GCE

Chemistry B (Salters)

Advanced GCE **A2 H435**

Advanced Subsidiary GCE **AS H035**

OCR Report to Centres

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Reports should be read in conjunction with the published question papers and mark schemes for the examination.

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Overview

Once again a lot of excellent work was seen, with most candidates trying hard to show what they could do and what they understood. Very few parts were left blank, and candidates did not seem to have problems finishing the units.

Re-take candidates dominated the ranks of those taking F332 and F335. As in previous years, these papers proved testing at the top end to these candidates, though there was a distinct improvement at the bottom end in F335.

F331 and F334 were dominated by those taking the units after one term in Year 12 and Year 13 respectively. A very good standard was shown by the Year 12 candidates, very creditable after just one term's work in advanced Chemistry.

There was some good work too in F334, again praiseworthy after just a term of A2 study. However, the Principal Examiner has included in his report several pieces of advice which those re-taking this unit in June would do well to heed.

It is pleasing to see how the setting out of calculations has improved over the years. Many more candidates now gain 'error carried forward' if they make a small slip early on in a calculation. Unfortunately, the understanding of significant figures does not seem to have kept pace with this.

Long answer questions continue to cause concern. Candidates must be encouraged to think through the points they want to make before they start writing and then express them in a logical order, taking care over the exact use of chemical terms. Where the Quality of Written Communication instruction '...using technical terms spelled correctly' is seen, candidates should ensure that their handwriting leaves no scope for ambiguity in spelling.

F331 Chemistry for Life

General comments:

Once more there was a wide range of marks on this paper. The mix of short, one mark, relatively straightforward questions, along with more challenging multi-mark questions achieved good discrimination over the paper as a whole.

The extra blank pages at the end of the paper were not used as much this session, but still proved useful. Time, as usual, was not an issue and there were few ‘no responses’.

Comments on individual questions:

Question 1

Part (a) was answered correctly by the majority of candidates.

In part (b)(i) The ether group proved easier to identify than the alkene for some candidates and in part b(ii) a majority of candidates scored both marks the balancing letting down some.

Part(c)(i) produced a range of marks, the mass of water and specific heat capacity of the water (some candidates just put down ‘heat capacity’, failing to explain for what) were the easier to score, with the M_r of furfural falling some way behind.

(c)(ii) Failing to put the sign was the most common mistake but most candidates scored this mark.

(c)(iii) A small but significant minority talked in terms of operator error when the question was looking for incomplete combustion and evaporation of fuel (both commonly scored) and either bond enthalpies are for gas state (occasionally scored) or experimental conditions not standard (more popular).

Numerical answer 1(c)(ii) -2385.

Question 2

Question 2 overall proved the most discriminating and challenging to candidates.

Part (a)(i) correctly calculated by a majority but some missed the 75% information in the stem.

Part (a)(ii) tests a specification statement that is not so regularly tested. It was set to be a challenging question (although ‘eased’ in its answer requirements) and it did indeed prove challenging. The most able candidates scored all three marks but for many the concept was jumbled (often with references to $24dm^3$), with wrong numerical values quoted (a numerical value was not required, but if there, had to be correct) and vague references to ‘substances’. The concept of ratio also caused difficulty for many candidates and along with references to the size of atoms rather than mass, and a determination not to link specifically to the carbon and sulfur in the question, had the effect of reducing the number obtaining the last two marks.

In part(b)(i) although the stem explained the reaction produced nitrogen gas, some candidates failed to produce the appropriate formula in their equation, a better attempt being 2N, but oxides of nitrogen were a worryingly minority response.

Part (b)(ii) despite the stem explaining potassium sulfide was ionic there were nevertheless a number of candidates who drew covalent structures.

Parts (c)(i) and (c)(ii) were reasonably answered. A flaw in answers to (c)(ii) was that students did not always make the link between the solid reactants and the gases in the products being the primary cause of the increase in entropy.

(d)(i) was generally answered correctly, either in terms of melting, or boiling point, however solubility and hardness appeared too often.

(d)(ii) proved very discriminating. ‘Electrons repel’ and ‘as far away from each other as possible’ were often correct responses, but marks for the identification of four sets of electrons around the sulfur and the consequent bond angle of roughly 109 degrees were regularly not scored. There were also still a few responses saying electrons repel as much as possible or bonds repel.

