2013 CHEMISTRY TRIAL MARKING GUIDELINES

MULTIPLE CHOICE

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| C | B | A | D | C | C | D | C | B | C |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| D | B | C | B | B | A | C | C | D | A |

| **Q** | **Marking Guidelines** | **Suggested Answer** | **Markers Comments** |
| --- | --- | --- | --- |
| 21a |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| 2 correct equations and at least 2 comparisons between the processes that make the two polymers | 4 |
| Three of the above | 3  |
| 2 of the above | 2 |
| 1 correct statement | 1 |

 |

|  |  |  |
| --- | --- | --- |
|  | Ethylene | cellulose |
| Type of polymerisation | Addition polymerization | Condensation polymerisation |
|  | Nothing is lost | A small molecule such as water is released |
|  | Same monomer | Same monomer |

Equationsn CH2=CH2 ------> [ -CH2-CH2- ]nn(HO–C6H10O4–OH) → H–(O–C6H10O4)n–OH + (n–1)H2O | This question was not well done. The girls are confused about the polymerization reactions in that they often forget the need to show how the polymer is made up of many (n ) units, not just 2 or 3 monomers joined together. Many girls are unaware of the meaning of the verb compare, and give lots of detail on one polymer only, without a COMPARISON to the other polymer.  |
| 21b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * at least 2 comparisons to the production method of a named biopolymer and polyethylene
* at least 2 comparisons of the properties of a named biopolymer and polyethylene
 | 4 |
| 3 of the above | 3 |
| 2 of the above | 2 |
| 1 correct statement | 1 |

 |

|  |  |  |
| --- | --- | --- |
|  | PLA | polyethylene |
| production | * Uses lactobacillus and lactic acid derived from starch
* Made from a renewable resource
 | * Uses either an intiator or a catalyst to join together ethane molecules derived from oil
* Made from a non renewable resource
 |
| properties | * Biodegradable
* Tough – can also be used for durable items such as buckets
 | * Not biodegradable
* HPDE – tough so used for durable items such as buckets
 |

 | Biopolymer knowledge was fine, but many neglected to say how the polyethylene was made, nor of the properties. Again the comparisons were not clearly made. Many neglected to mention the properties of the polymers. A few thought that polystyrene was a biopolymer, and several also said the polyethylene was formed from ethanol. Lots of confusion about the properties and productions of BOTH polymers in comparison to each other.  |
| 22a |

|  |  |
| --- | --- |
| **Criteria**  | **Mark** |
| Correct equation (no states) | 1 |

 | Fermentation%20of%20Ethanol | Generally fine BUT this was an easy question and the girls need to be able to write this equation confidently.  |
| 22b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| 2 correct conditions | 2 |
| 1 correct condition | 1 |

 | Water, warmth (37°C) | Yeast is essential but assumed |
| 22c |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Method includes * a correct and workable procedure including the collection of CO2 gas
* the recording of masses before and after fermentation
* length of time experiment was carried out for
 | 3 |
| Method includes 2 of the above | 2 |
| One correct statement | 1 |

 | 5g of sugar is added to 250ml water in a conical flask with a side arm together with 1g of yeast. The mass of the flask is then determined. The flask is stoppered and a piece of tubing is attached to the side arm and this is placed in a 250ml conical flask containing limewater. The mass of which was previously determined. The experiment was left at room temperature for 5 days. After 5 days the mass of the flask containing the reaction mixture and the mass of the flask containing the lime water was determined.  | The girls were not clear in general about the process to be followed. They neglected to specify amounts of reagents, time factor, weighing. (the meaning of the word monitor was obviously confusing. Many girls talked of putting their mixture in a volumetric flask.  |
| 23 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correct answer | 2 |
| One correct step | 1 |

 | Mol of EtOH burnt = 1028/1370 = 0.750364963 molMol of H20 = 2:6 = 0.750364963/3 = 2.50121654 molMass of H2O = 2.50121654 X 18 = 40.52g | There were the usual mathematical errors here, and many girls inverted the quantities.  |
| 24 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * correctly choses the right metals
* correctly calculates voltage generated
* writes a correct equation (no states)
 | 3 |
| 2 of the above | 2 |
| 1 of the above | 1 |

