PART 1 – Criterion 5

This section of the paper was performed well by most candidates despite the error in Qn 6.

Question 1

(a) There were many errors assigning the oxidation state of manganese in manganese ethanoate (acetate). Markers needed to search for the answers as they were often not stated in a clear manner.

(b) Candidates were confused by the term 'oxidising ability'. A minority equated it with the oxidation state.

Question 2

This question was generally well answered except that chlorine was often wrongly named 'chloride'. The chloride ions were frequently assigned an incorrect oxidation state of -2.

Question 3

The question was well done apart from the last dot point which was not on the course. A valid answer was to state that Cl\(^-\) ions were 'spectator' ions although this was not the case in this reaction. Any valid explanation received credit.

Question 4

(a) This was poorly done. Very few candidates understood the significance of the signs of the E\(^0\) values. There was confusion between whether the metal, the metal ions or the half-equations were acting as reducers. Many did not address the sign at all.

Parts (b) and (c) were generally well done.

Question 5

(a) (iv) Very few candidates placed the impure copper at the anode.

(b) Very few candidates answered the question completely and the results indicate that it was the most difficult question in this criterion 5 section. A common mistake was to state that the reduction of zinc ions at the cathode would occur before the reduction of copper ions. This problem could have been averted by specifying the electrolyte in the original question.
Question 6

As it was written, the question contained an error as the cell was acting as an electrolytic cell rather than an electrochemical cell as zinc was plated onto the negative electrode. To compensate for this problem, electrochemical cells or electrolytic cells were accepted and candidates were not penalised for having the electrodes with the wrong polarity. Most candidates answered the question correctly as an electrochemical cell as instructed at the start of the question.

Question 7

Some candidates did not realise that the Sydney Harbour Bridge was made of steel although most candidates answered the question well. Cathodic protection was poorly described. A mechanism would have helped their explanation and candidates were expected to include half-equations in their answers.

PART 2 – Criterion 6

Overall, the questions in this section were quite straightforward with none sufficiently difficult to help in identifying the 'A' candidates. However, some questions were worded such that the candidates were not able to interpret what was required. Further, because many of the questions required multiple answers, frequently not all components of the questions were answered.

Some handwriting was very challenging to read (not even considering special cases).

Far too many abbreviations were used. Candidates should be counselled to not using abbreviations other than those widely accepted in chemistry; (e.g. LCP and ppt were obvious, whereas ROR is not)

Candidates should also be counselled not to leave questions blank. If there is an issue with interpretation, they should still write something, explaining their interpretation.

Some candidates have been taught about entropy but there was a tendency not to use this concept correctly or they unfortunately used the word instead of enthalpy.

Candidates need to distinguish between rates of reaction concepts and equilibrium. There was confusion by some, particularly when deciding which concept to apply to each question.

Question 8

(a) Many candidates made the error of saying that it takes energy to form a bond.
Generally done well; any three valid points, without repetition or overlap, were accepted.

(b) Many candidates used 3 C–C bonds instead of 2, used C–O instead of C=O, and a significant few had the final sign the wrong way around.
Most did this question well, setting out their work clearly.

(c) Poor graph scaling did put some candidates off but most chose correctly.
If they had the wrong sign in (b) the error was carried forward to this section.
Quite a few forgot to label the diagram and lost one mark; see #1 of general comments.
Some labelling was very sloppy. Arrow positions and labels need to be clear.

(d) Almost everyone gained the full marks here.

Question 9

Many of candidates forgot that the first part of the question asked them to describe what was observed.

If candidates simply said that yellow was observed, failing to recognise that the chromate ion itself is yellow, this was ignored in the marking because of how the equation was represented.

Not many candidates identified the formation of a precipitate.

Some tried to answer this as an equilibrium question. Whereas it is indeed a precipitation reaction, equilibrium was not what the question was about.

Some did not explain the reasons adequately. They needed to have inferred the collision theory.

Some forgot to say what happened when water was added; see (i) in general comments.