Numerical answer 2(a)(i) 0.74.

Question 3

Part (a)(i) to (v) generally answered well. Unsurprisingly the molecular formula of compound D gave candidates the most difficulty, although some attempts, on even the most casual inspection, were clearly unfeasible.

In part (b)(i) answered correctly by the majority but references to octane number was a significant minority wrong answer.

Part (b)(ii) Despite the use of the term ‘catalyst’ three times in the stem, this part caused some confusion, with a number of candidates talking about the use of zeolites as molecular sieves. There were still a few candidates who marred their responses by talking about a catalyst taking no part in a reaction or not used in the reaction. Heterogeneous was the appropriate technical term and many candidates struggled with the spelling.

Part (c) was reasonably well answered, but isomerism cropped up occasionally as did reforming.

In part (d) the idea of incomplete combustion due to insufficient oxygen was grasped by more able students but rather worryingly some candidates insisted that hydrogen gas was produced in this combustion process.

Question 4

Question 4 overall, with the exception of part (a), proved the most straightforward.

4(a) proved very discriminating with only the better candidates scoring all three marks. Common issues included the use of significant figures and conversion of dm^3 to cm^3.

4(b)(i) Candidates answering this question frequently scored two out of the three available marks, with the lines getting closer as the frequency increases, being the usual mark missed. Some candidates unfortunately answered a previous session’s question and explained how emission spectra arise.

Tip for Centres
It is worth spending time with candidates explaining the difference between the various command words. In the above case the key word is 'describe' and this requires only knowledge of the appearance of emission spectra without giving an explanation of the scientific reasons leading to their formation. A look at the marks available would also have given candidates a clue as to the number of features needed to be described.

4(b)(ii) gave no problem to the vast majority of candidates.

4(c)(i) and (ii) as expected, were very well answered.

In part (d)(i) the inclusion of the diagram was expected to make this question relatively straightforward, and indeed to many candidates it was; however there were still some who failed to label the metal cations correctly; answers including nucleus and protons being typical.

4(e) was well answered despite a few candidates opting for a bulk property, eg malleable or structure.

Parts 4(f)(i) to (iii) were all straightforward and correctly answered by most candidates.

Numerical answers 4(a) 0.36 4(c)(i) 3900 – 4100.

F332 Chemistry of Natural Resources

General comments:

A wide range of marks was achieved by candidates for the paper as a whole, covering most of the available mark range. There was no indication that candidates lacked time in the examination, with answer spaces that were left blank being rare and resulting from a lack of knowledge or understanding of the question, rather than an inadequate amount of time.

Good attempts were made at questions involving chemical equilibria, intermolecular bonds and redox reactions. Many of the calculation questions were well answered, with candidates setting out their answers sufficiently clearly to be able to see what was being calculated at each stage, allowing credit to be given under the 'error carried forward' rules if a mistake had been made. With the exception of an ionic equation, questions requiring a chemical equation to be written were also well answered.

Answers to the longer questions tended to produce lower marks. Many candidates were not sufficiently careful about the use of technical language in their explanations, in particular using the word 'molecule' when meaning 'atom'. Questions on organic chemistry that required an understanding of molecular formulae and full structural formulae were less well answered, as were those requiring an explanation of organic reactions. Answers requiring an explanation of information given in the question also tended to produce lower marks.

Comments on individual questions:

Question 1

Most candidates found that this was one of their higher scoring questions.

(a)

- **(i)** Most candidates answered this correctly, with a very clear diagram.
- **(ii)** Most candidates gained some credit here, but few achieved full marks. In many cases marks were lowered by explanations that lacked clarity or contained contradictory statements (such as stating that the molecule is both linear and V-shaped).

(b) Many candidates gained one mark here, but few gained both. In most cases this was because the explanation was unclear or did not deal with the molecule as a whole.

(c) Answers to this question were generally very good, with most candidates scoring both marks. Those scoring only one mark had often put 2- and 6+, rather than -2 and +6.

(d) Most candidates gained some credit here. Those scoring only one mark often gave incorrect values for oxidation state changes in their explanation.

