Chemistry
CAT 3

GENERAL COMMENTS

Rationale for Assessment Procedures

General

Student responses are assigned numerical marks according to a detailed marking scheme provided by the Chief Examiner, in consultation with the members of the Panel of Examiners.

The questions are set in the light of the criteria published in the VCE Bulletin and the marks assigned are based on the extent to which the responses demonstrate:

1. knowledge of the key ideas
2. understanding of the key ideas & chemical principles
3. application of chemical concepts to explain observations
4. interpretation of experimental data
5. knowledge & understanding of experimental procedures & techniques
6. Understanding of experimental procedures and techniques
7. competence in performing calculations

Note that Area of Study 2 has a significantly lower weighting in this task than either Areas 1 or 3. The weighting was reflected with Area of study 1–41%, Area of study 2–24%, and Area of study 3–35%.

Marking Scheme and Chief Examiner's comments

Question 1: **2 + 1 + 1 + 4 + 2 = 10 marks** * Allocation of 1 mark.

a (2) ai $NH_2CH_2CO_2^-$ *; aii $^+NH_3CH_2CO_2H$ *

b (1)

CH_2COOH *
|
$NH_2CH_2CO_2H$

c (1)

either CH_2COOH *
|
$NH_2CHCONHCH_2CO_2H$

or CH_2COOH *
|
$NH_2CH_2CONHCHCO_2H$

d (4)

di carbon, hydrogen, oxygen (or C, H, O) * - one mark for an exactly correct answer

dii any correct two - examples: starch, cellulose ** - one mark for each correct response

diii C-O-C *

e (2) synthetic food is lacking the following essentials: carbohydrate; fat; essential amino acids; minerals; vitamins ** for any two of these.

This question related to the acid-base properties of amino acids. The question was an excellent discriminator, in general, students particularly found parts a, b and c more difficult.

Question 2: 7 + 1 + 3 = 11 marks

a (7)

ai hydrogen or H_2*

aii magnesium hydroxide*, $Mg(OH)_2$*

aiii $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ * OR $Mg(s) + 2H_2O \rightarrow Mg(OH)_2(s) + 2H^+(aq) + 2e^-$ * OR

$Mg(s) + 2OH^-(aq) \rightarrow Mg(OH)_2(s) + 2e^-$ * (one mark for any one of these)

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$* OR $2H^+(aq) + 2e^- \rightarrow H_2(g)$* (one mark for either)

aiv $Mg(s) + 2H_2O \rightarrow Mg(OH)_2(s) + 2H_2(g)$*

av electrolyte allows solution to conduct electricity*

b (1) $1s^2 2s^2 2p^6 3s^2$*

c (3) correct percentages*: 24 = 78 ± 1%; 25 = 10%; 26 = 12 ± 1%

calculation: RAM = (24 x 0.78) + (25 x 0.10) + (26 x 0.12) = 24.3** (one mark for correctly multiplying relative isotopic masses by fractions - or by percentages & dividing by 100; one mark for correct answer)

Part a was particularly challenging for students and generally not well handled - chlorine was a fairly common gas being evolved. On the other hand, parts b & c were well done

Question 3: 7 + 2 + 3 = 12 marks

a (7) A = copper oxide*; $CuO(s) + 2HCl(aq) \rightarrow Cu^{2+}(aq) + 2Cl^-(aq) + H_2O(l)$*

B = aluminium oxide*; $Al_2O_3(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2O(l)$*; $Al_2O_3(s) + 2OH^-(aq) + 3H_2O(l) \rightarrow 2Al(OH)_4^-(aq)$* OR $Al_2O_3(s) + 2OH^-(aq) \rightarrow 2AlO_2^-(aq) + H_2O(l)$* (one of either)

C = magnesium oxide*; $MgO(s) + 2HCl(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq) + H_2O(l)$*

b (2) * for a crude representation showing six water molecules with the O s close to the Cu^{2+}

* for making the octahedral shape clear.

c (3)

ci covalent bonding* OR electron sharing* (one mark for either)

cii ion-dipole attraction* (or electrical attraction) between the charged copper ion and the dipolar water molecule. * for showing the δ+ and δ- on the hydrogen end and oxygen end respectively of the water molecules (award this mark if the δ+ and δ- are shown in the sketch in ci).

