BOARD OF STUDIES
NEW SOUTH WALES

1998 HSC

EXAMINATION REPORT

Chemistry

Including:
- Marking criteria
- Sample responses
- Examiners' comments

Published by
Board of Studies NSW
GPO Box 5300
Sydney NSW 2001
Australia

Tel: (02) 9367 8111

Fax: (02) 9262 6270

Internet: http://www.boardofstudies.nsw.edu.au

February 1999

ISBN 0 7313 4117 1

99018

CHEMISTRY

General comments

1. Coverage of mandatory practical work has improved; however, responses from a minority of centres indicate that some students have limited experience of practical work.
2. Long and consequently often contradictory answers, especially in answering questions on Structure and Bonding, are a problem for many candidates. This is an area where many candidates need guidance and considerable practice before the exam.
3. All parts of the paper except the multiple-choice part are prefaced with the statement:

   'In questions involving calculations you are advised to show working as marks may be awarded for relevant working.'

   Most candidates heed this statement and show relevant working. Doing this can enable the award of full marks if the examiner detects, for example, an error in arithmetic, leading to an incorrect answer. If an arithmetic error is made in the calculation, leading to an incorrect answer, but no working at all is shown, no marks can be awarded.
4. Candidates had difficulty converting from units commonly used in the laboratory, eg mol L^{-1} to units more commonly used on labels of commercially available products, eg g L^{-1}.
5. Most candidates appeared to have had sufficient time to attempt all the core and one elective completely. There are signs that most candidates are using their exam room time constructively to go back through the paper completing and correcting answers.

As in previous years there are still a very small number of candidates who attempt all electives. Time wasted doing more than one elective would be better spent checking answers.

Marking Procedure

1. Shortly after the HSC Exam has taken place Exam Committee Members have discussions with the Senior Markers (SMs) who have been allocated to a question(s) by the Supervisor of Marking (SOM). A Trial Marking Scheme is established for each question.
2. SMs use the Trial Marking Scheme on a sample of candidates papers and if necessary modify and expand the marking criteria for Trial Marking Scheme II. No marks are placed on candidates papers used for trial marking. All marks are placed on separate sheets used for analysis of the scheme.
3. Each SM and two experienced markers called Pilot Markers (PMs) trial mark a larger sample of candidates papers. Input from the PMs is used to establish the Pilot Marking Scheme.
4. The SM and PMs brief the markers (Ms) allocated to that question on the latest draft marking scheme and the Marking Rules. SM, PMs and Ms use the scheme on a sample of up to 15% of the candidates papers. Once again no marks are placed on candidates papers. Separate sheets are used to record marks allocated in Pilot Marking. These sheets are used to analyse the scheme and improve marker consistency and reliability. Input from the Ms is used to produce a Final Marking Scheme.
5. Marking proper does not start until the Final Marking Scheme is approved by an Exam Committee Member and the SOM. Markers must use the Final Marking Scheme and not impose their own standards. Difficult to mark or unusual responses are considered in consultation with marking colleagues and may be drawn to the attention of the whole marking group.
6. Consistency and reliability are stressed throughout the marking operation so that every candidate’s paper is given careful consideration, no matter at what stage of the marking operation the paper is marked.

SECTION I — CORE

PART A

The following table gives the percentage of the candidature selecting each option for the multiple-choice questions. The correct answer is marked with an asterisk.

QUESTION	A	B	C	D
1	5.59	2.71	89.94*	1.54
2	2.65	70.43*	8.51	18.09
3	3.74	2.87	92.65*	0.52
4	2.74	74.16*	16.96	6.00
5	58.30*	13.89	19.55	7.91
6	10.41	8.67	22.52	58.05*
7	3.41	3.84	89.15*	3.39
8	46.50*	36.90	7.49	8.69
9	24.14	58.82*	8.59	8.12
10	17.72	6.23	5.40	70.34*
11	10.96	2.69	77.68*	8.40
12	1.93	7.70	4.01	86.14*
13	3.54	4.37	4.20	87.59*
14	12.82	55.00*	13.29	18.59
15	28.40*	4.69	55.09	11.44

Mean score out of 15 by candidates = 10.36

Question 6

Nearly two-thirds of candidates recognised the importance of hydrogen bonding in raising the boiling point.

Question 8

Over a third of candidates chose the incorrect alternative ‘B’ indicating that they had not considered the mole ratio in which KOH and H_2SO_4 react in carrying out their calculation.

Question 9

Nearly a quarter of the candidates either did not realise that a Bronsted-Lowry reaction involves proton transfer or did not recognise the conjugate acid and conjugate base of NH_3.

Question 12

Candidates this year demonstrated an improved understanding of IUPAC nomenclature.

