-carbon single bonds in the saturated fat.
C. there are carbon-carbon double bonds in the polyunsaturated fat and these can polymerise, causing the material to go rancid.
D. the carbon-carbon double bonds in the polyunsaturated fat react with water, breaking the fatty acid into smaller more volatile carboxylic acids.

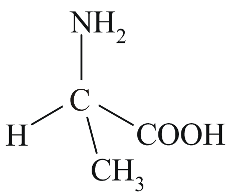
Question 5

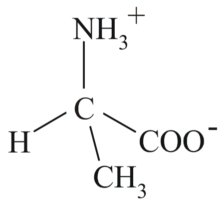
The hydrolysis of a fat in the body, will produce

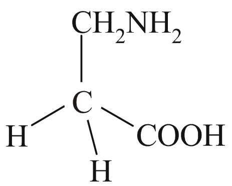
A. glycerol.
B. fatty acids.
C. glycerol and fatty acids.
D. glycerol and the sodium salts of the fatty acids.

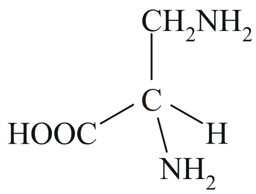
Question 6
When an enzyme catalyses a reaction, the
A. reactant substrate weakly bonds to the active site of the enzyme.
B. reactant substrate strongly bonds to the active site of the enzyme.
C. bonds within the reactant substrate are strengthened.
D. primary structure of the enzyme is altered.

Question 7
Which one of the following structures is **not** that of an α-amino acid?

A.


B.


C.


D.


Question 8
The functional group that links the saccharide units in a polysaccharide is the
A. ester functional group.
B. amido (or peptide) functional group.
C. ether functional group.
D. hydroxy functional group.

Question 9
A scientist prepared the following four 60 g food samples from basic nutrient materials.

Nutrient	Food Sample			
	I	II	III	IV
Fats	20 g	20 g	20 g	10 g
Protein	20 g	30 g	10 g	20 g
Total Carbohydrates	20 g	10 g	30 g	30 g

Which one of the food samples would provide the **least** available energy for humans?
A. Food mix I.
B. Food mix II.
C. Food mix III.
D. Food mix IV.

Question 10
In which one of the following processes does nitrogen fixation occur?
A. The action of denitrifying bacteria in soils.
B. The breakdown of animal waste in soils.
C. The action of nitrifying bacteria in soils.
D. The action of lightning.

Question 11

How does the human body treat excess glucose in the body?

A. It converts it all into glycogen.
B. It converts an amount of it into glycogen, then the surplus into fat.
C. It converts it into fats.
D. It converts an amount of it into fats, then the surplus into glycogen.

Question 12

Milk is

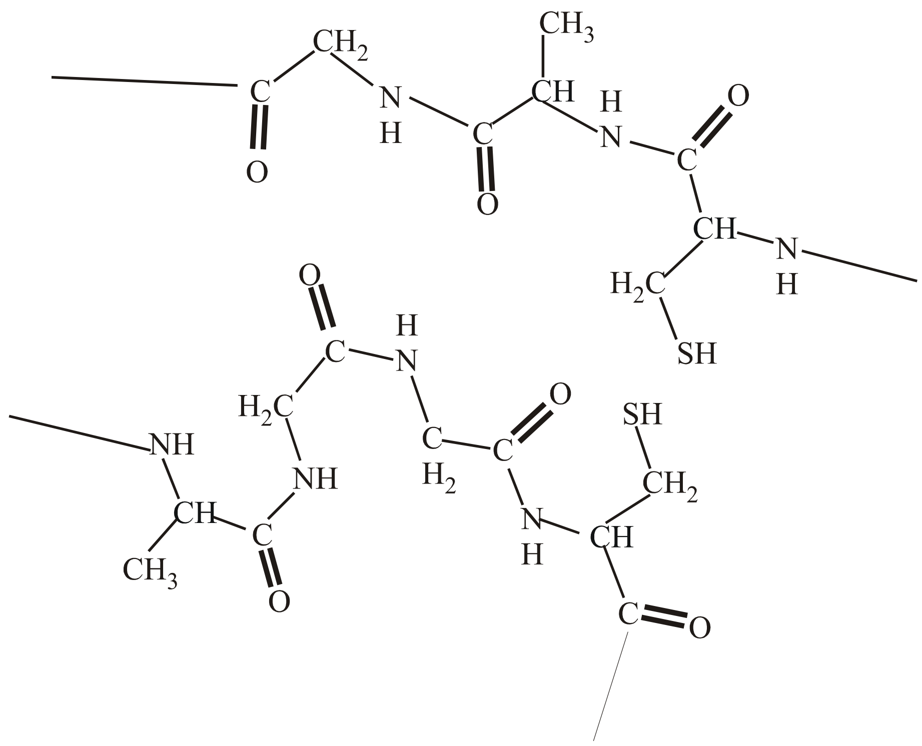
A. a water-in-oil emulsion where the hydrophobic tails of the emulsifier molecules are in the oil.
B. a water-in-oil emulsion where the hydrophobic tails of the emulsifier molecules are in the water.
C. an oil-in-water emulsion where the hydrophobic tails of the emulsifier molecules are in the oil.
D. an oil-in-water emulsion where the hydrophobic tails of the emulsifier molecules are in the water.