Question 10

This question was confused with an equilibrium system by some.

Some diagrams were missing and some did not know which diagram to give.

Diagrams were often not clearly drawn or not appropriately labelled.

Mostly this was straightforward and well answered.

Question 11

(a) The incorrect statement of ‘catalytic oxidation’ in the stem did not appear to put anyone off.
Some drew the wrong graph (e.g. an energy diagram) or had the lines straight or curved the wrong way.
Some failed to have the curves converge to show that the same amounts formed.
(b) Generally well done although some said catalyst provided energy for the reaction.

Question 12
(a) There were three clear sections to this question, awarded one mark each. A comparison between the forward and reverse reaction was needed for each component.
Most had the rates equal and lots got that $\Delta H$ had the same magnitude but opposite signs. The difficulty in marking was in the wording of the responses when the candidates did not make it clear what they meant.
Many simply did not address the activation energy issue.
Some could not interpret the question, only gaining one mark for the rates.
(b) Well done in general.

Question 13
(a) There were three components to this question and each had to address the colour change observations. Many did not address the fact that the colour was darker at the end.
A significant number of candidates thought that the first colour change was because the forward reaction was promoted because of the change, rather than an increase in concentration of both gases due to the decrease in volume.
It would have been better if the question had said that the syringe is sealed as a couple of candidates thought it went lighter because gas left the syringe.
(b) Some omitted to write the equilibrium expression. This may be because it was on the first line and separated form the rest of the question. See also (i) of general comments.
No penalty this time because of the other difficulties of the paper but candidates should say that temperature increases the rate of both forward and reverse reactions but favours the endothermic reaction. Some said that the temperature rise caused only the endothermic reaction rate to increase.
Generally done well. Square brackets are needed to be part of the equilibrium expression.
It would have been better if the question said there was no change in volume as a few candidates allowed this extra factor to confuse them.

Question 14
(a) Some candidates did not identify that the system was already at equilibrium at $t = 0$.
(b) (i) In this part, marks were allocated for answering ‘temperature change’ without considering if it increased or decreased. This was because those who had a knowledge
of entropy may have considered the conflicting information indicated by the chemical equation.

(ii) In this part, some candidates said that the change was due to 'pressure' or the 'removal of A' without further explanation. Despite this, most answers gained full marks although some missed this (ii) section completely because there was no dotted line given for an answer as there was in part (i).

(c) Generally done well; a few did not make the 1 : 3 ratio of reactant : product evident enough and some also had curves the wrong way.

PART 3 – Criterion 7

**Question 15**

Candidates generally answered part (a) well.

The graph in part (b) was allocated 1 mark. 0.5 marks were awarded if an upward trend in ionisation energies was shown, with 1 mark awarded if the large gap between $E_2$ and $E_3$ was shown.

The appearance of the graph was then related to electronic structure of the atom. A number of candidates did not comment on the change between $E_3$ and $E_4$ resulting in the loss of a mark.

**Question 16**

(a) Many candidates did not answer this question adequately although a number of possible suggestions would have been acceptable.

(b) The best answers were based on the concept that each noble gas corresponds to the final filling of a particular quantum shell and thus best comes at the end of the period.

**Question 17**

This question was generally well done. Some candidates provided much more information than was required, but still did not fully address the question.

(a) Candidates needed to mention that metals are electron donors (electropositive), and non-metals electron acceptors (electronegative) (2 marks); and metals form basic oxides, and non-metals often form acidic oxides (1 mark). Equations were not required, but supplied by a number of candidates.

(b) 0.5 mark was allocated for identifying that the element was magnesium. Writing the correct equation for the formation of the nitride was the other 1.5 marks. The equation needed to include states of the reactants and product. Some candidates gave the symbol of manganese Mn for magnesium, Mg.
Question 18

The structure of aspirin was not correctly shown but this did not affect candidates’ ability to answer the question.

(a) The two functional groups were the carboxylic acid and ester groups, but benzene was also accepted. Some candidates missed the second part of (a), and thus lost 2 marks.