Question 15

Most candidates looked beyond explaining the rapid change at time = 4 hours and answered the question by considering the slower changes that occurred hours afterwards.

PART B

Question 16

(a) Candidates had difficulty distinguishing between bonding in part (i) and structure in part (ii). Whereas the majority of candidates could explain the high melting point of sodium chloride in terms of ionic bonding, most had difficulty relating the bonding in phosphorus (III) chloride to melting point, simply stating covalent bonds were present and implying that these bonds were broken in melting. Confusion was apparent in use of the terms intramolecular and intermolecular bonding.

(b) This part was generally better answered than part (a) with many candidates showing an understanding of polarity and that the strength of intermolecular forces depends on molecular mass for dispersion forces. Some candidates responded knowledgeably about chlorine only, or about phosphorus (III) chloride only, but because they did not compare the two substances could not gain a mark. Other candidates expressed confusion at the idea of measuring the melting point of a gaseous element.

The marking scheme and a range of candidate responses follow:

Marking Scheme

In part (a) two marks were awarded, one for bonding and one for structure. Many candidates were unclear of the difference between a bonding explanation and a structure explanation and sometimes responded in the wrong part. Explaining the difference required candidates to give correct information about the bonding/structure of both the sodium chloride and phosphorus (III) chloride.

(i) The bonding explanation required the correct use of terms such as ionic/electrostatic attraction between ions for sodium chloride and the use of terms such as dispersion forces/London forces/van der Waals/weak forces between molecules/intermolecular /dipole-dipole for phosphorus(III) chloride.

(ii) The structure explanation required the correct use of terms such as lattice/network/array of ions compared with molecules/molecular/covalent molecular lattice.

In part (b) one mark was awarded for a comparison such as weaker intermolecular/dispersion forces/fewer electrons/less mass for chlorine or non-polar/dispersion/van der Waals compared with polar/dipole-dipole forces.

An example of a response scoring 3 marks

(a) (i) The ionic bonding between Na^+ and Cl^- ions is stronger than the intermolecular forces between PCl_3 molecules, therefore M.P. higher for NaCl.

(ii) NaCl exists in a rigid lattice structure of cations and anions. PCl_3 consists of molecules with weak dispersion forces and dipole-dipole forces between molecules.

(b) Cl_2 has a lower M.P. because the molecules are only held by weak dispersion forces (the molecule is non-polar) while molecules of phosphorus (III) chloride are held by stronger forces (dipole-dipole forces).

An example of a response scoring 0 marks

(a) (i) NaCl has ionic bonding whilst phosphorus (III) chloride has covalent bonding. Covalent bonds have a higher M.P. than ionic bonds due to their intermolecular forces.

(ii) the structure of NaCl is linear while PCl_3 is trigonal planar. As attraction between NaCl is larger than PCl_3 a higher temperature is required to break the structure.

(b) In Cl_2 there's only weak dispersion forces acting on it which is much weaker than the force that is is the covalent bond of PCl_3 thus less temperature is required to break Cl_2 bonds than PCl_3 bonds.

Question 17

(a) Some candidates did not appreciate that in determining which reactant was in excess a comparison in moles was required. Some comparisons of NaOH and HNO_3 were in terms of mol L^{-1} concentration, mass or volume.

Transcription errors where 3g or 300g was used instead of 0.300g prevented some candidates receiving a mark.

(b) Most candidates were familiar with the expression pH = -log $[H^+]$ and could correctly process this in the calculator.

A common error made by approximately one quarter of the candidature was to use $[H^+] = 5 \times 10^{-3}$ mol L^{-1}, the original acid concentration, rather than the $[OH^-]$ remaining in the final solution after reaction between NaOH and HNO_3 .

Question 18

This question was well answered with most candidates showing a good understanding of electron configuration and position of elements in the periodic table.

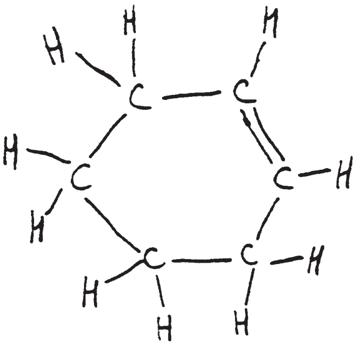
Question 19

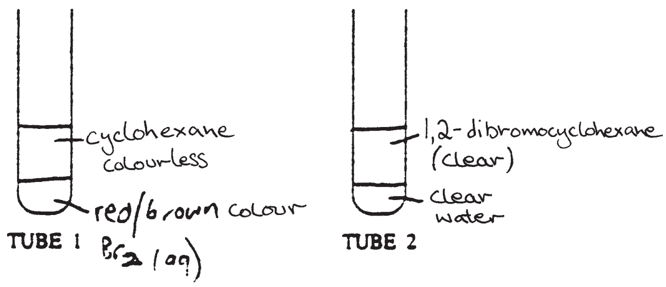
(a) This was well answered but some students gave both a straight chain structure and a cyclic structure. In a case like this where a single response is required but the candidate gives two responses, one of which normally receives a mark while the other does not then no mark is given.