End of Section A

SECTION B - [28 marks, 35 minutes]

This section contains four questions, numbered 1 to 4.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 - [8 marks, 10 minutes]
Proteins have many important functions in the human body and their structures play a key role in these. The diagram below shows two parts of the structure of a protein.



a. i. What is one type of interaction that contributes to the secondary structure of a protein?

ii. On the diagram clearly mark a region where this type of interaction could occur.

1 + 1 = 2 marks

b. i. What is one type of interaction that could contribute to the tertiary structure of this part of the protein?

ii. On the diagram clearly mark the region where this type of interaction could occur.

1 + 1 = 2 marks

c. i. How many different amino acids could be isolated from these parts of the protein when it is hydrolysed?

ii. Draw the two structural forms for one of these amino acids at neutral pH.

iii. Draw the structure for the above amino acid at low pH.

1 + 2 + 1 = 4 marks

Question 2 - [9 marks, 11 minutes]

a. A food technologist analysing a margarine sample placed a 0.3984 g sample in a bomb calorimeter with a calibration factor of 4882 J $^{o}C^{-1}$. The temperature increased from 20.198 ºC to 22.321 ºC following the combustion reaction.

i. Determine the amount of energy released by the sample analysed.

ii. The labelling of the product requires that the energy is expressed in kJ per 10 g serve. Calculate the value to be printed in the food nutrient label.

iii. When a sample of this margarine was digested by the body, how would the available energy compare with the value determined above?

2 + 1 + 1 = 4 marks

b. Another small sample of the margarine was mixed with some bromine solution. After a few minutes the colour of the bromine solution faded.

i. Why does the colour of the bromine solution fade?

ii. What does this suggest about some of the fatty acids present in the margarine?

1 + 1 = 2 marks

c. When a sample of the margarine was hydrolysed a fatty acid with a molecular mass of 280 was isolated and further analysis showed it contains 18 carbon atoms.

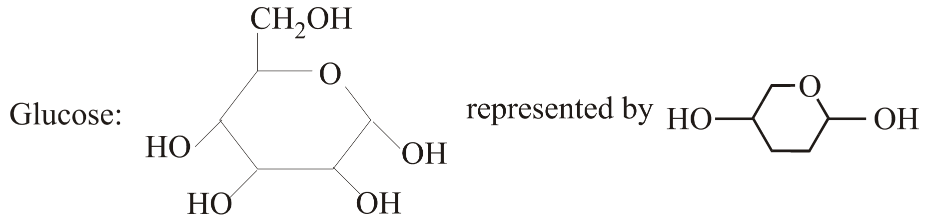
i. What is the molecular mass for a saturated fat containing 18 carbon atoms?

ii. What type of fatty acid was isolated?