Most students managed to work out the identity of the oxides in part a although the equation writing proved more difficult. Part b was adequately done - but the description of the bonding in c was very mixed. A significant number of students seem to believe that the bonding between the atoms in the water molecule is 'hydrogen bonding'.

Question 4: 2 + 2 + 4 + 3 = 11 marks

a (2) magnitude of current*; time current is flowing*

b (2) 2* x 425 C = 850 C*

c (4) melted NaCl: anode; $2Cl^- \rightarrow Cl_2(g) + 2e^-$ *. cathode; $Na^+ + e^- \rightarrow Na(l)$*

dilute aqueous NaCl: anode; $2H_2O \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ *

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

d (3) In aqueous solution water is present and is available to be both oxidised* and reduced*. The electrochemical series shows that water is easier to reduce than $Na^+(aq)$ and easier to oxidise than $Cl^-(aq)$

Answers to this question tended to be 'all or nothing'. Part d appeared to be difficult and quite a few students appeared to have difficulties expressing themselves.

Question 5: 2 + 1 + 2 = 5 marks

a (2) 2* x -173 = -346 kJ mol^{-1}*

b (1) 223 kJ mol^{-1}*

c (2) 50/2* = 25 kJ mol^{-1}*

Well done - this topic has been well covered in recent years and many students seem comfortable with navigating diagrams of this sort.

Question 6: 3 + 1 + 1 + 1 = 6 marks

a (3) Three marks for any three of following: copper deposits on Cu rod*; blue colour of $Cu^{2+}(aq)$ fades*; zinc rod is eaten away*; $Zn^{2+}(aq)$ concentration around Zn rod increases*.

b (1) from left to right on diagram*

c (1) from left to right on diagram*

d (1) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$*

Some students did this question absolutely 'perfectly' - except that all the equations, ion & electron flows were reversed. Generally, half marks were given when the question was answered this way. Otherwise this was a standard question that was quite well done.

Question 7: 4 + 1 = 5 marks

a (4) nuclear fusion: two nuclei combine to form a single heavier nucleus*;
hydrogen → helium + energy in sun*; OR helium → carbon in certain stars*....
nuclear fission: single nucleus is decomposed to two lighter nuclei*; uranium 235 + neutrons → lighter nuclei + energy*

b (1) any one of*:
Dalton: atomic theory
Bohr: orbiting electrons
Ramsay: inert gases
Curie: radioactivity
Seaborg: transuranic elements
Soddy: isotopes
Meitner: nuclear fission

Both a & b only required discursive answers - balanced equations were not required.

Question 8: 1 + 1 + 3 + 2 = 7 marks

a (1) $C_{12}H_{22}O_{11}$*

b (1) $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$*

c (3) No mark is to be awarded for the simple drawing of a bomb. Marks are awarded for each of the following relevant features accompanying the 'bare' bomb.

water bath surrounding bomb
thermometer or other temperature measuring device
stirrer in water bath
calibration heater within bomb
stopcock for admitting oxygen to bomb
spark generator to trigger reaction

*** give a mark for each of these included in the diagram and round off upwards to a maximum of three marks.

d (2)

di $ÆT$ = 297.733 - 297.221 = 0.512 K; heat evolved = 7690 x 0.512 = 3937.3 J*

dii molar mass of $C_6H_{12}O_6$ = 180 g mol^{-1}; no. of mole of fructose = 0.252/180 = 0.0014; heat evolved when one mole is burnt = 3939/0.0014 = 2812 kJ mol^{-1}*.

There were a variety of diagrams of a bomb calorimeter. Only a relatively small percentage of students seemed to have grasped the idea that the bomb is a vessel that must hold a gas, so that it should be connected to the source of gas via some sort of closable tube, and immersed in a water bath.