(b) This question, based on the type of practical experience all candidates should have undertaken, was poorly answered. (Cyclohexane is preferred over hexane for practical work because it is less toxic, has a higher boiling point and lower vapour pressure.)

The most common error was that candidates failed to draw two layers, either not knowing or not having experienced that hydrocarbons and aqueous solutions are immiscible. Other common errors were:

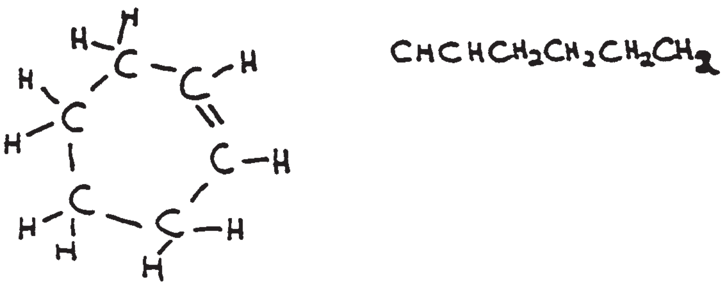
- drawing the aqueous layer above the organic layer;
- incorrect colour of bromine, eg purple, pink, green;
- incorrect names, eg 1, 2-dibromohexane or dibromocyclohexane instead of 1, 2-dibromocyclohexane;
- omission of the water layer in tube 2.

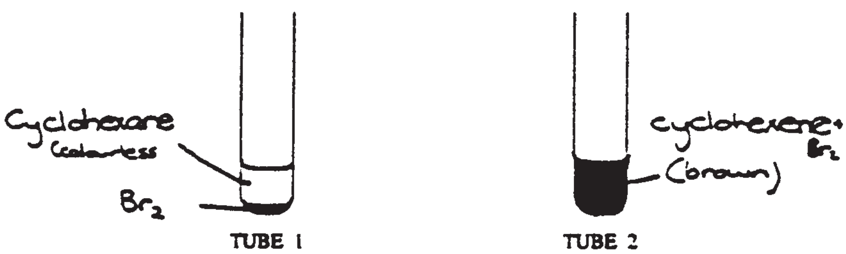




An example of a response scoring 3 marks

An example of a response scoring 0 marks:





Question 20

(a) Generally well answered using the concept of electronegativity. Simple diagrams can be useful as aids to explanations but a diagram using delta negative and delta positive without a word of explanation is insufficient.

(b) Not answered well. Most candidates had a poor understanding of dipoles and why the trigonal planar molecule is non-polar. Not all candidates appear to appreciate that the mark is awarded for the explanation and that stating that the molecule is non-polar is insufficient to gain a mark.

(c) Poorly answered. Most candidates simply stated it was a covalent bond rather than coordinate covalent or dative bond.

Question 21

(a) Once again candidates had few problems calculating pH from the $[H^+]$ concentration. However, many candidates did not provide an answer to three significant figures when relevant data for the calculation was supplied to three significant figures.

(b) Moderately well answered. There were, however, a lot of errors transcribing either numbers or formulae from the table and an understanding of significant figures again was poor. There appeared to be some confusion with the products of the ionisation of chloroethanoic acid, CH_2COOH^+ and Cl^- often being given.

(c) Poorly answered. Quite a few candidates failed to make a statement about which acid was stronger (or weaker). Many candidates assumed the $[H^+]$ values in the table were K_a values. Few candidates correctly calculated the K_a value for ethanoic acid and compared this with the K_a value calculated for chloroethanoic acid in part (b).

Question 22

(a) Fewer than 10% presented good answers. Most common errors were:

- no appreciation of the equilibrium situation;
- not linking a saturated solution to equilibrium;
- repeating or rewording the question data;
- use of the term molecules instead of ionic substance or ions.

(b) Only about a third of candidates obtained the mark here. Responses showed a significant lack of knowledge of the fundamentals of both formula and equation writing. Most common errors were:

- state of calcium hydroxide omitted;
- equilibrium symbol omitted;
- incorrect chemical symbols, eg Ca^+, for both reactant and products;
- unbalanced equation.

(c) Well answered. Most candidates understood the cause and effect in this question and demonstrated a sound knowledge of the common ion effect.

