OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

Advanced Subsidiary GCE

SCIENCE

G642 QP

Unit G642: Science and Human Activity

Specimen Paper

Candidates answer on the question paper.

Time: 1 hour 45 minutes

Additional Materials:

Electronic calculator

Candidate Name	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**21**	
2	**29**	
3	**26**	
4	**12**	
5	**12**	
TOTAL	**100**	

This document consists of **16** printed pages.

Answer **all** the questions.

1 This question is about the climate of the North Atlantic.

(a) One influence on weather is the pattern of distribution of high and low pressure. A typical pattern in this region is shown in Fig. 1.1.

(i) Use this pattern to predict the likely direction in which winds blow at point **A**. Mark the predicted direction with an arrow on the map. **[1]**

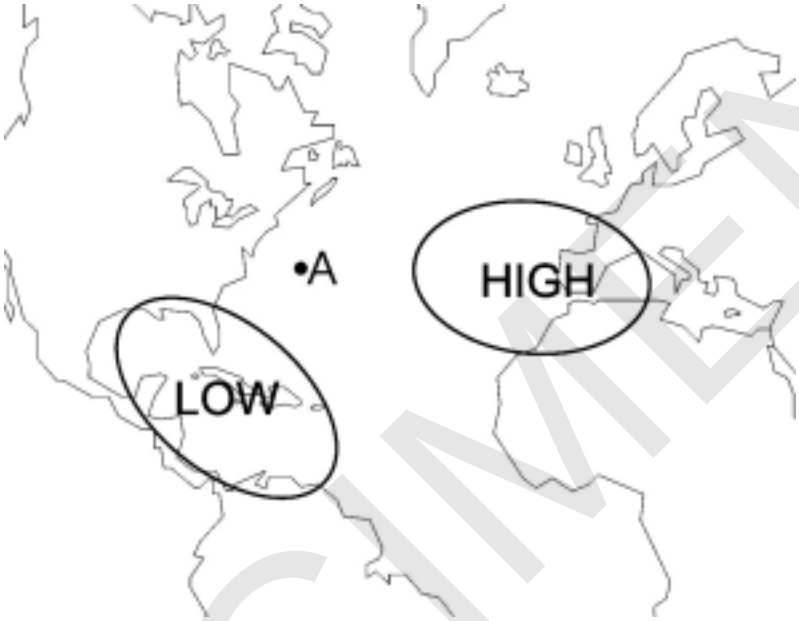

Fig. 1.1

(ii) Explain how you reached your prediction by discussing the factors affecting the horizontal movement of air in the atmosphere.

.....

.....

.....

..... **[3]**

(iii) The surface pressure at point **A** is 1.01×10^5 N m^{-2}. Calculate the force produced by this pressure on a surface with a total area of 2,500 m^2.

pressure = ... N **[2]**

(b) In the Gulf of Mexico, powerful hurricanes frequently form between August and October.

Describe and explain the processes which provide energy for these hurricanes.

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.....

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

(c) Regions in the higher latitudes of the North Atlantic have unusually mild climates. This is largely due to the thermal energy carried by ocean currents such as the Gulf Stream.

One reason why the ocean currents carry so much energy is the high specific heat capacity of water (4.2 J K^{-1} g^{-1}).

Use the value of the specific heat capacity above to calculate the amount of heat required to heat up 1 kg of water by 15 ^{o}C.

heat required = ... J **[2]**

(d) The high specific heat capacity of water can be explained by the fact that hydrogen bonds can form between molecules of water

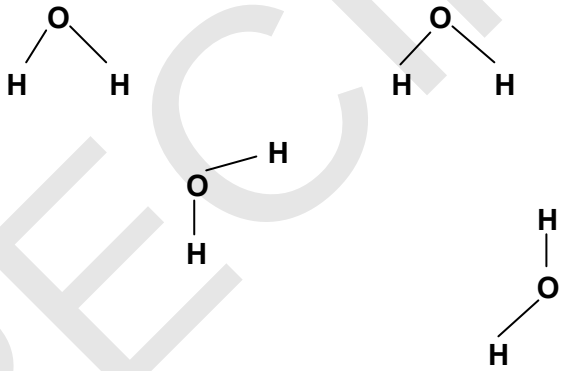


Fig. 1.2

(i) Mark on the diagram **one** hydrogen bond which could form between these water molecules. **[1]**

(ii) State **one** other unusual property of water which can be explained by hydrogen bonding.