(e)

- **(i)** A very high proportion of candidates gained this mark.
- **(ii)** Most candidates scored here. Those who did not gain credit had often not converted the volume to dm^3.
- **(iii)** Most candidates gained this mark, with some benefitting from the 'error carried forward' rules from their previous incorrect answer.
- **(iv)** Most candidates scored both marks here.

(v) Full marks on this answer were achieved by a minority of candidates. Some candidates carried out an incorrect calculation but gained one mark for giving their answer to three significant figures. Some candidates either did not remember that three significant figure answers were required, or did not understand what this meant.

Question 2

For many candidates, this was one of their higher scoring questions.

(a) Few candidates achieved less than two marks here.

(b) Correct answers to this question were seen from a minority of candidates, with a common incorrect answer being C_5H_9OH.

(c)

- **(i)** Most candidates scored both of these marks.
- **(ii)** A minority of candidates scored here and, as in part (b), this often resulted from answers that did not use molecular formulae.
- **(iii)** Most candidates gained credit here, with many scoring both marks.

(d)

- **(i)** Most candidates scored here. Those not gaining credit had often not classified their structure as an E isomer.
- **(ii)** Many candidates scored one mark for showing their understanding of the role of the C=C in the creation of isomers. A few candidates also knew that the second requirement was that the two carbons of the C=C both had two different groups attached to them and so gained both marks.

(e) A minority of candidates gained credit here. Answers often showed that candidates did not know either the reaction of an alkene or an alcohol group with hydrogen chloride, or in some cases both.

(f)

- **(i)** Most candidates gained this mark.
- **(ii)** Most candidates gained credit here, with many scoring three or four marks. Answers often showed a very good understanding of how hydrogen bonds form and linked this clearly to the example of polymer A dissolving in water. Some candidates gained credit from clearly drawn and labelled diagrams.

(g)

- **(i)** Most candidates scored here, with many gaining full marks.
- **(ii)** Incorrect answers to this question were rare.

(h)

- **(i)** Many candidates gained some credit here, but few scored both marks. In most cases those scoring only one mark did not state that the reaction mixture needed to be boiled.
- **(ii)** Most candidates gained some credit here, but few scored both marks. In many cases a score of one resulted from a diagram that was not a full structural formula.

Question 3

For many candidates, marks on this question were their highest within the paper.

(a) Most candidates scored some marks here. The most common reason for losing marks was an incorrect explanation for the difference in physical states in terms of a comparison of strength of forces in both chemicals.

(b) Most candidates scored one mark here and many gained full credit for their answer.

(c)
- **(i)** Many candidates did not score here and those gaining both marks were rare. Answers often lacked detail or focused incorrectly on atom economy.
- **(ii)** Many candidates gained this mark.

(d)
- **(i)** Incorrect answers to this question were rare.
- **(ii)** Many candidates gained this mark. Those not gaining credit often gave answers in terms of vibrations, but did not make it clear what was vibrating.
- **(iii)** Most candidates gained some credit here, with many going on to gain both marks.

(e)
- **(i)** Very few candidates gained no credit here and many scored all three marks. Answers were clear and showed a good understanding of how reaction conditions influence equilibrium processes.
- **(ii)** Most candidates gained this mark.

(f)
- **(i)** Many candidates scored both marks here.
- **(ii)** Most candidates gained some credit here. It was less common to see candidates gaining both marks, often because they were not sufficiently clear in their answer about why the radiation was required.

(g)
- **(i)** Many candidates gained this mark.
- **(ii)** Full marks were common here and few candidates gained no credit.

Question 4

For most candidates the quality of answers to this question was lower than on the other questions.

(a)
- **(i)** Most candidates scored here.
- **(ii)** Most candidates gained credit here, with marks of two or three being very common. For those gaining two marks, the need for the uv to be of high frequency was often the point that was omitted.

(b) Many candidates scored one mark; although few went on to gain both. Some gave answers that were not on the list they were asked to choose from.

(c)
- **(i)** Candidates who gained credit on this answer were rare, often because answers lacked detail or candidates' answers suggested that only chlorine radicals catalyse ozone breakdown.
- **(ii)** Many candidates scored one mark here, but few gained both, often because the answers given did not include a suitable advantage of HFCs.