An example of a response scoring 3 marks

(a) Yes, the reaction is in a state of equilibrium meaning the forward reaction rate equals the backward reaction rate. The solid is continuously going into solution while the solution is also precipitating at the same rate.

(b) Ca(OH)2(s) $\rightleftharpoons$ Ca^{2+} + $2OH^-$

(c) Adding conc. NaOH would cause the OH^- concentration to increase causing the equilibrium to shift to the left producing more solid $Ca(OH)_2$.

An example of a response scoring 0 marks

(a) Yes, because the solution of calcium hydroxide and water has reached equilibrium that means as more calcium hydroxide react with water the equilibrium shift to the right but to replace the reactant the equilibrium shift back to left.

(b) $Ca(OH)_2$ + H_2O $\rightleftharpoons$ Ca^{2+} +

(c) The equilibrium would shift to the left according to Le Chattleir Principal but since the solution is already at equilibrium it would stay at there.

Question 23

(a) Moderately well answered.

(b) Most candidates correctly wrote the equilibrium expression. Those who could not also did poorly on the other questions in part B.

(c) Well answered.

Question 24

(a) Well answered. The most common errors included giving the molecular formula instead of the name or not giving a systematic name, eg butene instead of 1-butene or 2-butene.

(b) Well answered. Candidates who chose to answer with a condensed structural formula often had the incorrect number of hydrogens in the product while students who responded with a full structural formula made fewer errors.

(c) Well answered when candidates drew an isomer of part (a) rather than part (b).

Question 25

(a) Well answered.

(b) Interpretation of the graph was good.

(c) Less than one third of candidates could correctly calculate the K_a. Many did not know how to substitute the ratio from (b) in the K_a expression or didn't realise pH = 8.5 needed to be used to calculate $[H^+]$.

PART C

Question 26

The majority of candidates received four or five marks for this question, indicating a good grasp of concepts. The candidates who received four marks usually did not receive a mark for (b) as a result of adding chemical descriptions which were incorrect. These incorrect chemical descriptions negated the initially correct answer given in (b). Candidates are advised to give concise answers rather than qualifying their answer with additional information which may lead to incorrect or unnecessary information.

Three of the five marks in this question were awarded for giving structural formulae. Candidates who give full structural formulae showing all bonds were more likely to give the correct formulae. All hydrogen atoms present must be shown and the bond from carbon to an OH must be drawn to the O.

The hydroxyl group OH should not be referred to as the OH^- or hydroxide group. In some cases in part (b) candidates identified a difference and then lost the mark in a following explanation using this type of incorrect chemistry.

The relevant mandatory experience requires students to use both $KMnO_4$ and $K_2Cr_2O_7$. In part (c) some candidates recalled the permanganate colour change rather than the dichromate colour change.

In part (d) a large percentage of candidates indicated an understanding of the esterification process. The most common error was the use of the primary alkanol in the ester formation.

Question 27

(a) Generally well done. However, many candidates failed to link to the stimulus material in the stem of the question. Consequently, they did not give a chloride or oxide of Period 3.

Many candidates could not distinguish between a physical property — a property measured of the pure substance by itself — and a chemical property — a property of the pure substance with another chemical. Candidates found it more difficult to give a chemical property than a physical property.

(b) Most students successfully attempted part of this question. Some candidates misunderstood the question and tried to compare the electrical conductivity of the oxide and the chloride. The most common misconception was that electrons conduct the current in the molten state.

(c) (i) Less than 5% of candidates could give a correct electron dot formula for an ionic compound, that included positive and negative charges on the ions and the correct number of outer electrons. Candidates appear to have had little experience of writing electron dot formulae for ionic compounds.

(ii) Almost 50% of the candidates gave a correct electron dot formula for a covalent compound.

An example of a response scoring 5 marks

(a) Sodium oxide

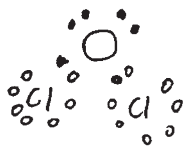
(i) high melting and boiling point

(ii) has high pH in water ie. basic

(b) The electrical conductivity of magnesium oxide is low when a solid as the ions are in a rigid lattice structure but high when molten as the ions are more mobile

(c) (i)

(ii)



Question 28

Overall, this question was generally well answered.

(a) Very well answered.

(b) A substantial number were able to substitute in the expression they had written in (a) but were then unable to calculate the final answer. It is assumed that all candidates can use their calculator to calculate using indices.

Unfortunately the 2.00 L was used unecessarily in calculations by many of the students. A small but significant number of candidates incorrectly divided the equilibrium concentrations by two.

(c) Two thirds of candidates scored the mark. Many candidates who did not score a mark gave a description of what was happening at equilibrium in terms of concentrations, colour etc instead of an explanation. Other common problems included candidates failing to mention rates of reactions or stating that rates cancelled each other out.

