TASMANIAN

CERTIFICATE

OF EDUCATION

TASMANIAN QUALIFICATIONS AUTHORITY

Chemistry

Subject Code: CHM5C

2004 External Examination Report

Criterion 4

Question 1

(a) Most candidates correctly said that standardising was necessary to ensure that the solution concerned had an accurately known concentration. To gain full marks candidates had to discuss the significance of $NaOH_{(aq)}$ undergoing reaction with $CO_{2(g)}$ from the air.

(b) Common errors included the failure to use an indicator (or pH meter) for determining the end-point and forgetting to find the initial mass of solid acid used. Answers varied greatly with different emphases given, some on glassware preparation, some on titration technique and others on data collection.

An alarming number of candidates titrated the organic acid against either $HCl_{(aq)}$ or even $KMnO_{4(aq)}$ rather than the standardised $NaOH_{(aq)}$.

(c) Those who prepared a 250 mL standard solution initially and then titrated 20 mL aliquots often forgot to incorporate the 250/20 factor in their final calculation of concentration. The fact that the acid was monoprotic was frequently overlooked.

Question 2

(a) (i) The expected metals were those listed on the ECS from Pb Zn although many listed all metals including Na, Li, Ca and K.

(ii) Some said that lead was not included because it was “too far up the table” rather than commenting upon its low strength as a reducing agent. Lead compounds being poisonous was not accepted as a reason for its omission but saying $PbCl_2$ was insoluble gained full marks.

(b) (i) Often answers merely restated the information by saying that Sn wouldn’t have reacted vigorously or that $SnCl_{2(aq)}$ was coloured. This only scored part marks and full marks were only awarded when more specific details were given.

(ii) This was well answered.

(iii) Electrochemical cells were often suggested as means of establishing the identity of ‘A’ but the availability of an electrolyte such as ‘A nitrate’ presented a dilemma. Electrolytic techniques were a possibility where weighing an anode made of metal ‘A’ before and after electrolysis gave a good chance of identifying ‘A’.

Most candidates used tests where ‘A’ was immersed in various known metal nitrate solutions and ‘reaction’ or ‘no reaction’ recorded.

Question 3

(a) This question was done very poorly and because many candidates were unsure of a procedure the diagrams were often quite extraordinary or imaginative beyond belief.

Many candidates thought that 'heat of combustion' meant the temperature at which heated candle wax would burst into flame! Some had candles burning under water and in enclosed spaces where O_2 supply would be inadequate. Very few candidates used a ruler and drew neat diagrams. Thermometers were frequently omitted from the diagram.

(b) Just about every possible answer was offered here with Le Chatelier's Principle being the most common error. Other suggestions included the Quantum Theory, Boyle's Law, Avogadro's Hypothesis and Bohr's Theory! Candidates who mentioned 'calorimetry' or the Law of Conservation of Energy gained the 1 mark allocated.

(c) Because there were so many strange experimental techniques suggested, the examiners gave marks for any measurements that might have been relevant for the procedure followed as per the diagram.

Those who used a correct calorimetric procedure (simple or bomb) often overlooked the need to know the mass of candle wax that was burnt.

(d) This question was similarly open to the technique employed and most answers received part if not full marks. Minimising heat losses through improved shielding and insulation were key points in the better answers. To gain the 2 marks, at least two improvements needed to be discussed.

Criterion 7

Question 4

(a) About 2/3 of candidates were able to assign N the correct oxidation states

(b) Only 5% of candidates could balance the net ionic equation. Many did not have the correct formula for the ions involved.

Question 5

(a) Almost all candidates correctly showed the reduction of bromine but very few used their data sheet to show the oxidation of Sn^{2+} to Sn^{4+}.

(b) To get full marks, candidates needed to explain why Br_2 could not oxidise Cl^- or Fe^{3+}. Most candidates only gave one part of the explanation.

(c) Relatively few candidates realised that $Fe^{2+}$was oxidised further to Fe^{3+}.

Question 6

(a) Most candidates recognised that Cr would be the anode and gave the correct half-equation.

(b) It was disappointing to see how many candidates used the wrong oxidation state for Cu in the reduction half-equation

(c) Too many overall equations had electrons left over or were not balanced for charge.

(d) The majority of candidates obtained 1.08 V but answers consistent with previous wrong half-equations received full credit.

(e) Almost all candidates stated that anions migrated to the anode and cations to the cathode but did not explain why this happened.

(f) This was well answered.

Question 7

(a) Many candidates did not recognise the polarity of the battery and it was a concern that a significant number thought that both anodes were in the same beaker. The anodes were A and C.

(b) Answers were disappointing. A minority recognised that Br^- ions were easier to oxidise than water molecules.

(c) A worrying number of candidates thought that Ca^{2+} ions could be reduced from aqueous solutions.

(d) The correct use of states was very rare. Candidates who wrote:
$2Br^-_{(l)} \quad Br_{2(g)} + 2e^-$ received a bonus half mark. Incorrect states was not penalised for this question.

(e) Very few candidates wrote $Ca^{2+}_{(l)} + 2e^- \quad Ca_{(s)}$.

Question 8

(a) Well answered. Most candidates discussed the formation of an electrochemical cell and that the more reactive metal was oxidised. Half –equations were generally appropriate.