2 + 1 = 3 marks

Question 3 - [7 marks, 9 minutes]
Plants produce the starch, amylose, that is a long chain polymer of glucose. In the first stage of digestion in the human body, the enzyme, amylase, present in saliva, catalyses the hydrolysis of amylose to the disaccharide, maltose. In the intestine the maltose is further hydrolysed with the aid of the enzyme maltase to yield glucose, which can then be absorbed through the gut wall into the body.

a. i. Using the symbol shown below for a glucose unit, draw a symbolic equation to represent these two chemical reactions.



ii. What key function do starches play in plant life?

iii. What is the other group of glucose polymers that plants also produce?

iv. When humans eat plant material most of the starches are completely digested and the glucose formed absorbed into the body, yet the other polysaccharide in the plant material largely passes through the body undigested. Why is there such a difference in how the human body deals with these two polymers of glucose?

2 + 1 + 1 + 1 = 5 marks

b. A group of students investigating the digestion of starches, placed various amylose solutions in water baths for 1 hour, then tested them for the presence of starch, and any monosaccharides or disaccharides. Their results are in the table below.

Tube	**Solution**	**Temperature (ºC)**	**Starch**	**Monosaccharides and/or disaccharides**
1	Amylose	30	Present	Not present
2	Amylose + amylase	30	Trace only	Present
3	Amylose	80	Present	Small amount
4	Amylose + amylase	80	Present	Small amount

i. What does the result obtained in tube 1 suggest about the hydrolysis reaction?

ii. What does the result in tube 4 suggest?

1 + 1 = 2 marks

Question 4 - [4 marks, 5 minutes]

Plants require available nitrogen for their development and growth.

a. Plants obtain the majority of their carbon from the atmosphere, yet even though it contains significantly more, about 78 %, nitrogen most plants cannot obtain their nitrogen from this source. Why is the atmospheric nitrogen essentially unavailable to plants?

1 mark

b. i. One way for an agriculturalist to provide plants with available nitrogen is to use synthetic fertilizers. What are the **two common** nitrogen containing ions that are used in these fertilizers?

ii. What is one problem associated with using fertilizers containing either or both of these ions?

1 + 1 = 2 marks

c. Apart from synthetic fertilizers how else could an agriculturalist provide available nitrogen to the plants they are cultivating?

1 mark

END OF TASK

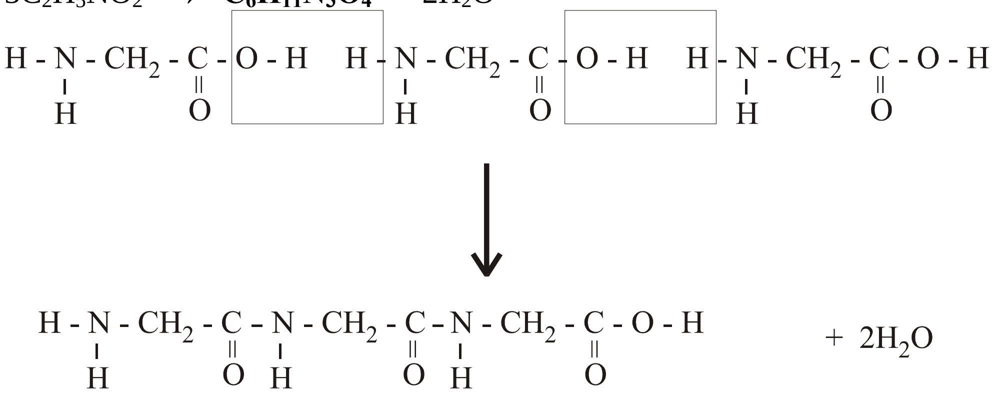
Suggested Answers VCE Chemistry Unit 4 Food Test

SECTION A [1 mark per question.]

Q1 **A** When a protein is denatured by either heat or changing the pH significantly the molecular shape of the protein is altered. This will result in changes to the **secondary** and **tertiary structures**.
The primary structure of a protein is the sequence of amino acids that make up the protein and this is not changed when the protein is denatured.

Q2 **C** The tripeptide results when three amino acid molecules undergo condensation reactions. This will result in the formation of **two peptide links and the release of two molecules of water**.