(d) Just over one third of candidates recognised that at a constant temperature the equilibrium constant would be unchanged. The concept of a constant was poorly understood. Many linked the equilibrium constant to Le Chatelier's principle and therefore incorrectly deduced that the constant would change depending on which side of the reaction was favoured.

(e) Although a little over 70% of candidates scored a mark in this part the answers were characterised by very imprecise language, poor expression and sometimes illegible writing. A significant number of candidates used expressions like ‘a catalyst speeds up the time’ or ‘quickens time’ instead of ‘reduces the time taken’.

Question 29

(a) Most students gave the correct species H_3PO_4.

(b) Many students were able to give the correct step but only 30% were able to give a correct explanation to obtain the mark.

(c) About 60% correctly named phenolphthalein.

(d) To gain the two marks for this part candidates had to give a correct name and show its amphiprotic behaviour by using equations. Unfortunately many candidates did not read the question carefully and did not give a different amphiprotic species from the ones given in the question.

An example of a response scoring 5 marks

(a) H_3PO_4

(b) Step 1, as H_3PO_4 is the strongest acid out of the 3, and has the greatest degree of ionisation in water. The equilibrium lies to the right.

(c) Phenolphthalein

(d) Another example of an amphiprotic species is HCO_3^-

$$HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$$

$$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$$

An example of a response scoring 0 marks

(a) HPO_4^{2-} is the conjugate acid of $H_2PO_4^-$

(b) All the steps would have the same K_a values as temperature remains constant in all 3 reactions and K_a is temperature dependent.

(c) Bromothymol Blue would be best

(d) A different amphiprotic species is H_2SO_4

$$H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$$

$$HSO_4^- + H^+ \rightleftharpoons H_2SO_4$$

Question 30

(a) The most common error was the drawing of a non-branched structure, most commonly that of hexane. The next most common errors were the omission of some or all of the bonds between the atoms and the exclusion of the hydrogen atoms in the expanded structure. Once again, more mistakes occurred when candidates drew a condensed structure rather than a full (expanded) structural formula.

(b) Most candidates could name the structure they drew in part (a) but did not always score a mark for their answer. This resulted from the candidates' failure to observe the following rules for the writing of the names of organic compounds:

- when indicating with numbers the position of two or more side chains in the structure, a comma must separate the numbers, eg 2,2 not 22;
- a hyphen must separate the final number from the beginning of the name, eg 2,2-dimethylbutane not 2,2 dimethylbutane;
- the name of the compound must be one continuous word, with no gaps or capitals; eg not 2,2-dimethyl Butane;
- the name must be spelled correctly eg methyl not methy; pentane not pentone.

Some candidates confused themselves when naming the structure they drew in (a) by not drawing the main chain horizontally.

(c) Most candidates could correctly balance the equation for the combustion of the alkane but many did not know the state of this alkane. Candidates who did include states frequently did not indicate them clearly enough. Combustion is not an equilibrium situation and therefore two way arrows should not have been used in the equation.

Many candidates wrote the equation twice — the first for their working and the second for the final answer. When candidates did this, there was a tendency for them to not transfer all the information to the final answer, eg all the coefficients or all the states.

(d) This was generally well answered. Many candidates also included equations and/or the name of the compound; this extra information (which was viewed as being irrelevant to the answer) frequently indicated that the candidates did not understand that this was a substitution reaction.

(e) This part asked for only ONE safety precaution. Where candidates wrote more than one precaution, frequently one of the answers was incorrect, resulting in the candidate scoring no mark for this part.

The precaution given had to be specific to the reaction. Frequently candidates' responses reflected a general safety precaution rather than a specific one, eg 'use protective clothing'. Many candidates focussed on the hazard instead of the precaution required.

Scientific equipment was often incorrectly named, eg a fume cupboard referred to as a 'gas chamber', or incorrectly identified, eg a fume cupboard as a closed system.

Many candidates chose sunglasses as a safety precaution when using UV in the laboratory. Sunglasses are in fact considered hazardous in a laboratory situation because of reduced visibility and would not necessarily protect against the UV frequencies used in a laboratory.

Question 31

(a) Many candidates appear to believe that a base is never used in the burette and that they must therefore always pipette the base. Rinsing the pipette with the NaOH solution was consequently the most common response such that it outweighed the correct response. Practical analysis of acidic samples frequently requires titration using base in the burette; provided the base solution is not too concentrated and is not left to stand for a long time in the burette, negligible dissolving of glass and alteration of the internal volume of the burette would occur.