..... **[1]**

(e) Hydrogen bonds are also able to form between molecules of ammonia (NH_3). This is partly due to the polarity of the bonds.

(i) Predict the polarity of the bonds in ammonia, using the following electronegativity values. Mark your predictions on the diagram below.

Electronegativity values: N = 3.1, H = 2.1

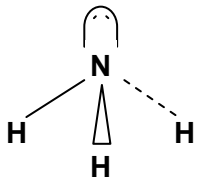


Fig. 1.3

[2]

(ii) The ammonia **molecule** possesses a permanent dipole. Explain this statement, using the information in the diagram

.....

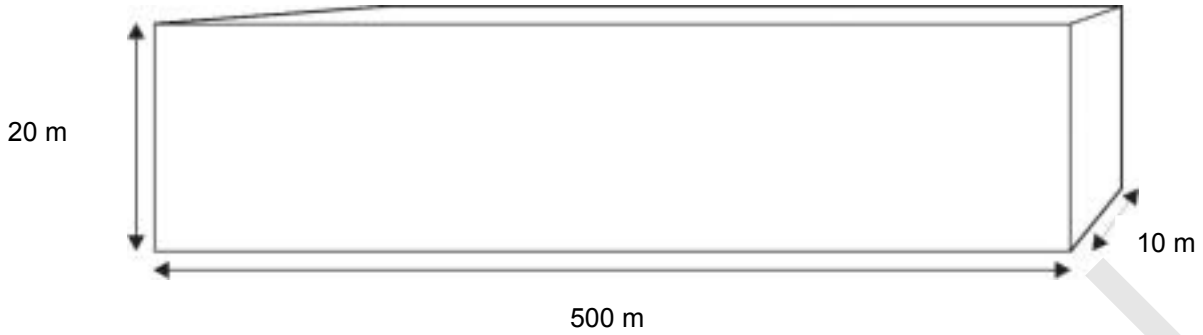
..... **[2]**

(f) The Gulf Stream is a surface current. Eventually the water in the current becomes so dense that it sinks, forming a deep sea current.

(i) Mark on the map below one region where this is likely to happen. **[1]**

Fig. 1.4

(ii) The density of sea water is normally about 1027 kg m^{-3}. Use this data to calculate the mass of sea water in a section of sea water with the dimensions shown below.



mass of sea water = ... kg **[2]**

(iii) Describe **one** naturally occurring process occurring in the North Atlantic which can increase this density and hence cause the water to sink.

.....

.....

.....

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

[Total: 21]

2 Acid deposition ("acid rain") is a significant environmental problem in many parts of the world.

One of the major causes is the emission of nitrogen oxides, such as NO, by internal combustion engines in motor vehicles.

(a) Describe how nitrogen oxides are formed in the engine of a motor vehicle.

.....

.....

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

(b) NO is converted in the atmosphere into other substances, such as NO_2.

(i) Balance the equation below by writing appropriate numbers (if necessary) in the spaces provided. **[1]**

……. NO +……. O_2 → …….NO_2

(ii) This process is described as an oxidation. What is the oxidation number of nitrogen in:

NO ……

NO_2 ……

[2]

(iii) Explain why this process is described as an oxidation.

.....

..... **[1]**

(c) NO_2 is in turn converted in the atmosphere into substances such as HNO_2 and HNO_3.

(i) HNO_2 and HNO_3 are acids. State the formula of the ion present in aqueous solutions of both substances.

..... **[1]**

(ii) HNO_3 is described as a strong acid and HNO_2 can be described as a weak acid. Explain the difference between a strong and a weak acid.

strong acid .....

weak acid ..... **[2]**

(iii) Use the information above to suggest possible pH values for dilute aqueous solutions of these acids.

HNO_2 …….

HNO_3 ……. **[2]**

(d) The pH value gives information about the acidity of a solution.

To find the concentration of an acid in a solution, a titration is needed.

Describe how you would carry out a titration to determine the concentration of acid in a lake acidified with nitric acid (details of the method for calculating the concentration is not required).

In your answer, you should make clear how the steps in the process are sequenced.

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..... **[6]**

(e) Nitrogen oxides, such as NO, have also been identified as causing the depletion of the ozone layer in the stratosphere.

(i) Explain why the depletion of the ozone layer is likely to endanger human health.