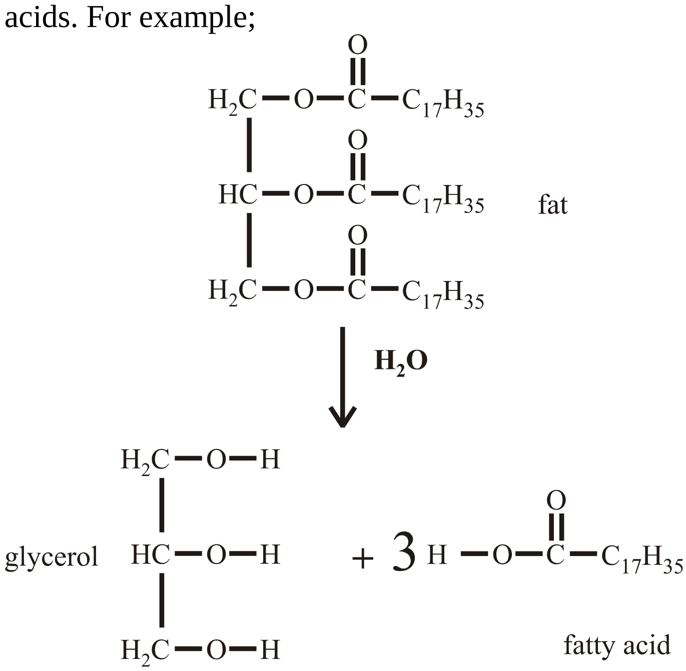
$3C_2H_5NO_2 \rightarrow \mathbf{C_6H_{11}N_3O_4} + 2H_2O$



Q3 **A** The body excretes excess nitrogen as **urea, H_2NCONH_2**.

Q4 **B** Facts become rancid as a result of oxidation of the fatty acid by atmospheric oxygen. Polyunsaturated fatty acids contain carbon-carbon double bonds that are more reactive and are more easily oxidised than the carbon-carbon single bonds in saturated fatty acids. Therefore polyunsaturated fats will become rancid more readily.
In commercial products, such as margarine, this is slowed down by the addition of antioxidants during the manufacture process.

Q5 **C** Fats are triglycerides and the hydrolysis of a fat will produce glycerol and fatty acids. For example;



Q6 A When an enzyme catalyses a reaction the **reactant substrate weakly bonds to the active site of the enzyme** and in doing so the **appropriate bonds within the substrate are weakened** allowing a reaction to occur at these. This process **lowers the activation energy** for the reaction compared with an uncatalysed reaction and a faster rate will occur as more fruitful reactions are possible for a given temperature.

Q7 C An **α-amino acid has both the amino, $-NH_2$, and carboxy, -COOH, functional groups, or their corresponding ionic forms, $-NH_3^+$ and COO^-, in the zwitterion, attached to the same carbon atom**. Only response C does not fulfil this criterion.

Response B is the amino acid in its zwitterion form.

Q8 C The saccharide units in a polysaccharide are joined together by the **ether, -C-O-C-**, functional group.

Q9 D Fats provide 37 kJ g^{-1} and carbohydrates and protein provide approximately 17 kJ g^{-1}.

Therefore the food with the lowest fat content will provide the least energy.

Food mix IV will provide $10\times37 + 20\times17 + 30\times17 = 1220$ kJ, while the other three food mixes will each provide 1420 kJ.

Q10 D Nitrogen fixation is the process where atmospheric nitrogen is converted into soluble nitrogen compounds that plants can absorb. Lightning is the only process that involves molecular nitrogen as a reactant.

Q11 B The human body stores excess glucose initially as the **polysaccharide glycogen**, then converts any further excess into **fats**.

Q12 C Since milk is soluble in water it is an **oil-in-water emulsion**. The hydrophobic tails of the emulsifier molecules will always be in the non-aqueous phase.

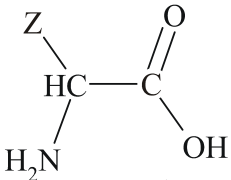
SECTION B

Question 1 - [8 marks, 10 minutes]

a. i. **Hydrogen bonding between the –CO and –NH groups** is the key interaction that contributes to the secondary structure of a protein. This can lead to helical structures in some proteins. **[1 mark]**

ii. A number of possible sites for this type of interaction are shown on the diagram below. **[1 mark]**