 | Pd2+ + Cd  Cd2+ + Pd Pd2+ + 2e-   Pd 0.92VCd  Cd2+ + 2e- 0.40V 1.32V | Some confusion here-the ones who added ALL FOUR EQUATIONS were obviously unclear on what the question required. Many selected the wrong pair of metals. Ecf was applied here.  |
| 25a |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly identifies particles X and Y | 2 |
| Identifies one particle | 1 |

 | X = beta particle or electronY = neutron | Mostly well done |
| 25b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Good description of method of production of both isotopes | 2 |
| Correctly identifies one method of production | 1 |

 | Neptunium would be made in a nuclear reactor where uranium -238 is bombarded with neutrons.Curium is made in a cyclotron (or linear accelerator) where plutonium atoms are bombarded with helium nucleus’  | Many girls simply put what was happening in the reactions into words, neglecting to say that there needed to be bombardment of the target nucleus. Nuclear reactor/cyclotron as the place where the reaction occurred was often omitted.  |
| 26a |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly determines volume of NO  | 2 |
| One correct step | 1 |

 | Mass per day of NO = 0.87 X 50 = 43.5g. Mol NO = 43.5/30 = 1.45 molL of NO = 1.45 X 24.79 = 35.9455 =35.95L | Generally well done. Some did not convert to moles before obtaining volume, just multiplied the mass by the 24.79L.  |
| 26b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly determines the no of mol of HNO3  | 1 |

 | As 1 mol of NO produces 1 mol of HNO3, 1.45 mol of HNO3 will be produced | Poorly done! The girls did not note the mole ratios between the equations.  |
| 26c |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly determines the pH of the solution  | 1 |

 | 1.45 mol in 1000L. C=n/v, 1.45/1000 = 1.45 x 10-3 Mol/LpH = -log[1.45 x 10-3] =2.84 | Ecf had to be applied often here. But the girls could do the pH calculation.  |
| 27a |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly draws both diagrams  | 2 |
| Correctly recognises either of the terms concentrated/dilute or strong and weak | 1 |

 |  | Poorly answered. Some could not show difference between concentrated and dilute. Ie number of particles in the beaker. Many had used a key which did not clearly demonstrate or show that the difference between weak and strong was the degree of ionisation. The weak acid should only be partially ionised whereas the strong needed to be 100% ionised. |
| 27bi |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correct equation | 1 |

 | HCl(aq) + NH4OH(aq)  NH4Cl(aq) + H2O(l) | Generally well answered however some do not know formula for ammonium ion few had NH3OH. Did not penalise for states. |
| 27bii |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Explanation that the conjugates of the base cause hydronium ions to be formed in solution therefore acidic | 2 |
| Demonstrates some understanding of the reaction of ions with waterOrIdentifies salt correctly and states that it is acidic | 1 |

 | The salt produced contains NH4 + ions and Cl- ions. Cl-  are unable to ionize water. NH4 + are able to ionize water NH4 + + H2O ↔ NH3 + H3O+Therefore as the solution contains hydronium ions it is acidic. | Many managed to correctly identify that the salt was acidic, but did not explain why. For the second mark they needed to show using equations or explain the reason ammonium chloride was acidic. |
| 27biii |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Gives explanation why it is not a suitable indicator | 1 |

 | The end point of the reaction will be below 7. As phenolphthalein changes colour at about pH 8, this is not a suitable indicator for this reaction. | Generally well answered |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 28 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Demonstrates a thorough understanding of both techniques by describing features of steps with appropriate reference to techniques and equipment used
* Calculates the mass of sodium carbonate required
 | 5 |
| Demonstrates a thorough understanding of both techniques by describing features of steps with appropriate reference to techniques and equipment used | 4 |
| Demonstrates a sound understanding of both techniques by outlining features of steps with appropriate reference to techniques and equipment usedOrDemonstrates a thorough understanding of one technique by describing features of steps with appropriate reference to technique and equipment used. | 2-3 |
| One correct statement | 1 |