(d)
- **(i)** A small proportion of candidates gained marks here, with those gaining both marks being very rare. Answers often lacked detail or gave a partial explanation.
- **(ii)** Many candidates scored here, with marks of two being very common. Answers were often very clearly worded.

Question 5

The quality of answers to this question was generally below those of the other questions, with answers suggesting that candidates had not used the article to full effect to help them to prepare for this question in advance of the exam.

(a) Most candidates gained credit here, with a mark of two out of three being the most common. Those not achieving full marks either gave no answer to the method by which radicals form, or gave an incorrect example of a radical.

(b) Very few candidates scored here. Many incorrect answers were either not ionic equations, or showed every atom from the equation converted individually to an ion.

(c) Most candidates gained some credit, with a fairly even spread of marks from one to four being gained. Some candidates did not gain the mark for spelling the term 'instantaneous dipole – induced dipole' either because their handwriting lacked care or they had used an abbreviation (id-id). Candidates scoring three or four marks had produced clearly structured answers with explanations in a logical order.

(d)

(i) Most candidates gained one mark here and some scored both. Some incorrect answers had organic molecules that did not contain three carbon atoms.

(ii) Most candidates scored this mark.

(e) Most candidates gained some credit, with some scoring both marks. The most common reason for a score of one mark was not multiplying the value by five to account for the transfer of five electrons.

(f) Many candidates gained half the available marks or less here, with few going on to gain greater credit. Answers often suggested that candidates were not sufficiently familiar with the content of the article and a minority of answers included details from the article that did not answer the question. Some candidates included relevant content, but did not compare that property in chlorine dioxide with the same property for chlorine (for example stating that chlorine dioxide is soluble in water, but not that it is more soluble than chlorine).

F334 Chemistry of Materials

General comments:

Some candidates were well prepared for this examination, had revised hard and practised past papers. Some points to bear in mind to ensure better performance in June are:

- Read questions more carefully and in particular noticing the command words used. 'Name' and 'Give the formula of' were often interchanged, as were 'Explain' and 'Describe'. Also when asked to 'use' data or an answer given to explain chemistry, some memorised statement was sometimes written instead.
- Check formulae used in answers; carbon and oxygen atoms with the incorrect number of bonds were often used. Common metal ions were given incorrect charges. 'Full structural formula' means all bonds and H atoms need to be shown. Missing charges were common.
- Provide adequate working-out for calculations; although calculations have improved over the years, a significant number still lose marks through poor presentation and a lack of supportive wording. However the most serious problem seen was in the use of 'appropriate significant figures'. This is a step-up from the stated number used at AS. Very few candidates gained the mark which included the use of correct significant figures (Q.4ci).
- Realise that parts of questions numbered with Roman numerals (i), (ii), etc are usually intrinsically related. Thus one part can provide a clue or link to the next eg Q.3b parts (i) and (ii).
- Use the *Data Sheet* to identify infrared spectrum peaks; often data quoted off the sheet was inadequate or wrong, whilst the frequencies from the spectrum were not given accurately enough leading to confusion in identifying the compound.
- Express ideas and descriptions clearly; often answers were incoherent and lacked logical thought, resulting in many contradictions (eg Q.1e, Q.1civ, Q.2b, Q.3b., Q.4civ and Q.5b).
- Use electrode potential data to interpret redox reactions; poor use of technical terms and an unfortunate desire by many to begin at the wrong end of the reaction with a yellow solution reduced the marks awarded considerably (in Q5.b).

Question specific comments:

Question 1

(a) Most candidates gave the correct formula here without leaving out bonds or hydrogen atoms.

(b) Most candidates showed a good knowledge of both the reagents and necessary conditions but sometimes an inappropriate acid was specified or an incorrect oxidation state included for chromium.

Some candidates appeared to decide that the purified product was ethanoic acid and then manipulated the evidence to fit their assumption. Perhaps lack of practise with infrared spectra meant that they could not distinguish broad –OH peaks from those due to CH bonds. Candidates need to realise that giving a molecular formula to identify the product is insufficient when dealing with functional groups.

(c) In part (ii) specific atoms were often circled rather than 'species'. Most candidates were not able to distinguish between an acid and a base, or did not know that there was two of each represented in the equation.