(b) Many candidates appear to have not mastered the preliminary course outcomes involving calculation of number of moles as they did not convert volumes to litres or correctly manipulate the quantities in their calculation. Further, many candidates averaged the volumes used in all three of the titres, rather than ignoring the ‘rough’ first value. This seems to indicate infrequent exposure to the technique of titration.

(c) The most common error here involved transposition of the volumes used such that the volume of wine was considered to be 10 mL.

(d) Many candidates appeared unfamiliar with the expression of concentration in g L^{-1} even when they had correctly calculated the molar concentration in (c). g L^{-1} is more frequently used on the labels of commercially available products than mol L^{-1}.

An example of a response scoring 5 marks

(a) Potassium tartrate

(b) c = moles/vol therefore moles = conc x vol

= 0.01 x 0.0101

= 0.000101 moles

(c) 0.000101 moles of 0.01 M NaOH titrate 50 mL of potassium tartrate c = moles/vol = 0.000101/0.05 = 0.00202

[potassium tartrate] = 0.00202 moles/litre

(d) 188g mol^{-1} x 0.00202 moles = 0.380g

[potassium tartrate] = 0.380g L^{-1}

Despite three of the numerical answers being wrong the following candidate was awarded full marks because correct working methods were shown:

(a) the wine (acid)

(b) n = M V = 0.01 x (10.1 x 10^{-3})

= 0.00101 moles = 1.01 x 10^{-3} moles

(c) 1.01 x 10^{-3} moles / 50mL

= 2.02 x 10^{-2} moles per litre = 0.02 M

(d) n x 188 = 3.8 g L^{-1}

ELECTIVES

Candidates choosing each elective

ELECTIVE	ELECTIVE NAME	CANDIDATE NO.	CANDIDATE %
QUESTION 32	Chemical Energy	5297	52.0
QUESTION 33	Oxidation and Reduction	3814	37.4
QUESTION 34	Biological Chemistry	787	7.7
QUESTION 35	Chemistry and the Environment	235	2.3

Question 32 — Chemical Energy

(a) Generally well answered. Candidates who did not obtain a mark usually gave a very basic definition of a fuel as a source of energy without indicating that a chemical reaction was involved.

(b) (i) Less than 20% of candidates gained the 2 marks for this part, while the majority gained 1 mark. Most candidates showed some understanding of the term flashpoint but were unable to give an accurate definition.

Common errors included:

- not referring to the production of vapour;
- not mixing vapour with air/oxygen;
- confusion with ignition temperature;
- not indicating that flashpoint is a temperature.

A significant number of candidates tried to explain the meaning of the statement ‘Ethyne has a low flashpoint’, rather than the term ‘flashpoint’.

(ii) An advantage — about 30% of candidates were able to give a reasonable answer. Many others had the misunderstanding that they could reuse unburned fuel/products.

A disadvantage — well answered by over 75% of candidates.

(iii) Well answered by the majority of candidates.

(iv) Quite well answered. Many candidates made one error such as:

- not doubling _H_f for water;
- not reversing the sign for _H_c for C_2H_2
- confusing _H_c with _H_f for C_2H_2.

(c) (i) Quite well answered-the majority of candidates were able to gain marks by showing an understanding of the process involved.

Common errors were:

- using C - O instead of C = O
- using O - O instead of O = O
- only 2 x O - H instead of 4 x O - H.

(ii) Poorly answered. Many did not link (c) (ii) with (c) (i), trying to calculate an independent answer. Others just used the _Hv in place of the O - H bond energy for

(c) (i) A significant number made a minimal attempt to answer the question, showing a lack of understanding of the relevance of the _H$_{v}$.

(d) (i) This equation was generally well understood.

A significant percentage tried to determine the mass using Q = m.c._T and _T = 80°C.

(ii) The ideal gas equation was well applied by the majority of candidates.

(iii) Some candidates focussed on the transportation of the container rather than the containment of gas under high pressure.

(iv) This was well understood by most candidates. They knew that they had to apply Hess's Law and use the mole enthalpy ratios for the two following equations. However a significant number of candidates failed to recognise that the combustion equation at the beginning of part (d) was also required.

(v) Most candidates showed a good understanding of the relationship between the negative value of the enthalpy change and the exothermic nature of the reaction. Better students were able to relate the relative enthalpy of reactants and products.

(e) (i) This question was poorly answered by the majority of candidates. Many were unable to deal with the concept of an endothermic reaction and the transfer of heat into the system affecting the results.

(ii) Candidates clearly recognised that insulation would improve results by reducing heat transfer.

(f) (i) The majority of candidates gave the correct response. The principal source of error was the employment of incorrect units, eg -273 K.

(ii) This was generally well answered. A good understanding that intermolecular forces affect the volume of a real gas was evident. Yet again, some candidates had difficulty expressing clearly the role of gas particle volume, confusing it with the volume of the gas sample.