.....

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

(ii) State the name of **one other** class of substance known to cause depletion of ozone in the stratosphere.

..... **[1]**

(f) A series of reactions which remove ozone is shown below.

Equation 1: $NO + O_3 \rightarrow O_2 + NO_2$

Equation 2: $O + NO_2 \rightarrow O_2 + NO$

(i) Write an overall equation which summarises the effect of these two processes.

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

(ii) Identify the role of NO in this process by circling the appropriate word. **[1]**

oxidising agent **catalyst** **acid** **base**

(iii) Justify your choice

.....

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

[Turn over

(g) One possible electronic arrangement to show the bonding in the nitrogen dioxide molecule, NO_2, is shown in Fig. 2.1.

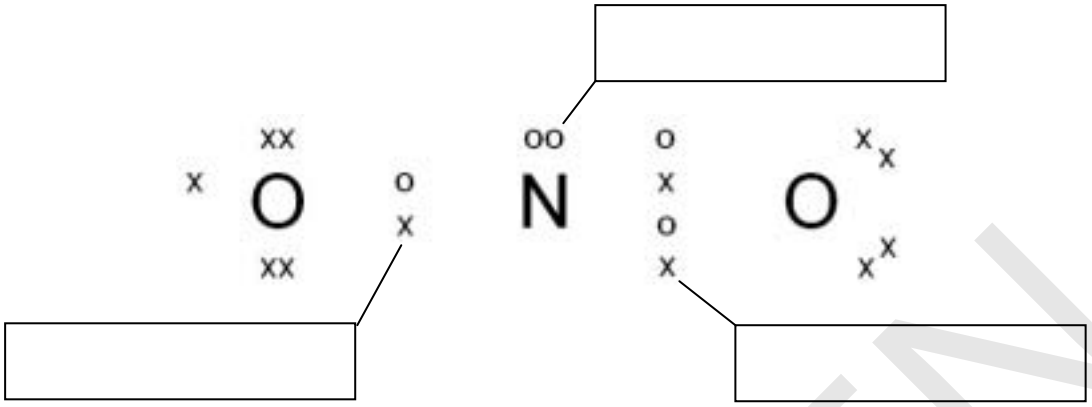

Fig. 2.1

(i) Explain why this molecule can be regarded as a radical.

.....

..... **[1]**

(ii) Complete Fig. 2.1 by adding the following labels in the appropriate boxes. **[1]**

lone pair **double bond** **bonding pair**

(iii) The bond angle around the central N atom in this suggested structure can be predicted to be 120°. Explain the scientific principles which lead to this prediction.

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.....

..... **[3]**

[Total: 29]

Genetic engineering is increasingly being used to create crops with advantages over conventional crops.

For example, a gene for an enzyme can be introduced into sugar beet which then allows the sugar beet to break down a particular herbicide, known as Roundup.

Enzymes are proteins essential to all cell processes.

A ribbon diagram of an enzyme is shown in Fig. 3.1.

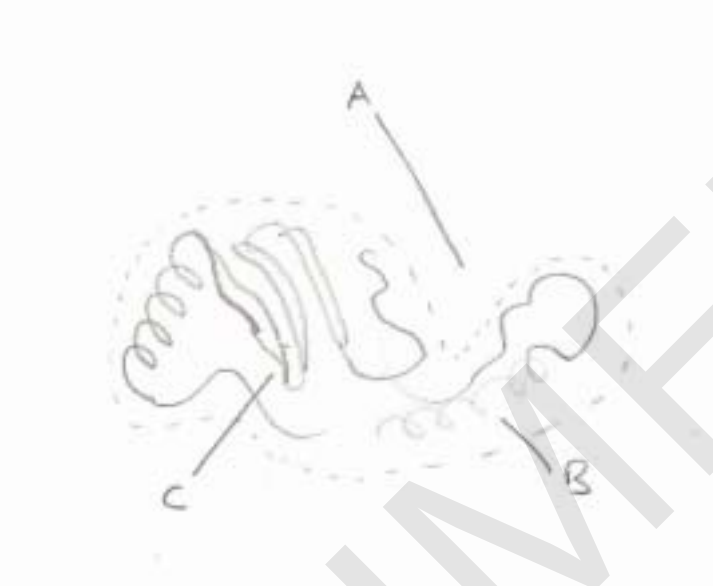

Fig. 3.1

(h) Choose words from the following list to describe the features present at points **A**, **B** and **C.**

substrate **active site** **α-helix** **β-pleated sheet**

A: .....