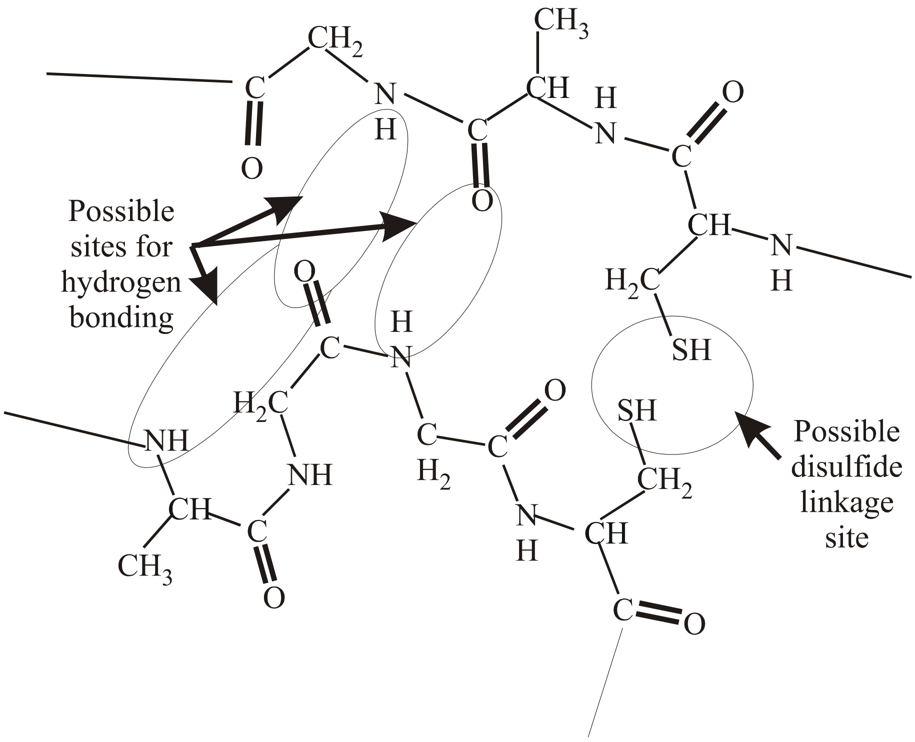
b. i. In this part of the protein the only interaction that could contribute to the tertiary structure would be the formation of a disulfide, -S-S-, link between the two thiol, -SH, groups. **[1 mark]**



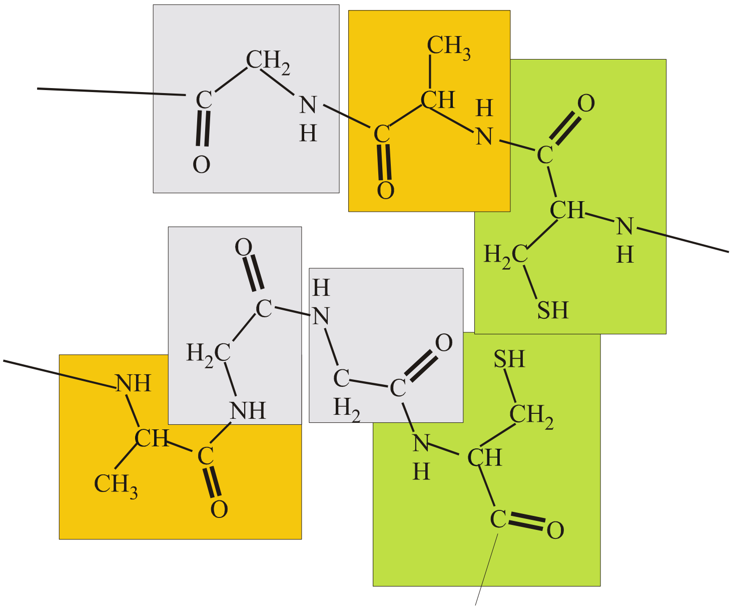
General amino acid structure

Other interactions that can influence the tertiary structure of proteins include; electrostatic interactions between $–COO^-$ and $–NH_3^+$ groups and/or the formation of peptide linkages between carboxy and amino groups that are attached to the **Z** groups of the amino acids.

ii. The site where the disulfide link can form is shown on the diagram. **[1 mark]**

