SPECIFIC INFORMATION

Section A – Multiple choice

Question	Correct response	%	Question	Correct response	%
1	**C**	70	11	**C**	24
2	**D**	71	12	**B**	72
3	**C**	54	13	**B**	70
4	**A**	66	14	**A**	28
5	**D**	72	15	**A**	54
6	**D**	37	16	**B**	79
7	**C**	94	17	**C**	74
8	**C**	73	18	**B**	65
9	**B**	13	19	**D**	46
10	**A**	73	20	**D**	82

Comments on the five items that were answered correctly by fewer than 50% of the students.

Question 6
D was the correct answer, but over 25% went for B.

Question 9
Once you have a given amount of electric charge delivered, the only thing left for a given metal is the charge on the ion. Yet only 13% of students made that selection. Nearly half the students choose D, effectively omitting the phrase '… and a given amount of electric charge passed through the solution …'.

Question 11
C was the correct answer but 43% chose D. They knew (correctly) that water is preferentially discharged but had not grasped that all ions will move to one or other of the electrodes in an electrolyte solution that is being electrolysed. (In this case the sodium ions will move to the cathode, where reduction is occurring according to: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ and the sodium ions are 'needed' to 'neutralise' the negative charges of the hydroxide ions as they are generated.)

Question 1
A surprisingly bad result. A is the only non-α-amino acid. But the presence of the -SH group attracted nearly 50% of responses compared with the 28% for A.

Question 19
Twenty-eight per cent went for Al_2O_3 acting as a basic oxide in C.

Section B – short answer

Question 1 (10 marks)

a. (Available marks 1/Percentage with correct response 60%)
The cathode reaction is $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$

In line with the instructions for Section B no marks were given if the equation was not balanced or the states were not indicated.

b. (4/63)
no. of mol of ethanol used in 20 minutes = (0.46 g/46) = 0.010 mol ethanol (1 mark)
no. of mol of electrons released in 20 minutes = 0.010 mol x 12 electrons released at the anode
= 0.12 mol electrons (1 mark)
charge involved = 0.12 mol x 96 500 Coulomb mol^{-1} = 11 580 C (1 mark)
=> current in cell = 11 580 C/ (20 x 60) s = 9.67 C/s = 9.7 A (1 mark)

c. (2/42)
from the anode reaction, 1 mol ethanol releases 12 mol electrons
=> energy released by one mol of ethanol = 1.10 Joule/Coulomb x (12 x 96 500) C***** = 1.27 x 10^6 J*****
Part c is actually unrelated to part b, but many students did not recognise this.

d. (3/48)

Three pairs of actions are needed:

weigh mass, m (in gram), into calorimeter <u>and</u> add excess O_2 (1 mark); ignite electrically <u>and</u> measure ΔT (1 mark)
calculate ΔH = calibration factor x ΔT (1 mark) => calculate energy released per gram = ΔH/m*.

Many students revealed little understanding of the bomb calorimeter. Many attempts to answer the question were built around the simple calorimeters commonly used in school to measure a temperature rise related to a reaction occurring externally to the calorimeter. A significant number of students ignored the information in the stem that the calorimeter was 'already calibrated' and wrote sentences explaining how the calorimeter would be calibrated. This is a recurring problem in examinations and students need to pay attention, during their preparation, to writing of coherent answers that address the question and its parameters.

Question 2 (6)

ai. (2/59)

ΔT = 43.4 – 20.0 = 23.4 K
=> ΔH = 23.4 x 4.2 x 100 (1 mark)
=> ΔH= 9820 ≡ 9.8 kJ (1 mark)

aii. (2/50)

$\Delta H/mol$ = 9820/0.05 (1 mark)
=> $\Delta H/mol$ = 196 560, exothermic ≡ -197 kJ mol^{-1} = -200 kJ mol^{-1} (1 mark, including correct sign)

b. (2/48)

The same energy was released in experiment A and experiment B but there was more aqueous solution through which to transfer the energy. The average kinetic energy of the particles, temperature, in experiment B is therefore less than in experiment A.