B: .....

C: .....

[2]

(i) Describe in general terms the mechanism of a process in which an enzyme breaks down a herbicide molecule.

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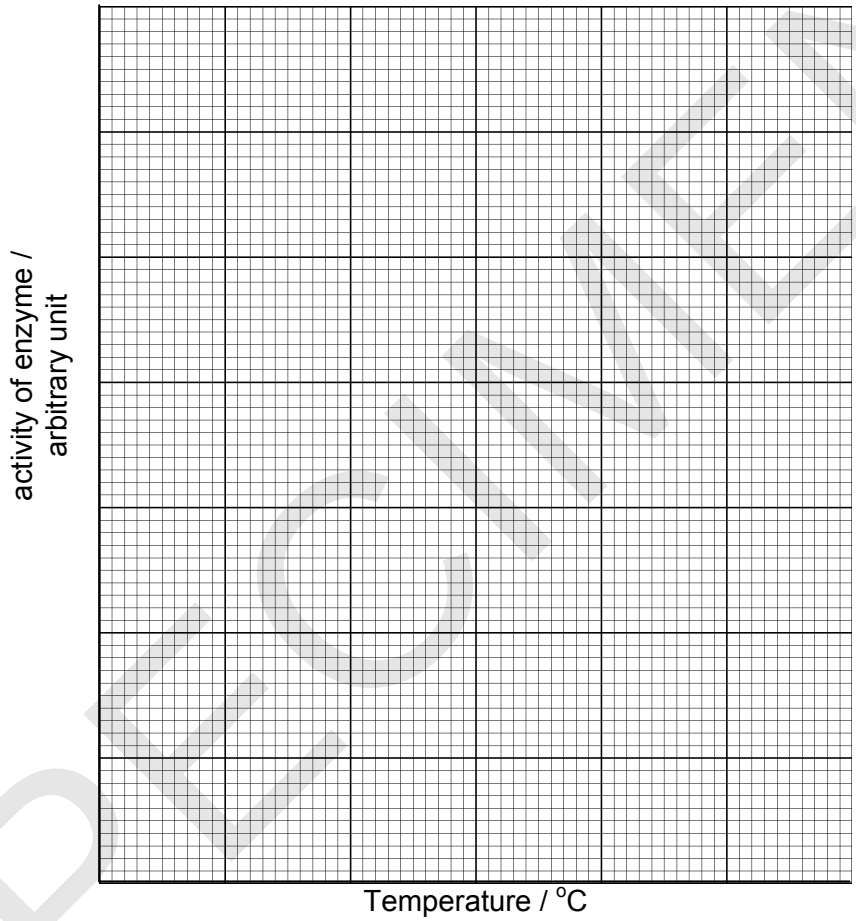
..... **[3]**

(j) Enzymes, such as the one which breaks down “Roundup”, are affected by temperature. The table below provides data from an experiment to show how the activity of an enzyme is affected by temperature.

temperature / ^{o}C	activity of enzyme / arbitrary units
15	4.3
25	8.8
35	10.3
45	9.6
55	1.2
65	0.0

(i) Plot these data on a graph. Use a smooth curve to show the pattern in the data. **[3]**



(ii) Use the graph to suggest the likely optimum temperature for the enzyme.

..... **[1]**

(k) Some farmers are now growing beet which has been modified to contain an enzyme which breaks down "Roundup".

Suggest why it is an advantage to a farmer to grow beet which can break down the herbicide “Roundup” in this way.

.....

.....

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

(l) In the process of genetic modification, a gene is transferred from a bacterium into cells of a beet plant.

Use the words below to complete this passage which describes the processes involved in the gene transfer.

restriction enzymes	**ligase enzymes**	**viruses**
plasmids	**marker gene**	
start codon	**recombinant DNA**	**passenger DNA**

Bacterial DNA is in the form of circular pieces of DNA known as ……

These are opened up using ……

This gene can be transferred into individual beet cells by microinjection. A

…… may also be transferred at the same time.

The DNA of the beet is now described as …….. **[4]**

(m) Describe the process by which a gene in the nucleus of a beet cell can cause a protein to be produced in the cell.

In your answer, you should make clear how the steps in the process are sequenced.