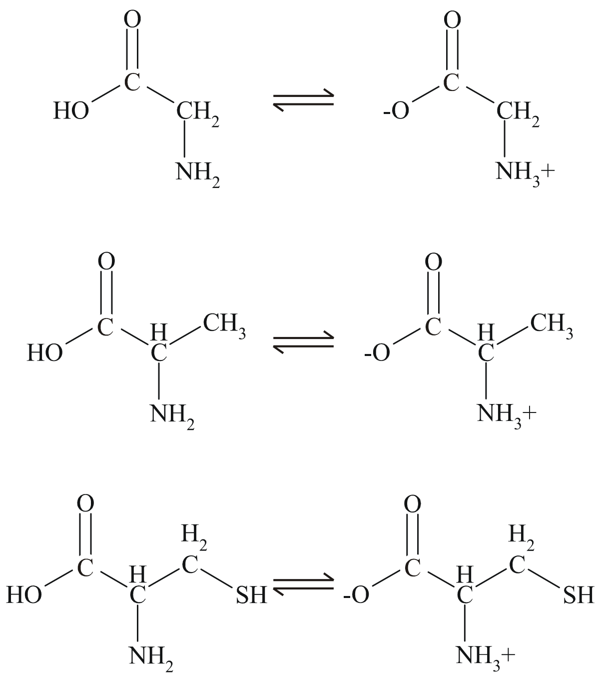
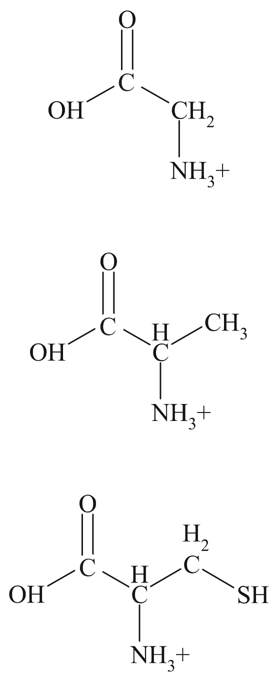


c. i. There are three different amino acids that could be obtained when this part of the protein chain is hydrolysed. **[1 mark]** These are shown on the diagram below.



ii. At neutral pH the two structural forms are the neutral molecule and its zwitterion, these are shown below for each of the three amino acids.
[Total marks allocated 2 marks. 1 mark for each correct structure.]

iii. At low pH both the carboxy and amino groups are protonated, as shown in the structures below. **[1 mark]**

Structures at neutral pH	Structures at low pH
	

Question 2 - [9 marks, 11 minutes]

a. i. CF = 4882 J °C^{-1}

$\Delta T = 22.321 - 20.198 = 2.123$ °C **[1 mark]**

$E = CF \times \Delta T = 4882 \times 2.123 =$ **1.036×10^4 J** **[1 mark]**

ii. 1 kJ = 1000 J

$E = 1.036\times10^4 / 1000 = 10.36$ kJ

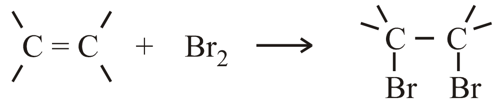
E(in 10 g) = (10.36 / 0.3984) × 10 = **260 kJ** (10 g)$^{-1}$ **[1 mark]**

iii. The **available energy would be less** than the value printed in the nutrient information panel that was determined in the bomb calorimeter, because some substances are **not completely absorbed** by the body following digestion and/or some substances are **not completely oxidised** by the body. **[1 mark]**

The heat of combustion for fats is about 39 kJ g^{-1}

The available energy for fats is about 37 kJ g^{-1}.

b. i. The colour of the bromine fades because **bromine undergoes addition reactions across a carbon-carbon double bond**. **[1 mark]**

Bromine addition reaction: 

ii. Since the colour faded then there are carbon-carbon double bonds in the fatty acids present in the fat, therefore the **fat is unsaturated**. **[1 mark]**

c. i. A fatty acid contains the carboxy group, -COOH.

A fatty acid with 18 carbon atoms will have a hydrocarbon chain attached to the carboxy group with 17 carbon atoms.

