# Chemistry GA 3: Written examination 2

## SPECIFIC INFORMATION

### Section A

| Question | Correct response | % | Question | Correct response | % |
|---|---|---|---|---|---|
| 1 | C | 51 | 11 | B | 83 |
| 2 | B | 48 | 12 | C | 76 |
| 3 | A | 61 | 13 | A or B | 89 |
| 4 | D | 35 | 14 | D | 59 |
| 5 | B | 58 | 15 | A | 75 |
| 6 | B | 41 | 16 | C | 41 |
| 7 | A | 83 | 17 | C | 43 |
| 8 | A | 78 | 18 | D | 76 |
| 9 | D | 77 | 19 | C | 96 |
| 10 | B | 61 | 20 | A | 74 |

### Comments

**Item 4**

Response A was more common than the correct D. The stem referred to an 'alkaline' hydrogen-oxygen fuel cell so that D is clearly a 'better' response.

**Item 6**

Response A was nearly as popular as B, but B is clearly 'better'.

**Item 13**

B is the correct answer to the question as written (although both A or B were accepted).

**Item 16**

A difficult item. 'The path that is affected most' referred to the path of the ion that would be most deflected by a given magnetic field. $^{63}Cu^{2+}$ combines the higher charge with the lower mass of the ions available for choice. Response D was nearly as popular as the correct C (maybe mass is not seen as being as important as charge).

**Item 17**

Response B was nearly as popular as the correct C (perhaps the fact that seven ionisation energies are shown led to the assumption that there were only seven electrons in the atom).

### Section B

Summary of the answers together with some commentary where appropriate. Note that an asterisk (*) indicates 1 mark.

**Question 1 (5 marks)**

**a.**

Molecule must be folded so as to provide the correct shape to allow the reacting substrate/molecule(s) to complete the reaction* (appropriate key words/terms – 'active site; lock and key ...')

**bi.**

As temperature rises a higher proportion of the reacting molecules will have enough energy to react*.

**bii.**

Above 40 degrees, the tertiary structure of the enzyme begins to denature/degrade so that the enzyme is less well able to function as a catalyst*

**c.**

$-NH_3^+$ * and $-CO_2H$ *

Answers to b. were the weakest part. Students have difficulty in seeing that an enzyme-catalysed reaction is still an ordinary chemical reaction whose rate will, in general, increase with increasing temperature. This explains the rate increase between 10 and 40° C. A quite different process becomes important around 40° C – the enzyme denaturation which leads to the eventually catastrophic decrease in rate with increasing temperature because of the destruction of the catalyst. Students are still too prone to say something like '... 40° C is an optimum temperature for the enzyme-catalysed reaction'. This is not an explanation and was not rewarded.

## Question 2 (13 marks)

**a.**

(1/32)* mol methanol gives (1/32) x (1454/2)* = 22.72 = **22.7** kJ* heat released.

**bi.**

$\Delta H$ = 22.72; $\Delta T$ = (26.5 – 15.0) = 11.5 K; calibration factor = (22.72/11.5)* = **1.98 kJ/K***

**bii.**

Heat released by burning bread = 1.98 x 20.5 = 40.6 kJ; heat energy of bread = (40.6/2.7)* = **15.0 kJ $g^{-1}$***

**biii.**

Lower; moisture will add to mass of sample so that mass recorded is greater than actual mass of bread* – hence less heat per mass than expected will be released* and $\Delta T$ will be too small.

**biv.**

Energy released by 0.90 g will be less than 'correct' amount so that $\Delta T$ will be too low*; hence calibration factor will be too high*; hence calculated energy content of bread will be too high*.

**bv.**

Not all of the bread is digestible*.

The 'errors' parts of this question were quite well done considering that making the explanation under pressure is not always easy.

## Question 3 (6 marks)

**ai.**

$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ *

**aii.**

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ *

**bi.**

Keeps the products of electrolysis apart*.

**bii.**

Lower health hazard than other technologies **or** impermeable to chloride ions ('ion-selective') so minimises NaOH contamination*.

**c.**

Hydrogen (or $\mathbf{H_2}$)* and sodium hydroxide (**NaOH**)*

## Question 4 (10 marks)

**ai.**

$\mathbf{PbO_2(s) + Pb(s) + 2SO_4^{2-}(aq) + 4H^+(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)}$ *

**aii.**

Oxidant - **$PbO_2$***; reductant - **Pb***

**bi.**

Amount of electricity = 3.50 x 2.00 x 60 = 420 C*; mole of electrons flowing through each cell = (420/96500)* = 4.35 x $10^{-3}$; mole of $PbO_2$ per cell = (420/2 x 96500) = 2.18 x $10^{-3}$; mole of $PbO_2$ per battery = 2.18 x $10^{-3}$ x 6 = **0.0131 mol***

**bii.**

Total mole of $PbSO_4$ deposited = 4.35 x $10^{-3}$* per cell; mass per cell = 4.35 x $10^{-3}$ x 303* = **1.32 g***

**biii.**

3.50 x 2.00 x 60 x 12.0 = **5040 J***

The 'per cell' and 'per battery' distinction tripped up most students – although only 1 mark was lost for this error as marks are not deducted for consequential errors.

## Question 5 (6 marks)

**a.**

$\mathbf{6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)}$*; endothermic*

**b.**

$\mathbf{Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)}$* ; 6*; the presence of a group of outer and next to outer shell electrons (3d and 4s) all with similar energies allows transition metals to use differing numbers of electrons for bonding purposes*;

e.g. $Cr^{3+}(aq) + 6NH_3(aq) \rightarrow Cr(NH_3)_6^{3+}$ *

This style of question always seems to create problems. Very often, when students were asked to generate their own example they left it blank.