 | Step A 1. Na2CO3 should be initially dried and stored in a dessicator.2. 1.32g of Na2CO3 should be weighed out accurately to 2 decimal places Mass of Na2CO3 = 0.05 X 0.25 X 105.99 = 1.32g3. 250ml volumetric flask was cleaned and rinsed with distilled water. The accurately weighed mass of Na2CO3 dissolved in a small volume of distilled water in a beaker. This was then transferred into the volumetric flask and the procedure was repeated until all the Na2CO3 had dissolved. Distilled water was then added to the flask until it was level with the bottom of the meniscus.Step B1 Clean a burette by rinsing with distilled water and then with the unknown hydrochloric acid solution. Fill the burette with the unknown acid solution.2 Rinse a 250mL conical flask with distilled water3 Rinse a 25mL pipette with distilled water and then rinse with Na2CO3 solution. Use the pipette to transfer 25mL of Na2CO3 solution to the conical flask by filling with the solution so that the bottom of the meniscus is on the mark.4 Add a suitable indicator to the conical flask.5. Slowly add the acid from the burette to the conical flask until the indicator changes colour. Record the volume of acid added. This is a rough titration. Repeat the titration 3 more times and use the average of these 3 to determine the concentration of the acid.  | Very poorly answered for method A, method B was better.Most did not calculate the mass of Na2CO3 needed to accurately make up 250mL of 0.05M standard. Many did not answer step A. Students must learn the name of the equipment used 250mL volumetric not measuring cylinder; conical flask or beaker. When titrating you must pipette known volume into conical flask. Specific volumes must be given. Most included having to rinse with water and then the solution for the burette, pipette and conical flask. They must NOT rinse the conical flask with anything but water. Rinsing with the solution will affect the volume.Must also remember to repeat titration see suggested answer. |
| 29 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Correctly reads graph to determine mass in 100mL
* Correctly determines moles of CO2
* Correctly determines volume of CO2
 | 3 |
| 2 of the above | 2 |
| 1 of the above | 1 |

 | 0.15g in 100 mL at 25°C0.15 X 30 = 4.5g in 3LMol CO2 = n=m/M , n = 4.5/44 = 0.102277molVolume of CO2 = 0.102277 x 24.79 = 2.54L | Generally well answered. Some had problems converting g/100ml that they read off the graph to total grams in 3L This meant that the total moles were incorrect. Ecf was applied for the final calculation. |
| 30 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Describes tests in correct order
* Describes correct tests to identify ions and the observations that will be made
 | 3 |
| Describes all tests and observations but in wrong orderORGives two correct tests and observations | 2 |
| Identifies a test to identify one of the ions | 1 |

 | First add nitric acid. If bubbles are observed then the sample contains carbonate ionsCO32- + 2H+   CO2 + H2ONext add silver ions. If a precipitate forms that is white, then it is chloride ionsAg++ Cl-  AgCl(s)If a precipitate forms that is yellow then it contains phosphate ions3Ag+ + PO43-   Ag3PO4(S) | Generally well answered, but many did not do the tests in the correct order. Must test for carbonate first to remove all carbonate before testing for chloride and phosphate. Did not penalise for lack of equations. Girls are advised to include equations wherever possible. |
| 31 |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Outlines tests carried out in a school laboratory for both hardness and total dissolved solids | 3- 4 |
| Identifies two tests that can be used to determine hardness and TDSOr Outlines one test  | 2 |
| Identifies a test for either hardness OR TDS | 1 |

 | TitrationTake a 25mL sample of water and add 1mL of buffer and 2,3 drops of eriochrome black –T indicator. Titrate using EDTA solution. TDSTake a 100mL sample of water and filter it. Transfer the water to an evaporating basin of known weight and evaporate the waterReweigh the evaporating basinThe total dissolved solids can then be expressed as ppm.  | Many girls gave qualitative test methods for hardness. They used precipitation to identify calcium and magnesium or they used a soap solution to see if the solution formed lather. TDS was answered well. But some confused TDS with suspended solids and turbidity. Tests needed to be quantitative when you measure quality. |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 31b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Gives a correct reason  | 1 |

 |  Water possibly contaminated with sewage | Generally well answered. Many had the run off of phosphates that led to eutrophication and algal growth that reduced the amount of dissolved oxygen. This was accepted. BOD measures the oxygen used by biological material within a 5 day period. |
| 32a |