A saturated hydrocarbon with 17 carbon atoms has the formula: $C_{17}H_{36}$; therefore the formula for the fatty acid is **$C_{17}H_{35}COOH$** **[1 mark]**

The molecular mass = 18×12 + 36×1 + 2×16 = **284** **[1 mark]**

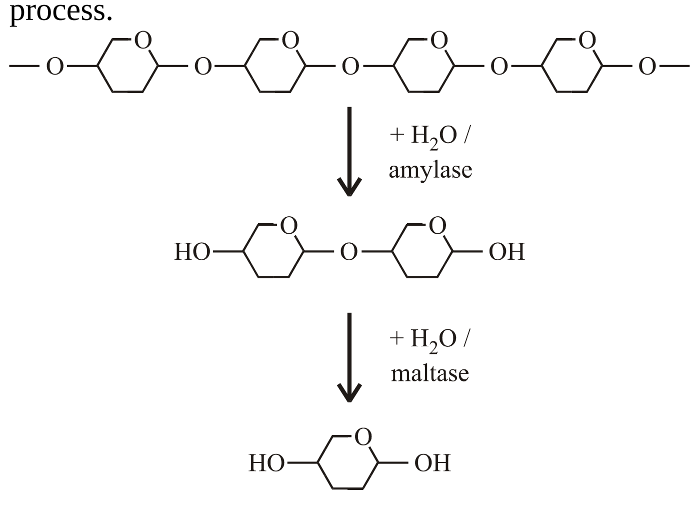
ii. Since the molecular mass of the isolated fatty acid is 280 this is 4 less than that for the corresponding saturated fatty acid.

Each carbon-carbon double bond will reduce the number of hydrogen atoms in the hydrocarbon chain by 2.

Therefore there are 2 carbon-carbon double bonds, so the fatty acid isolated is a **polyunsaturated** fatty acid. **[1 mark]**

Question 3 - [7 marks, 9 minutes]

a. i. The symbolic equation must show the ether, -C-O-C-, linkages between the glucose units in the amylose and maltose, and that the reaction is a two stage process.



[2 marks]

ii. Plants use **starches to store energy**. **[1 mark]**

iii. The other group of glucose polymers that plants produce are **cellulose** which they use for their structure. **[1 mark]**

iv. The human digestive system **does not have the enzymes required to hydrolyse cellulose**, therefore they essentially pass through the body undigested. **[1 mark]**
Small amounts of cellulose are digested by bacteria in the digestive tract.
Cellulose has the vital role as dietary fibre which prevents bowel disease and constipation.

b. i. The **rate of reaction** for the hydrolysis of amylose **is slow** in absence of a catalyst at 30 ºC. **[1 mark]**

ii. The results from tubes 3 and 4 are the same. Tube 3 shows that some hydrolysis does occur without the enzyme therefore the tube 4 result suggests that **the enzyme has been denatured at this temperature** and is not catalysing the reaction. **[1 mark]**

Question 4 - [4 marks, 5 minutes]

a. The nitrogen in the atmosphere **mainly exists in the form of the N_2 molecule** which has a **nitrogen-nitrogen triple covalent bond** holding the nitrogen atoms together. A **large amount of energy is required to break this bond and convert the nitrogen into available nitrogen compounds**. **[1 mark]** Most living organisms do not have enzymes with the ability to achieve this, however some bacteria, such as the *Rhizobium* bacteria in the root nodules of legumes and the *Trichodesmium* cyanobacteria found in the oceans, do have enzymes that can catalyse the reduction of nitrogen to ammonia and ammonium compounds. (Names of bacteria are not required knowledge.)

b. i. **Ammonium, NH_4^+ and nitrate, NO_3^-, ions. [1 mark]** [Must have both for mark]

ii. Possible answers include: **[Total marks allocated = 1 mark]**
Both ammonium and nitrate compounds are readily soluble in water and require continual application in wet areas.
Nitrate compounds can dissolve readily in rain and the run-off from where the fertilizer was used can enter waterways and cause algal blooms and other environmental problems.
Nitrates in water supplies can be converted by some bacteria into nitrite ions which can have serious impact on human health.
Production of these fertilizers require the use of extensive energy making them costly.

c. Possible answers include: **[Total marks allocated = 1 mark]**
The use of animal manure.
The use of treated human sewage effluent.
Planting legume crops either together with the crop, or before and ploughing these into soil prior to growing the next crop.