Question 33 — Oxidation and Reduction

(a) (i) This part was not answered well. Many candidates did not seem to know what the question was asking. There was a poor understanding of the role of the sulfuric acid electrolyte, even though the overall reaction equation was given in terms of the ions in the sulfuric acid.

(ii) Good responses for this part. However, understanding the meaning of the word 'multiple' seemed difficult for some candidates.

(iii) It was pleasing that most candidates correctly identified the cathode and that a correct chemical explanation was provided.

(iv) Answered well. However, some answers did not give an explanation, but simply restated the words in the question. Also some students concentrated more on trying to explain the 'why' it is a measure of the state of charge (often with very poor chemistry) rather than the 'how' it is used as a measure. Other students seem to think that the state of charge of a cell related to the terms 'positive' and 'negative'.

(b) (i) The majority of candidates indicated that they had a good understanding of the term 'oxidant'.

(ii) This was the most successfully handled question in this elective!

(iii) It was pleasing to see that this half equation was generally well balanced, but a common error was to show nine electrons in the half equation (the result of not indicating 2 chromium ions or neglecting to double the charge on the chromium ion). It was evident, however, that a small number of centres were poorly prepared to handle this type of question.

(iv) Responses for this part showed that candidates did try to get a balance in terms of the multiplier and cancelling electrons from the half equations. However, a significant number failed to check the balance of the total number of atoms and electrical charge.

(v) Well answered, generally showing the correct use of scientific notation.

(vi) Most candidates used the correct multiplier or a multiplier consistent with their overall equation, but many failed to appreciate that it was a 250 mL sample (not the average titration volume).

(vii) A significant number of students did not convert the number of moles of iron to a mass. Some candidates seemed confused by the request to calculate a percentage even though the question generously reminded them it was g/100 g.

Some answers were attempted using molarities and by calculations which tried to get the number of moles of steel by dividing one gram by the atomic mass of iron.

The answers from many candidates showed that they did not seem to realise that steel is predominantly iron. These answers seem surprising considering corrosion of metals, methods of rust prevention and the applications of redox chemistry in everyday life are significant parts of the syllabus.

(c) (i) It was apparent from the responses that many candidates had not performed this mandatory experience. Only 50% of candidates were able to correctly identify a material to be plated, the cathode and the direction of electron flow.

Of the candidates who failed to answer the question correctly about 60% chose electrochemical cells to perform the task with no external source of energy.

Some candidates who provided functional electrolytic cells placed labels 1 and 2 on different electrodes.

(ii) The question asked candidates to name the solution used. Many chose inappropriate solutions or just provided a chemical formula. The most common errors included choosing potassium nitrate, sodium chloride or insoluble salts.

(d) (i) About 60% of candidates could correctly identify the oxidation number of carbon in methanal. The most common errors included stating it as 4 or providing the atomic number or atomic mass.

(ii) 40% of candidates could correctly write a balanced half equation for the oxidation of methanal. Others simply wrote combustion equations or formed equations unbalanced for charge or wrote reduction half-equations.

(e) (i) Approximately 70% of candidates could identify iodine as being the species with the dark brown colour. The most common error was iodide.

(ii) This was the most poorly answered part of this elective and a good discriminator.

Good candidates were able to answer the question efficiently and effectively whilst weaker candidates had little idea as to how to attempt it. 30% of candidates obtained full marks. Most had little trouble in identifying an equation for acid conditions however a majority of candidates failed to identify an equation to describe the basic conditions.

Many candidates coupled the oxidation of I- to the reduction of O_2 under acidic conditions producing a positive E value and stating this was the spontaneous reaction with no consideration of the basic conditions.

A small percentage of candidates, instead of showing working, attempted to describe their answers by writing about reactions being higher and lower in the Table.

(f) (i) A majority of candidates could identify Fe as being the major component of steel and performed a calculation or described the fact that Ti acts as a sacrificial anode.

As in (e) (ii) a significant number of candidates could correctly extract E values from the Table but were unable to manipulate them to show why their chosen metal would be oxidised in preference to Fe.

Students need to realise that E values as given in the Table are standard reduction potentials, and avoid statements such as ‘Ti has a higher E value than Fe and will corrode first’.

(ii) 90% of candidates provided a method to protect a metal from corrosion. The most common error was simply restating the method in (f) (i) using a different active metal.

Question 34 — Biological Chemistry

(a) (i) This part was well answered. Candidates were able to identify a correct monosaccharide.

(ii) Most candidates were aware of the two molecules that needed to be joined to form maltose. However the formation of the bond between the monosaccharides and the representation of the overall structure of the maltose was very poorly done. Many structures were drawn hastily and without attention to detail of individual bond linkages.