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..... **[7]**

(n) Genetic engineering is a controversial technique. Discuss some of the reasons why it has attracted so much controversy.

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..... **[4]**

[Total: 24]

[Turn over

4 Nuclear fission is a controversial method for generating electrical power. However, many countries are increasing their provision of nuclear power stations using this process.

(a) Describe **one** reason why nuclear fission is likely to become increasingly important as a method of generating energy in the future.

.....

.....

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[2]

(b) The hazards of nuclear fission are largely due to the dangers of the products of the fission process.

A fission process can be represented by the equation below.

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3\ ^{1}_{0}n$$

Use this equation to write down:

(i) the atomic number of a Uranium (U) atom;

..... **[1]**

(ii) the symbol for a neutron;

..... **[1]**

(iii) the number of neutrons in a barium-142 atom (^{142}Ba).

..... **[1]**

(c) Each ^{91}Kr produced in this process decays to produce one beta (β) particle.

(i) Circle the answer which best describes a beta particle. **[1]**

neutron **proton** **electron** **helium nucleus**

(ii) Complete the nuclear equation below to show the decay of Krypton. **[2]**

$$^{91}_{36}Kr \rightarrow \_\_Rb + ^{0}_{-1}e$$

(d) If **sources** of beta particles contaminate food likely to be eaten by human beings, there is a considerable risk to human health. This has happened when an accident at a nuclear power station caused a leak of radioactive material. No such risk occurs when food is simply exposed to beta radiation (irradiation).

(i) Describe and explain the risk to health when the human body is directly exposed to a **source** of beta particles.

.....

.....

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

(ii) Explain why the irradiation of food is regarded as a safe procedure.

.....

.....

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

[Total: 12]

4 The discovery of radioactive isotopes, such as 235-U, was of major importance in the development of the modern model of the atom, in which shells of electrons surround a nucleus made up of protons and neutrons.

(a) Describe **one** earlier model of an atom which you have studied and explain how another piece of evidence was used to develop this model into the one described above.

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..... **[3]**

(b) Energy produced by nuclear fission reactors in this country is supplied to the National Grid which transmits the energy to consumers over long distances.

Fig. 5.1 shows the key features of such a system

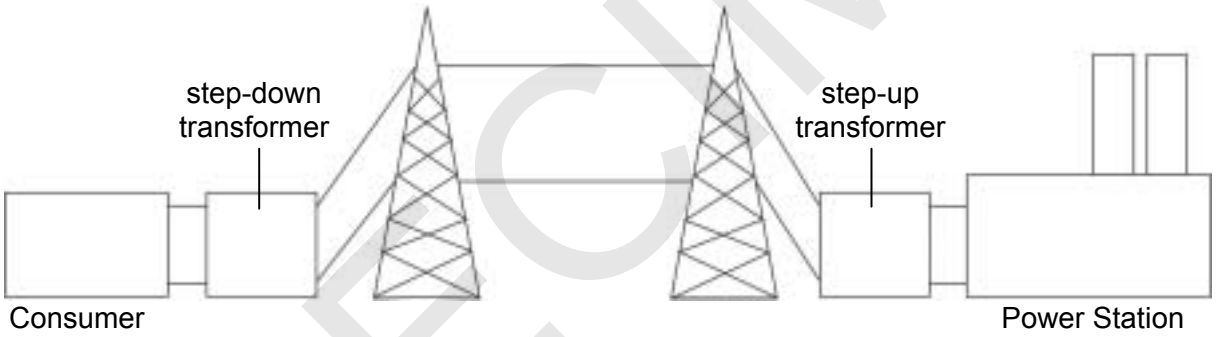

Fig. 5.1

(i) Explain what happens in the step up transformer and why it is necessary.

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.....

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

(ii) The electrical current in this system is described as *AC*. State the meaning of the term *AC*.

..... **[1]**

(c) The high power supplied by the transmission lines can create relatively high level electric and magnetic fields.

(i) What is meant by the term *electric field*?

.....

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

(ii) Calculate the current in a 400 MW line if the voltage is 275 kV.

(1 MW = 10^6W, I kV = 10^3 V)

current = ... A

[2]

(iii) This current can cause significant power loss unless the resistance of the power lines is low.