|  |  |
| --- | --- |
| **Criteria**  | **Mark** |
| Correct equation including states and equilibrium arrows | 1 |

 | habereq | Generally well answered but there were a significant number that did either not have correct states or equilibrium arrows. |
| 32b |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Explains the effect of temperature by referring to Le Chateliers principle
* Explains the effect of pressure by referring to Le Chateliers principle
* Explains the effect of temperature and pressure on reaction rate

or* Explains effect of pressure or temperature on rate with an overall statement on compromise of temp/pressure for yield and rate.
 | **4-3** |
| Two of the above | **2** |
| One correct statement | **1** |

 | The reaction is exothermic. This means that it is favoured by low temperatures. According to Le Chateliers principle, this will shift the equilibrium to the right to release more heat, since any system at equilibrium will adjust itself to minimise the disturbance. This will increase the yield of NH3. However, a lower temperature lowers the kinetic energy of the molecules and so decreases the number of successful collisions and the rate of reaction becomes too slow. Therefore the reaction is carried out at a compromised temperatureAccording to Le Chatelier's Principle, if you increase the pressure the system will respond by favouring the reaction which produces fewer molecules. That will cause the pressure to fall again. In this reaction this means that the forward reaction is favoured as 4 moles goes to 2 moles. High pressures also increases the rate of the reaction. In order for any reaction to happen, those particles must first collide. If the pressure is higher, the chances of collision are greater. | Girls still mixing up left/right, products/reactants. Must refer to Le Chateliers principle. Many did not discuss effect of reaction rate for both temperature and pressure.Some did not discuss rate at all. |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 33a |

|  |  |
| --- | --- |
| **Criteria**  | **Mark** |
| Correct definitions of the two terms | 2 |
| One correct definition ORLimited understanding of the two terms | 1 |

 | Sensitive means that it can detect metals at very low concentrations and selective means that it can identify/quantify individual metals in a sample. | Some students did not understand what these two terms meant. There was also confusion with the term accuracy. Some students thought that accuracy meant sensitive. Be careful, results can be accurate without being sensitive. |
| 33b |

|  |  |
| --- | --- |
| **Criteria**  | **Mark** |
| Demonstrates a thorough understanding of AAS by describing the main features or principles of the technique and suitable diagram | 3 |
| Demonstrates a sound understanding of AAS by outlining some features or principles of the technique | 2 |
| 1 correct statement | 1 |

 | AAS analysis involves spraying an aqueous solution of the metal to be analysed into a flame. The flame atomises the metal ions. Light of a particular wavelength, generated by a hollow cathode lamp made of the same metal that is to be analysed, is then shone through the flame. The amount of light absorbed by the metal atoms is measured using a detector. The absorbance is proportional to concentration. The concentration of the unknown is determined by running a series of standards (samples of known concentration), plotting a calibration curve and determining the concentration of the unknown from this. | Generally well done. There were some misconceptions with the flame. Some students thought that the flame excited the electrons. It is the light from the lamp that does this.Some students talked about atoms being excited. This is incorrect. It is the electrons that are excited.Some students talked about a furnace. It is actually a flame that the sample ends up in. (a furnace can be used to atomise solid samples)Some students talked about the flame being a nebulizer. A nebulizer turns a liquid into a fine mist. This is quite separate from the flame. |
| 33c |

|  |  |
| --- | --- |
| **Criteria**  | **Mark** |
| Correctly explains what is meant by quantitative analysis | 1 |

 | This means that the total amount of a particular substance is determined, usually as ppm.  | Generally well done. |

OPTION – INDUSTRIAL CHEMISTRY

|  |  |  |  |
| --- | --- | --- | --- |
| **Q** | **Marking Guidelines** | **Suggested Answer** | **Markers Comments** |
| **34 ai** |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Recognises that the temperature was increased
* Describes the effect on the products and reactant
* Relates this to Le Chateliers principle
 | **3** |
| Two of the above | **2** |
| One of the above | **1** |