(b) Each structural formula was allocated 1 mark. A number of candidates placed the methyl groups at the end of the chain, so the compound was not based on propane. Two differences in physical properties were required for the remaining mark for this question. Quite a few candidates gave chemical differences rather than physical properties.

Question 19

(a) This question was generally well done. One mark each was allocated for the molecular formula of the hydrocarbon, a double bond, and the correct propene structure.

(b) A number of candidates were not able to correctly respond to this question. Credit was given for recognising that a polymer was formed. Some candidates mistakenly included Fe in the equation for the formation of the polymer and included it in the polymer structure. Some candidates had the correct monomer from part (a), but were not able to orient it to obtain the correct polymer.

(c) Generally well done.

Question 20

Most candidates were able to identify propanoic acid as a compound that could be used to prepare sodium propanoate. This was allocated 2 marks and the correct chemical equation was allocated 3 marks. Marks were deducted for using Na metal instead of NaOH in the equation (-0.5), and not showing products, the sodium salt and water.

For compound 2, 1 mark was allocated for the compound and 1 for the chemical equation. The alkaline hydrolysis of a propanoate ester was required for this. Many candidates were unaware of the (alkaline) hydrolysis of an ester by NaOH so found this section difficult.

Question 21

This question presented a challenge to candidates due to the incorrect formula provided for compound B, which should have had additional hydrogen (C₃H₁₂O). It was evident that a considerable amount of time was spent on this question by a significant number of candidates.
Some candidates covered the blank page of their booklet in addition to the provided page in attempting to arrive at solutions based on the given information. Some candidates were sufficiently confident to state the error in the question and then proceed and others proceeded just assuming that the additional H was in compound B. 

Due to the above, the question was marked reasonably leniently. Those candidates who provided clear and coherent explanations were generally rewarded. Few candidates noted that the bromoalkane was a branched chain. Marks were not deducted for this.

The explanation for what compound C might be, needed to include 4 facts e.g. that it was an oxidation product, why it could not be an aldehyde or carboxylic acid, derived form a secondary alcohol, and that it must be a ketone. This was allocated 4 marks.

The structural formula for B needed to indicate that it was an alcohol (0.5 marks), and was a secondary alcohol (0.5 marks).

Writing an equation for the reaction A → B elicited a great variety of responses. 2 marks were allocated for this, with a range of responses gaining marks.

PART 4 – Criterion 8

As referred to in previous years, there are a number of key points that need to be emphasised, especially for this 'calculation' section where many candidates lost marks due to poor answering technique or errors in expressing their answers.

- ‘Significant figure’ misuse was frequently encountered and usually penalised by a ½ mark. As a general rule, expressing final answers to 3 significant figures is usually sufficient. Many gave answers to 1 or sometimes 9 sig figs! In general, significant figures need more attention, as it would appear that some candidates believe that 0.009 is correct to 3 significant figures rather than 0.00924
- Candidates must take more care with setting out calculations. All calculations should be labelled (e.g. n(HCl) = ... rather than n = ...) and calculation steps should follow sequentially.
- Candidates should avoid rounding off numerical answers prematurely;
- e.g. in 250.0 mL of 0.400 mol L⁻¹ X(aq) the n(X(aq)) = 0.100 mol not 0.1 mol
- For most chemical equations, the reactant and product states should be indicated as subscripts. This was frequently overlooked.
- Candidates should be advised not to cross out any answer part until they are sure it has been replaced by a preferred answer. In some cases we saw correct answers that had been crossed out but not replaced by anything else.
- Candidates need to be reminded to consider whether their answer is within the bounds of sensibility.
Question 22

This was generally well answered by most candidates. The most common errors included using the molar mass for NH$_4$NO$_3$ instead of NH$_4$NO$_2$ or dividing the 224 kJ mol$^{-1}$ by the number of mole. A few candidates resorted to using $E = mc\Delta T$.