Use the formula

power loss = $(\text{current})^2$ x resistance

to calculate the power loss in this short section of line if the resistance is 2.0×10^{-2} Ω.

power loss = ... W

[2]

[Total: 12]

Paper Total [100]

OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

SCIENCE G642

Unit G642: Science and Human Activity

Specimen Mark Scheme

The maximum mark for this paper is **100**.

This document consists of **8** printed pages.

Question Number	Answer	Max Mark
1(a)(i)	SW / from SW to NE;	[1]
(ii)	Air moves from high to low pressure; Deflected by rotation of earth / Coriolis effect; Clockwise (in N hemisphere); Accept labels drawn on diagram	[3]
(iii)	F = pressure x area; 252,500,000 / 2.525 x 10^8	[2]
(b)	Heat from Sun causes evaporation of water / warm water in Gulf evaporates rapidly; Water vapour condenses releasing heat	[2]
(c)	Use of 4.2 multiplied by either temp rise or 1000; Correct value = 63,000J;	[2]
(d)(i)	Bond formed between any H and any O atoms	[1]
(ii)	High boiling / melting point AW high enthalpy of vapourisation AW high surface tension	[1]
(e)(i)	H marked as +, N as – Use of δ+, δ- terminology AND all polarity of all 3 bond shown	[2]
(ii)	There are two (opposite) charges At different ends of the molecule	[2]
(f)(i)	Label points to region close to Greenland coast	[1]
(ii)	Volume of cuboid = 100,000 m^3; Mass = 1027 x 100,000 = 102,700,000 / 1.027 x 10^8 kg	[2]
(iii)	Evaporation of water; Increases concentration of salt AW Becomes colder; In contact with meltwater ice / glaciers;	[2]
	Total	[21]

Question Number	Answer	Max Mark
2(a)	Nitrogen and oxygen <u>from air;</u> **React at high temperatures**	**[2]**
2(b)(i)	2,1,2 (or 1, ½, 1)	**[1]**
(ii)	+2, +4 (one mark max if signs omitted)	**[1]**
(iii)	Oxidation number increases; AW Combines with more oxygen	**[1]**
(c)(i)	H+	**[1]**
(ii)	Strong acid completely dissociates; weak acid incompletely dissociates AW strong acid dissociates; more than a weak acid (other wordings possible)	**[2]**
(iii)	HNO_3: pH 0-2 HNO_2 any number greater than HNO_2 and less than 7	**[2]**
(d)	Place alkali / named alkali; In a burette; Concentration of alkali needs to be known; Known volume of acid placed in flask / beaker Measure out using a volumetric pipette / pipette of known volume; Add indicator / named indicator (NOT universal / pH paper) Add alkali to acid; Until colour changes; Dropwise close to end-point Repeat and take averages Any 5 points QWC: *Correct sequence of procedure (as above) scores **one** mark.*	**[5]** **[1]**
(e)(i)	More UV radiation reaches the earth's surface UV radiation causes skin cancer / cataracts	**[2]**
(ii)	CFCs / chloroflurocarbons	**[1]**
(f)(i)	$O_3 + O \rightarrow 2O_2$ correct substances on RHS and LHS; balancing;	**[2]**
(ii)	Catalyst	**[1]**
(iii)	Provides a new pathway for the reaction; Is not used up in the reaction;	**[2]**
(g)(i)	Unpaired electron present AW odd number of electrons in molecule	**[1]**

Question Number	Answer	Max Mark
(ii)	3 Labels in appropriate places	[1]
(iii)	Pairs / groups of electrons; Repel each other; 3 groups of electrons; 120^0 is maximum separation;	[3]
	Total	**[29]**
3(a)	A: active site B: helix C: sheet	3 correct = [2] 2 correct = 1
(b)	Substrate fits into active site; Shapes are complementary AW by a lock and key mechanism Bonds to active site; Conformational shift causes substrate to break up AW mechanism has a lower activation energy	[3]
(c)(i)	Suitable scales chosen; Points plotted correctly; Smooth curve drawn;	[3]
(ii)	Temperature between 35°C and 45°C (NOT 35);	[1]
(d)	Farmer will use Roundup to kill weeds / competing plants Beet will not be affected	[2]
(e)	Plasmids; Restriction enzymes; Marker gene; Recombinant DNA	[4]
(f)	2 marks are available for each of the following pairs of points (A-C) (second mark depends on the first; first marking point can be scored even if second is absent A: DNA (of gene) unwinds; mRNA forms on (one strand of) DNA; B: mRNA strand diffuses out of nucleus; binds to ribosome; C: tRNA molecule brings amino acid to ribosome; because anti-codon on tRNA recognises codon on mRNA; 2 marks max can be scored for marking points D-F to make a maximum of 6 in total D: peptide bonds form between amino acids E: sequence of codons determines sequence of amino acids F: mRNA has a complementary structure to original DNA strand; QWC: *Correct sequence of process (as above) scores **one** mark.*	[6] [1]