(iii) Most candidates seemed unable to formulate a satisfactory definition of a reducing sugar in terms of what the sugar can do and how this occurs.

(iv) The few candidates who gained a mark for this section simply recalled the structure of sucrose from a text book. Candidates seemed unable to use the relevant structural diagrams in the examination material to draw the disaccharide.

(v) Barely satisfactorily answered. Many candidates referred to the dipeptide as a bond rather than a structure or a molecule.

(vi) Most candidates were able to draw a correct peptide linkage between two amino acids but failed to present the correct transcription of the side chains. Individual bond representations were again poor.

(vii) This was satisfactorily answered with most candidates correctly describing the result/product of each test.

(viii) This was satisfactorily answered. Candidates’ explanations of processes leading to the formation of the overall 3-dimensional shape were well expressed.

(ix) Very well answered.

(b) (i) Poorly attempted. Many candidates repeated information from the diagram without reference to the source of the carbon dioxide, or identification of the monosaccharide formed.

(ii) Candidates were able to nominate photosynthesis as an endothermic reaction but did so without giving a satisfactory explanation. Candidates frequently referred to 'heat' energy being absorbed in the process.

(c) (i) Satisfactorily answered. Most were able to identify starch with the characteristic test using iodine. Fewer candidates were able to give a characteristic test for protein.

(ii) Satisfactorily answered by candidates, with most gaining both marks. Candidates need to be encouraged to focus on chemical explanations rather than biological statements of fact.

(d) (i) Very well done.

(ii) Poorly done. Candidates often made the statement that the ethanol altered the pH and it was this that affected the enzyme.

(iii) Poor response. Most candidates did not refer to the changing rate of reaction in their responses. Instead they focussed only on the effect of excessive heating of the enzyme causing denaturation and stopping the reaction, without commenting on a general increase in the rate of reaction (up to the optimal temperature), and then a rapid decrease as the temperature increases above this optimum.

(e) (i) Most candidates recalled this information.

(ii) Very poor response. Candidates showed minimal understanding of the role of the cycle or the importance of Acetyl Co A / acetic acid / acetate.

(iii) Considering the satisfactory response to the first part, this part was poorly done. Candidates did not refer back to the information given in this first part and many failed to include the production of carbon dioxide in the fermentation reaction.

(iv) About 30% of candidates were able to calculate the mass of the glucose. Many had considerable difficulty in converting the 4% to a mass of ethanol.

Question 35 — Chemistry and the Environment

(a) (i) 1. Equation writing was very poor. Molecular oxygen was included but coefficients were not manipulated correctly.

2. Calculations were superficial, often as a consequence of molar ratios not having been correctly included from part 1.

(ii) Answers were very general and equations were not always included.

(iii) Most candidates followed the question context and (correctly) referred to the oxygen. Ozone concentrations were often discussed, however the location of the stratosphere within the range stated was not always recognised.

(b) (i) Equations for the formation of acid rain were frequently recalled. The environmental effect was not always included.

(ii) Very poor calculations; conversion of the units given was not done well.

(iii) Only a small number of candidates recalled the appropriate test, suggesting that this experience had not been completed by the majority of candidates.

(c) (i) There were specific answers given by the majority of candidates. An appreciable number of general answers such as ‘out of the ground’ were not awarded a mark.

(ii) Many candidates apparently failed to read the material in the question and did not make reference to the given half-life of the isotope U-235.

(iii) Generally well answered by the majority of candidates.

(iv) The importance of a suitable containment method during disposal was not always included in answers. Uninformative answers such as ‘dump in the ocean’ were common.

(d) (i) Le Chatelier’s Principle was correctly applied in most cases.

(ii) 1. Chlorine gas instead of chlorine atoms or Cl was a very common error.

Explanations were generally satisfactory with specific reference to the given information.

2. The majority of candidates answered this question satisfactorily. This year, there were minimal references to global warming.

(iii) 1. ‘Car Exhausts’ was a common but insufficiently detailed answer.

2. Most candidates were able to isolate a danger concerning photochemical smog. Many, however, went for a ‘high impact’ answer, eg ‘causes cancer’, before considering the direct effect on humans.

(e) (i) 1, 2 and 3. Calculations and conversions were poorly attempted. Few candidates gained the marks here.

(ii) 1 and 2. Descriptive answers were often very general and lacked depth. Candidates tended to write extensively but failed to address the question. Candidates need to be encouraged to write briefer answers.

(iii) Recalled well by most candidates, with an equation often provided to support the answer.

(iv) As in part (iii) answers tended to be extended and general.

ISBN 0 7313 4114 1