Virtually all candidates identified the gas in part (iii) correctly. Only a small number gave the correct formula for the solid product, realising that it was a salt (basing it on Ca^{2+}) rather than an oxide or hydroxide of calcium.

In part (iv) only a few candidates took note of E330 reacting with carbonates. Many candidates lost marks because either phenol was deemed more acidic since it formed the more stable anion or E300 contained alcohol groups only, or E300 was more acidic because it formed the more stable anion or had more ionisable –OH groups.

(d) A significant number of candidates performed the two necessary calculations in parts (i) and (ii) correctly, but then started the calculation to part (iii) and ended up with an incorrect value for moles of I_2 formed.

In part (iii) many began the calculation with the answer to part (ii), whilst units given were incorrect or inappropriate. Here many tried routine methods rather than thoughtful reasoning.

Part (iv) discriminated well. Most candidates made the link between the I_2 reacted with E300, the I_2 left over and the concentration of E300, however they were not all able to explain it coherently. Those who failed made it clear they had not really understood the basis of the E300 analysis.

(e) Many candidates explained, incorrectly, that the ability to twist a C=C was needed for *E*/*Z* isomerism and that the inability to do this in E300 explained its lack of isomerism. Only some of those who had the right idea were able to express it clearly. The essence of the correct answer is that the ring with the C=C does not allow the two –OH groups to be on opposite sides.

(f) Many answered a different question in part (ii); they attempted unnecessarily to draw the full structure of the new antioxidant. Most candidates did well on the other parts.

Question 2

(a) Deducing the monomers for nylon-6,6 was well done, however some candidates struggled with POM, giving methanol as a common error.

Few candidates recognised the ether link in POM; many suggested other groups, some containing O, for example aldehyde.

Some candidates focussed on 'Describe' in part (iii) and were able to trigger the 'vertical' – 'non-vertical' link and thus gain both marks. Others were unable to express any worthwhile difference clearly, often discussing whether a reaction went to completion. It appears that some have no practical experience of either technique.

(b) Few were aware that POM could form hydrogen bonds with water, otherwise most scored some of the marks.

Areas of confusion included:

- water absorption – hydrogen bonding to water not specified,
- T_m – rather than comparing relative strengths of intermolecular bonds, 'amounts of' were sometimes discussed,
- flexibility – sometimes strength of intermolecular bonds were used to argue this difference, often resorting to water molecules forcing chains apart in the case of nylon-6,6.

Again, here the poor quality of communication was apparent.

(c) An occasional co-polymer was seen and some other rather random suggestions.

Question 3

(a) Most candidates achieved ‘2-amino’ but did not score the rest of the name. ‘Di-pentanoic acid’, pentadioic and di-carboxylic acid were quite common.

(b) Most were able to explain clearly either through describing the reaction in terms of an acid and basic group reacting or in terms of proton transfer. A good number started with ‘zwitterions’ but did not always use them in explaining their proton transfer properties.

Only a few used these references to ‘zwitterions’ in explaining the high melting point of the acid. Successful candidates did not need to discuss at length how hydrogen bonding was the reason for very strong attractions between the acid molecules necessitating in the input of large amounts of energy.

(c) Some good structural drawing here, with a few NH_3^+ added or the odd carbonyl group omitted.

(d) Optical isomerism is well understood although there were references to non-superimposable isomers without any reference to a mirror image.

(e) Although all answers included a N atom, after that doubt set in and a variety of atom combinations were seen. However, a majority of candidates were able to recognise a correct structure.

Most were able to make good suggestions in part (ii), some answers to part (iii) were vague with a good number believing that tests were not conducted until post-thalidomide.

Question 4

(a) Most candidates were able to work out the oxidation states correctly; but sadly many failed to read the question carefully so discussed ‘gaining electrons’ instead of the change in oxidation state.

In part (ii), some candidates included new species into an equation whilst others struggled with balancing.

Much creative chemistry was invoked in part (iii) but those who had considered the whole question carefully realised the significance of acid as a necessary reactant.

(b) Most candidates knew that the Br_2 product is red–brown in colour, but many ignored the fact that the reactants are colourless. A wide variety of other colour changes were also suggested.