## Question 6 (4 marks)

- Elements arranged in order of increasing RAM*; noting that elements with similar chemical properties recurred at regular intervals* (i.e. periodically) forming groups.
- Modern tables are based on arranging elements in order of electronic configuration/increasing atomic number*
- Because electron configurations/increasing atomic number approximately correlate with atomic mass/statement identifying reasons for success of Mendeleev's scheme, e.g. allowance for undiscovered elements.*

A standard style of question for which students often resort to answers consisting of a brief phrase. Whilst it is given that students receive the benefit of the doubt whenever meaning is uncertain, the rule for students should be 'when in doubt, spell it out'.

## Question 7 (7 marks)

**ai.**

The energy needed to remove the highest energy electron (an outer shell electron) from an atom in its ground state (minimum energy needed to remove an electron from an atom)*.

**aii.**

The core charges of the atoms of the second period increase (from 1 to 7) going from Na to Cl*; the higher the core charge, the more energy is needed to remove one of the outer shell electrons*.

**bi.**

oxidising – increase* from Na to Cl; reducing – decrease* from Na to Cl

**bii.**

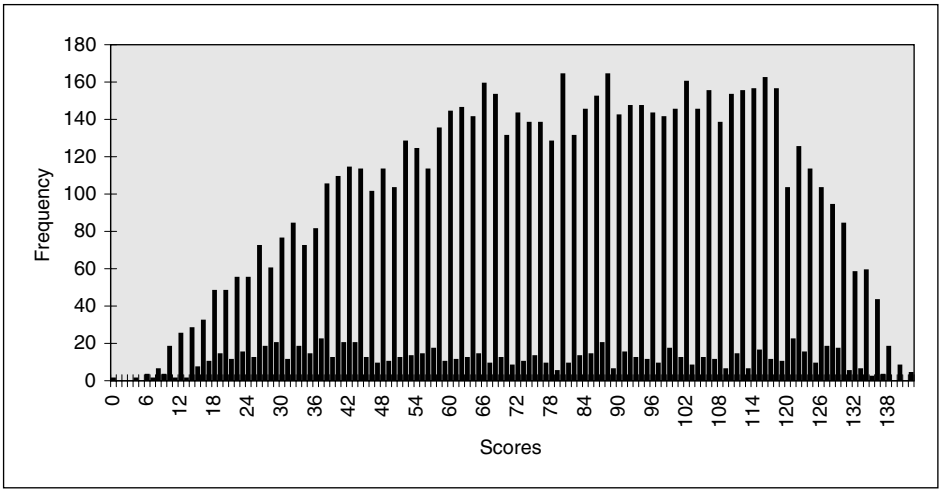
'Electronegativity' is a measure of the electron attracting power of an atom*; strong oxidisers gain electrons readily – hence oxidising agents will tend to have high electronegativities*.

A well done question. A significant number of students did not attempt this question, but those that did coped quite well.

GA CH033 CHEMISTRY WRITTEN EXAMINATION 2

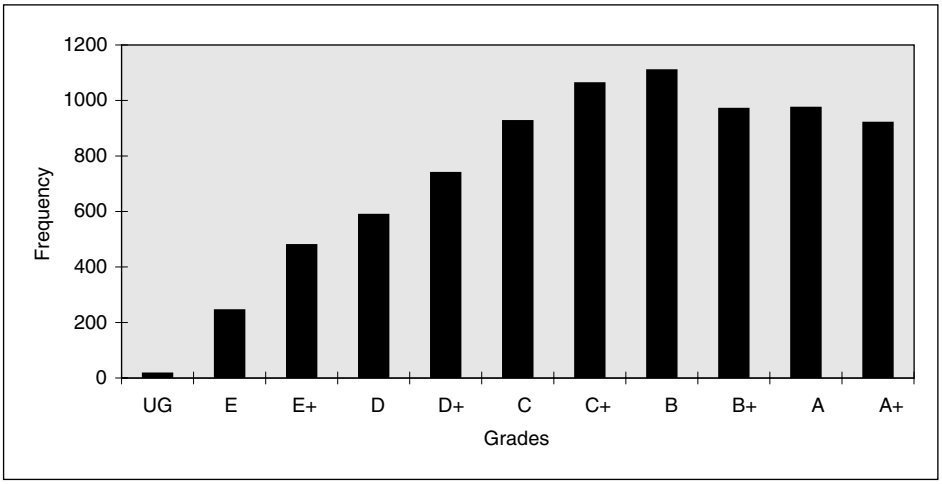
HISTOGRAM OF TOTAL SCORES 2000

Count 8016 Mean 79.03 Standard Deviation 31.90 NA Result 175




HISTOGRAM OF TOTAL GRADES 2000

Count 8016 Mean 6.28 Standard Deviation 2.53 NA Result 175




| ENROLMENTS | | % |
|---|---|---|
| Female | 4431 | 54.1 |
| Male | 3760 | 45.9 |
| Total | 8191 | |

## GLOSSARY OF TERMS

**Count** Number of students undertaking the assessment. This excludes those for whom NA was the result.

**Mean** This is the 'average' score; that is all scores totalled then divided by the 'Count'.

**Standard Deviation** This is a measure of how widely values are dispersed from the average value (the mean).