Question Number	Answer	Max Mark
(g)	2 marks are available for each of the following pairs of points (A-E) to a maximum of 4 marks (second mark depends on the first; first marking point can be scored even if second is absent A: Superweeds could be created; Gene for e.g. herbicide resistance passes to wild plants B; Will affect food chain / biodiversity; Elimination of weeds / pests will cause other organisms in the food chain to die out; C; May cause toxic substances / proteins to be produced in crops; Could cause effects on human health when eaten D; Ethical issue: e.g. this is an "unnatural process"; May be offensive to certain religious groups E; Can cross-contaminate other non GM crops; Consumers may thus be consuming GM organisms without knowing	[4]
	Total	**[26]**
4(a)	A: Other sources of energy release CO_2 This causes global warming OR B: other sources of energy are non-renewable They will run out eventually	[2]
(b)(i)	92;	[1]
(ii)	$^{1}_{0}n$;	[1]
(iii)	86;	[1]
(c)(i)	Electron;	[1]
(ii)	91; 37;	[2]
(d)(i)	Beta particles are ionising radiation; They can damage cells; Cause cancer Any 2 points	[2]
(ii)	Contaminated food is radioactive /contains a radioactive source, irradiated is not / does not; Hence cells in body are exposed to radiation from contaminated food but not from irradiated;	[2]
	Total	**[12]**

Question Number	Answer	Max Mark
5 (a)	Atom as hard sphere /plum pudding model; Reference to Rutherford alpha scattering experiment; Deduction from experiment e.g. atom is mostly empty space / contains a nucleus	[3]
(b)(i)	Increases the voltage / decreases the current; Reduces power / energy loss;	[2]
(ii)	Alternating current / description of alternating current	[1]
(c)(i)	Region in which a force acts; on a charged particle	[2]
(ii)	Current = Power / Voltage; = $400 \times 10^6 / 275 \times 10^3 = 1454$ A; ecf	[2]
(iii)	Power loss = $1454^2 \times 2 \times 10^{-2}$; = 42282 W	[2]
	Total	[12]
	Paper Total	[100]

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)(i)		1		**1**
1(a)(ii)	3			**3**
1(a)(iii)		2		**2**
1(b)	2			**2**
1(c)		2		**2**
1(d)(i)		1		**1**
1(d)(ii)	1			**1**
1(e)(i)		2		**2**
1(e)(ii)		2		**2**
1(f)(i)	1			**1**
1(f)(ii)		2		**2**
1(f)(iii)	2			**2**
2(a)	2			**2**
2(b)(i)		1		**1**
2(b)(ii)		1		**1**
2(b)(iii)		1		**1**
2(c)(i)	1			**1**
2(c)(ii)	2			**2**
2(c)(iii)		2		**2**
2(d)			6	**6**
2(e)(i)	2			**2**
2(e)(ii)	1			**1**
2(f)(i)		2		**2**
2(f)(ii)		1		**1**
2(f)(iii)		2		**2**
2(g)(i)		1		**1**
2(g)(ii)		1		**1**
2(g)(iii)	2	1		**3**
3(a)		2		**2**
3(b)	1	2		**3**
3(c)(i)			3	**3**
3(c)(ii)			1	**1**
3(d)		2		**2**
3(e)	4			**4**
3(f)	4	3		**7**
3(g)	2	2		**4**
4(a)	2			**2**
4(b)(i)		1		**1**
4(b)(ii)		1		**1**
4(b)(iii)		1		**1**

4(c)(i)	1			**1**
4(c)(ii)		2		**2**
4(d)(i)	1	1		**2**
4(d)(ii)	2			**2**
5(a)(i)	1	2		**3**
5(b)(i)	2			**2**
5(b)(ii)	1			**1**
5(c)(i)	2			**2**
5(c)(ii)		2		**2**
5(c)(iii)		2		**2**
Totals	**44**	**46**	**10**	**100**