(c) Some candidates had difficulty in getting the correct numbers into the equation, whilst others decided to go back and use their own rate equation. A large majority lost the significant figure mark, presumably because of a failure to consider all of the data used.

In part (iv) only a few candidates recognised the significance of the rate equation and the rate determining step and understood what was required next. Unfortunately, the ability to express this clearly was not seen often.

Question 5

(a) Some answers showed precision in the use of the correct technical terms and in identifying what the question was asking. These considered ‘in terms of frequencies’ and thus avoided answering by rote about electrons jumping gaps, followed by reflecting or emitting colour.

(b) Some candidates considered carefully what was being asked of them, whereas many plunged into writing what they knew about vanadium chemistry, often including misunderstood ideas about electrode potentials and the feasibility of redox reactions.

Common errors included:

- starting with yellow VO_2^+ which was then reduced,
- failure to mention the role of oxygen in the reaction sequence,
- not referring to the data correctly but using inappropriate language (eg volts, electronic, greater, electronegative, ‘it’),
- stopping when they had identified the solution as blue and forgetting about the final part of the question.

(c) The complex was often named rather than the ligand.

(d) Many candidates managed to construct a correct electronic configuration. However, there were quite a mixture of other answers, usually involving 4s electrons, incorrect numbers of electrons and even 4d sub-shells.

F335 Chemistry by Design

General

This is primarily a paper for those in their seventh term in the sixth form. There were fewer candidates than last year and, while the standard at the top end was about the same as last year, that at the bottom was better. All candidates made a real effort to show what they knew and could do and there was no evidence that they found time a problem.

Candidates showed good understanding of equilibrium and rates, equations, entropy and mole calculations, the origins of colour, molecular recognition, inter-molecular bonding and infrared spectroscopy. Many candidates laid out calculations well and most candidates, though not all, organised their longer answers logically and wrote clearly.

Their understanding was less sure on NMR spectroscopy, unfamiliar pH calculations and dot-cross diagrams and shape explanation in unfamiliar situations. The significant figure mark was scored by very few candidates and rounding errors were unfortunately quite common.

Question 1

1 **(a)** Most candidates scored many of the available marks here on questions about equilibrium and rates and some managed to describe the *frequency* of collisions in part (i). In part (ii), most candidates focussed on the cost of energy to run the compressors or the need for thick pipework, and avoided vaguer answers. In part (iii) most candidates had the idea of the equilibrium shift and some managed to mention that it was the 'equilibrium *position*' that changed. Parts (iv) and (v) were often well done, with a few candidates tripping up over the units.

(b) There were some good marks in this question about entropy. The majority realised that two moles of hydrogen were involved and again most candidates realised the need to covert the ΔH to joules – this latter has not always been the case.

(c) Most candidates scored for the reagents, though a few candidates' answers were spoiled by 'dichromate(IV)' or even 'potassium(VI) dichromate', which are not allowed at A2. Many candidates realised the need to distil, but some showed lack of understanding by writing 'reflux and distil'.

The understanding of infrared spectroscopy shown by candidates in part (ii) was commendable. The unfamiliar NMR question was found quite testing, although some candidates managed it, including the splitting.

Part (iv) was designed to be testing. Few candidates scored more than one mark, usually for making some reference to hydrogen bonding between the molecules. Just a few candidates scored for a more quantitative analysis of the data (eg 'volume half expected').

(d) There was some good understanding here of esters, their intermolecular bonding and their hydrolysis. Most candidates attributed permanent dipole–permanent dipole bonding to esters and most named the product of hydrolysis as 'sodium methanoate' or 'methanoate ion'.

Numerical answers: 1(a)(v): 1000 $dm^6\ mol^{-2}$*; 1(b)(i): –220; 1(b)(ii): 414*

Question 2

2 **(a)** Many candidates answered this question about bonding in BH_3 correctly, most scoring the electron configuration mark. Many candidates realised in part (ii) that BH_3 had just three pairs of electrons, though some added a lone pair for good luck. Those who gave the correct structure in part (ii) were often successful in part (iii) but some were led astray by their errors in part (ii).