Question 3 (7)

ai. (1/98)

aii. (1/59)

the functional group is an 'ester'

bi. (1/96)

the reaction is 'hydrolysis' (1 mark)

bii. (4/57)

sequentially: water (on H_2O)*****; glycerol structure***** (accept a middle CH_2); glycerol*****; $C_{17}H_{35}CO_2H$***** (balancing not essential).

Question 4 (7)

ai. (2/44)

Students need more practice in both the creation and interpretation of written material.

aii. (1/59)

A hydrogen bond is weaker than a single covalent bond.

bi. (1/96)

The maximum rate of starch formation is between 7.9–8.1 on the graph.

bii. (1/48)

temperature

biii. (2/60)

Denaturation is the breakdown and/or the unravelling***** of tertiary structure. (1 mark)
A decreased rate of reaction occurs because the active site in the enzyme is made less reactive or completely unreactive. (1 mark)

Question 5 (7)

a. (2/43)

Nitrogen is needed for protein production. (1 mark)

Another point is needed to access the full 2 marks; for example, $N_2(g)$ is not directly fixable by plants <u>or</u> comments about the specific chemistry of nitrogen fixation.

b. (4/31)

	Pathway			
	I	II	III	IV
i. pathway/s involving nitrogen fixation	✔	✔		
ii. pathway/s involving soil bacteria	✔		✔	✔
iii. pathways in which nitrogen atoms undergo reduction	✔		✔	
iv. pathway/s showing reaction/s caused by lightning strikes		✔		

c.(1/40)

Any appropriate one of, for example, NH_4NO_3, $(NH_4)_2SO_4$, NH_3 etc.

This was generally a poorly answered question. The details of the chemistry of the nitrogen cycle were not well known. Question 5 reflected the common problem of student difficulty in writing a few sentence; but even more surprising was the very poor responses to b. To score each point it was necessary to get the line completely correct but only about 3% of students scored full marks for part 5b. Most knew about lightning strikes, but the other three discriminators were all found to be difficult.

Question 6 (4/78)

Any two of the scientists studied as part of the study design: Dalton, Bohr, Chadwick, Marie Curie, Meitner, Ramsay, Rutherford, Seaborg, Soddy. Another person could be used, so long as the case could be made for their contribution to the development of atomic theory. (1 mark each)

A concise indication of the contribution and connected correctly to the scientist identified. (1 mark each. 1 mark deducted for an incorrect match between person and contribution.)

Question 7 (8 marks)

a. (1/80)

Two isotopes of helium: abundance 100% and 0.000 14%

b. (1/9)

${}^{22}_{10}Ne$ or ${}^{22}Ne_{10}$ or ${}^{22}Ne$

It is necessary to show the mass number, at least, of the isotope.

c. (2/59)

Rel. atomic mass of Ar = (0.00337 x 35.968) + (0.00063 x 37.962) + (0.99600 x 39.962) (1 mark)
= 39.95 (1 mark, but must have just 4 sig. figs)

di. (2/69)

Rel. atomic mass =10.81 = {10.0**x** + 11.0(100 - **x**)}/100 (1 mark)

⇨ **x** = 19.0.

⇨ ${}^{10}B$ = 19.0%, ${}^{11}B$ = 81.0% (1 mark each – a tolerance of ±1 is allowed)

Question 8 (7 marks)

a. (1/71)

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$ (1 mark)

b. (1/46)

Iron has a partly-filled d sub-shell or ‘the highest energy electron is a d-electron’. Other acceptable answers included details about iron, for example, coloured compounds, magnetism etc. *provided* that the unfilled d-shell was indicated.

ci. (3/44)

$Fe(H_2O)_6^{3+}(aq) + 6F^-(aq) \rightarrow FeF_6^{3-}(aq) + 6H_2O(l)$ (1 mark)

cii.

Some students incorrectly sketched the $Fe(H_2O)_6^{3+}$ ion. Others gave a close approximation to the structure but an incorrect net charge.

ciii.

ion-dipole bonding

d. (2/48)

It is relatively easy to remove an s^1 electron from a Group 1 element. This forms a singly charged, positive ion. Further electrons can only be removed with the application of much higher energy.

Notes:

1. significant figures: required in Q7c; no further marks withheld.
2. states in chemical equations: correct states were required in Q1a; no further marks withheld.