Question 23

This was well answered although some candidates neglected to convert °C to K. Rearranging the combined gas equation resulted in a number of errors.

Question 24

(a) Many candidates used the molar masses of Fe$^{2+}$ and MnO$_4^-$ rather than FeSO$_4$ and KMnO$_4$. The molar ratio of 5 : 1 was frequently overlooked or reversed.
(b) This question was well answered by most candidates although the molar ratio of 1 : 6 was sometimes omitted or reversed.

Question 25

This question was very well answered although some candidates didn't reverse equation 3 and also multiply by 3. Occasionally some candidates incorrectly reversed equation 2.

Question 26

Very few candidates gained full marks for this question and in general it was answered very poorly. Most found the n(HF) by using PV = nRT rather than using the molar volume of a gas being 24.5 L at SLC. This would have saved time.

Many candidates then divided the n(HF) by the volume of the gas rather than the volume of the solution.

Another frequently occurring error was to regard the initial [HF$_{(aq)}$] as being the equilibrium value and thus ignored the dissociation of HF. Some included water in their equilibrium expression and a number thought that the [F$^{-}_{(aq)}$] was the same as the [OH$^{-}_{(aq)}$]. Establishing the [H$^{+}_{(aq)}$] from the pH caused a number of errors too.

Question 27

The most common error was to omit the water of crystallisation when determining the molar mass of hydrated sodium thiosulfate.
Many used the mass of sodium thiosulfate (5.80 g) in the calculation \(E = mc\Delta T\). The total mass of 55.8 g was acceptable but most used the value of 50.0 g which was expected. A disturbing number of candidates established the temperature change of 5.2°C and then added a further 273 and thus used 278.2 K for \(\Delta T\). Some even calculated the calibration factor for the calorimeter. Otherwise, this was well answered by the majority of candidates.

**Question 28**

This was a relatively simple question and it was well answered by most candidates. Some candidates were apparently unsure as to the method for calculating the final \([\text{Zn}^{2+}(\text{aq})]\) and left this part out.

**Question 29**

Once again, this was a relatively simple question and it was well answered by most candidates. Common errors included:

- having the formula for silver chloride as \(\text{AgCl}_2\).
- rounding off too early.
- having 1.56 as a % of 1.57
- finding the % silver in AgCl which by chance gave an answer remarkably close to the desired answer.

**Question 30**

A significant number of candidates determined incorrectly that aluminium sulfate was the limiting reactant - presumably because it was present in the least amount. This error was allowed for in the case of applying ‘error carried forward’. A number of candidates did the whole question correctly until the final line where they found the mass of \(\text{BaCl}_2\) rather than \(\text{BaSO}_4\) which was the precipitate.
\[ \text{mass of NaOH required} = 0.010 \times 0.2 = 0.002 \text{g} \]

\[ \text{mass of NaOH required} = 0.0034 \times 0.25 = 0.00085 \text{g} \]

\[ \text{V} = 25 \text{mL} \]

\[ \text{\( P = 0.04 \times 45 \text{g} \)} \]

\[ \text{V} = 25 \text{mL} \]

\[ \text{\( T = 25 \text{K} \)} \]

\[ \text{Initial} \ [\text{HF}] = 0.12 \text{mol} \]

\[ \text{Final} \ [\text{HF}] = 0.02 \text{mol} \]

\[ \Delta \text{H} = -114.2 \text{kJ mol}^{-1} \]

\[ \text{\( \text{HF} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{F}^- \)} \]

\[ \text{\( \text{Fe}^{3+} + \text{Cl}^- \rightarrow \text{FeCl}^+ \)} \]

\[ \text{\( \text{Fe}^{3+} + \text{Cl}^- \rightarrow \text{FeCl}^+ \)} \]

\[ \text{\( \Delta \text{H} = -145.5 \text{kJ mol}^{-1} \)} \]

\[ \text{m} \]

\[ \text{\( \text{M} = 54.05 \text{g mol}^{-1} \)} \]

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**ASSESSMENT PANEL REPORT**

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