(b) A few candidates managed to work out that the three-centre bond contained two electrons. More showed their understanding of 'how science works' by answering part (ii) in terms of the *utility* of dot-cross diagrams in *most* situations.

(c) The definition of electronegativity was known by a minority but many candidates could assign correctly the unusual oxidation states of boron in part (iii).

(d) Most candidates could calculate the atom economy and many candidates qualified it by commenting on the *large amounts* of waste product. Most candidates recognised the bonding as ionic in part (ii) but only a few drew the correct dot-cross diagram for a metal hydride.

(e) Candidates did well in writing an unfamiliar equation in part (i) and deciding on another possible product in part (iii). Many candidates could perform the calculation correctly in part (ii), but only a very few realised that only two significant figures were justified by the data (25g).

Numerical answer 2(b)(i): 2; 2(e)(ii): 150

Question 3

3 **(a)** There were some good answers to an unfamiliar question on oxidation states and formulae in part (i). In part (ii), a substantial number of candidates realised that the $4s^2$ electrons had been lost from the cobalt atom (and not two of the d electrons).

(b)(i) Few candidates realised that the reflectance on the right of the spectrum was out of the visible region and described the colour as blue.

Most candidates named cobalt as the element in part (ii) and many candidates (but by no means all) avoided contradicting a good answer on the origins of colour by a final statement 'when the electrons drop back, they emit light'.

(c) Here, of course, the falling electrons *do* emit light and many candidates moved from the absorption situation to the emission without difficulty. Most candidates remembered to explain why the spectra of different elements differed, some by drawing a useful diagram.

(d) Part (i) on molecular recognition in the context of enzymes was well answered. Most candidates talked about the substrate fitting and then failing to fit and many of these stated that the substrate fitting led to a reaction. Many candidates explained part (ii) in terms of the dimercaprol binding with the arsenic (using its SH groups) thus freeing the enzyme from the effect of arsenic, rather than incorrectly in terms of the dimercaprol binding with the enzyme and competing with arsenic. In part (iii) some candidates correctly focussed on the fact that dimercaprol was stated as being toxic and therefore testing was needed to determine a safe dose

Question 4

4 **(a)** Many candidates recognised that oleic acid was *Z* and explained this in terms of groups on the same side *of the double bond*.

(b) Most candidates could describe the intermolecular bonds correctly with no or only very minor errors in the spelling. Most candidates described the packing in oleic acid comparatively and scored well on part (ii).

(c) This part was well answered in most parts. Most candidates realised that the M_r of iodine was 253.8 [254 was accepted] and some noticed that stearic acid was fully saturated, so would have an iodine number of zero.

(d) Some candidates were able to name intermolecular bonds made and broken and state (in some way) that more energy needed to be put in than was released. Most candidates scored some credit here.

(e) Most candidates managed to draw the triglyceride correctly and give the correct products. Many candidates realised that three moles of water were needed.

Numerical answer 4(c)(iii): 90.0

Question 5

5 **(a)** Most candidates recognised that the empirical formula was CHO.

(b) Just a very few candidates realised that an acid anhydride was formed, but not that it was cyclic. Some candidates were close to talking about the need to rotate the double bond in fumaric acid in order for reaction to occur.

(c) Most candidates got the number of chiral centres correct. Some candidates scored by mentioning non-superimposable mirror images in part (ii). Very few candidates realised that two of the possible four isomers were the same.

(d) Candidates started well on this part, with most candidates avoiding inserting square brackets or naming H^+ as the conjugate acid. Most candidates got part (iii) correct and avoided rounding errors. Many candidates scored the first two marks in part (iv) for naming the approximations, avoiding saying that they had assumed that the acid was fully dissociated. Very few candidates were able to state that, as $[H^+]$ was not much smaller than [HA], appreciable dissociation must have occurred.

(e) Most candidates could describe the action of buffer solutions well and many mentioned the vital contribution of the excess A^- ions. Many candidates could solve the buffer calculation in part (ii).

(f) Some candidates calculated the volume of sodium hydroxide required but very few arrived at the correct answer in part (ii).

Numerical answers: 5(c)(i): 2; 5(d)(iii): 2.01; 5(e)(ii): 3.33; 5(f)(i): 4.5; 5(f)(ii): 2.73

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