(b) Storage solutions were many and varied. A noble coating for the anchor was not awarded a mark, as this would tend to exaggerate the problem. The most common solution was to separate the anchor from the aluminium hull using a rubber mat or plastic bag.

Criterion 8

Question 9

(a) This question tossed up a few surprises. There was a percentage of people who did not know the formula for methane. A few equations remained unbalanced and many people could not recognise that releasing heat meant an exothermic reaction.

(b) This question was generally well done and supported their ΔH value from (a) [even when wrong above]. The most common error occurred because candidates thought that a match was a catalyst – thus leading to a graph with an alternative pathway.

(c) Candidates were often general without giving any specifics. We were looking for two things to be mentioned – large E_a because it is not spontaneous, and a decent sized drop between reactants and products because ΔH was a reasonable size.

Question 10

This question was not well done by most candidates. Many just restated the information in the question without any further additions. Quite a few candidates talked about Le Chatelier's Principle in terms of more forward or backwards reactions occurring, and many candidates failed to grasp that although the reactants will have more E_k because of the rise in temperature, so will the products.

Question 11

(a) Candidates generally completed this one well. The small number who got the answer wrong either recognised the mole ratio as being important but went the wrong way, or didn't see the mole ratio as being important.

(b) This question caused confusion because of the similarity between C-Cl and Cl-Cl. There was a large number of candidates who were unable to interpret the structure of CH_2Cl_2 and thus could not obtain its bond energy. Some candidates saw $2Cl_2$ as being 4 Cl-Cl bonds.

Question 12

This question was very well done by all candidates. The only confusion they suffered from was the wording of the mixing being “carefully added” and just “added”.

Question 13

(a) This was well answered by most candidates. Often the steps to their explanation were jumbled and in many cases the idea of “effective” collisions was not mentioned. The use of a graph showing the proportion of molecules with sufficient EK for each of the temp regimes was rarely presented.

(b) Well answered by most. Some thought changing either the pressure or increasing the volume of the flask would increase the reaction rate. Some answered with reducing the concentration of the solid by either diluting the carbonate or reducing its mass/size. A few believe that increasing the size of the lump increases the surface area.

Question 14

(a) In this question, a number of candidates did not get the idea that at equilibrium the rates of the forward and reverse reactions are equal; i.e. $R_f = R_r$

(b) This question was very well done.

(c) Many thought the reaction was just the reverse reaction and therefore answered that the reaction was endothermic. Many answered without any reference to the actual reaction.

(d) Many candidates failed to show equal rises and fall in the concentrations of the gases. Many ended up with more $COCl_2$ than initially. Some failed to extend the graphs for the full 4 minutes. Some did not “plateau’ their graphs and some candidates had the rates of decay/formation starting off slowly then increasing with time.

(e) This was well done by most candidates.

Criterion 10

Question 22

Most candidates used the ‘Combined Gas Equation’ $P_1V_1/T_1 = P_2V_2/T_2$ although many found $n = PV/RT$ and then multiplied by 24.4. Common mistakes involved:

- the failure to convert to kelvin.
- using STP instead of SLC.
- ratios inverted due to incorrect mathematical manipulation.

Question 23

This question was generally well done by most candidates with pleasing setting out. Common mistakes involved:

- not including oxygen and thus getting the empirical formula C_1H_2.
- converting data to % mass which was not necessary.
- using the total 3.433 g in molar ratio calculations.

Question 24

Some of the best candidates tried to include conversion ratios to account for the temperature discrepancy. Candidates consistently struggled with the $[H_3O^+_{(aq)}] = 10^{-14}/27.3$ conversion to pH and many thought that a pH of 15.4 was an improbable result.

Question 25

There were several different ways of proceeding to get +3.
Some just wrote that $In_{(s)} \quad In^{3+}_{(aq)} + 3e^-$ but this did not score marks. Some candidates used the element iridium and got the answer +5. A few candidates arrived at the oxidation state of −3 and lost marks for this.

Question 26

Most candidates found the correct number of moles of each species although several used 1 g rather than 1 kg. A significant number selected carbon as the limiting reactant and nearly all candidates answered in *grams* for the *amount* of silicon carbide rather than in *moles*. This wasn't penalized although the 'amount' does require a mole answer.
In part (b) a common misconception was that the number of mole of carbon reacted was 16.6 mol rather than 33.3 mol.

Question 27

This was a very easy question and to score full marks, candidates were expected to present their answers carefully. Marks were deducted for failure to rewrite the equations correctly and/or for those who didn't include the correct energy terms. Numbers stated without equations scored no marks at all. Many candidates subtracted 284 kJ rather than adding it. The unit of kJ mol^{-1} should have been used but kJ and even Kj were accepted.

Question 28

(a) This part of the question was poorly done by many candidates. Often the wrong formulae for reactants were shown or the equation was not balanced properly. A disturbing number of candidates had H_2 gas as a product.

(b) Very poorly done by many! The relationship n = vc had all possible variations and the volumes of NaOH and H_2SO_4 were frequently interchanged possibly due to the wording of the question.

(c) Some forgot to take the original dilution into account and thus didn't multiply by 250/20. The poor use of significant figures was penalized by the deduction of 1 mark.
It appeared that several candidates ran out of time before completing this question.

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