 | The reaction is endothermic. The temperature was increased which favours the forward reaction. According to Le Chateliers principle, the system will adjust itself to minimise the disturbance and will use up the heat added. this produces more Cl2 and CO2 and uses up more COCl2 | Generally well done. Most errors in this question were because students didn’t read the question properly. We told you that the temperature changed! Lots of students quoted LCP but didn’t actually explain how this affected the position of the equilibrium.Some students spoke about increasing the temperature caused there to be more collisions which meant that there were more products produced. Be careful – this increases the rate of the reaction but not the position of the equilibrium.Some students also thought that a positive value meant that it was exothermic. This is incorrect. |
| **34aii** |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Recognises CO was removed
* explains the effect this has on the reactants and products
 | **2** |
| One of the above | **1** |

 | The product CO has been removed from the system. According to Le Chateliers principle, the system will adjust itself to minimise the disturbance by producing more CO. This in turn will increase the amount of Cl2 produced and decrease the amount of COCl2 present | Generally well done. You needed to talk about the reactants **and** products as well as recognizing why the CO decreased so suddenly. Be careful about what happened to the CO too, as some didn’t mention that it’s concentration started to increase. |
| **34aiii** |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Provides correct equilibrium expression
* Correctly determines the equilibrium constant
 | **2** |
| Provides correct equilibrium expression | **1** |

 |  K = [Cl2] [CO] = 0.12 X 0.06 = 0.24 [COCl2] 0.03 | Generally well doneSome students added the concentrations rather than multiplying them.Some students had reactants over productsSome students were squaring the concentrations – they were using the subscript numbers in the formula – this is incorrect |
| **34aiv** |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| Correctly identifies that K will increase and can explain why. | **2** |
| One correct statement | **1** |

 | At a higher temperature, the equilibrium constant, K will be higher. This is because the reaction is endothermic. Increasing heat energy favours the products. As the equilibrium constant is a ratio of products over reactants, more products and less reactants gives a larger value of K. | Generally well done.  |
| **b** |

|  |  |
| --- | --- |
| **Criteria**  | **Marks** |
| * Correct equation for the reaction at the anode
* Correct equation for the reaction at the cathode
* Correct explanation for the reaction at the anode
* Correct explanation for the reaction at the cathode
 | **4** |
| 3 of the above | **3** |
| 2 of the above | **2** |
| 1 of the above | **1** |

 | Positive electrode – anode where oxidation of water takes place:H2O    ½ O2 +2H+ + 2e-The production of H+ ions makes the water acidic, therefore turns UI red. Water is oxidized rather than Cl- ions as the solution is dilute. Bubbles form because O2 gas is forming.Negative electrode – cathode where reduction of water occurs:H2O + e-  ½ H2 + OH-Bubbles occur because hydrogen gas is produced. The production of OH- ions make the solution basic thus turning UI indicator blue/purple | Some students answered this question with thorough knowledge even realized that Cl2 gas would be produced in small amounts as well as oxygen. They could explain why using the standard electrode potentials.Some students had sodium atoms and chlorine atoms going to ions. This is incorrect.Some students did not realize that there was water presentSome students had the reaction at the cathode as O2 being reduced. This is incorrect.Some students were confused between acids and electrons. They thought that acids were electron donors. This is incorrect. Acids are proton donors. |
| **c** |

|  |  |
| --- | --- |
| Criteria  | Marks |
| * Thoroughly describes the 3 processes including equations
* Identifies reasons/ factors that led to changes in the production process of sodium hydroxide
* Relates the implications of the factors to the change in production process
* Demonstrates coherence and logical progression and includes correct use of scientific principles and ideas
 | 7 |
| * Describes the 3 processes
* Identifies reasons/ factors that led to changes in the production process of sodium hydroxide
* Relates the implications of the factors to the change in production process
* Demonstrates coherence and logical progression and includes correct use of scientific principles and ideas
 | 5-6 |
| * Outlines the three processes
* Outlines reasons for a change in the production process
 | 3-4 |
| * Outlines the processes

OR* Provides reasons for a change in the production process
 | 1-2 |

 | For each process, the overall reaction is:  2NaCl(aq) + 2H2O(l)  H2(g) + Cl2(g) + 2NaOH(aq). In the mercury process, Sodium chloride solution forms the electrolyte, and chloride ions are oxidised at the anode according to the following reaction: 2Cl-(aq)  Cl2(g) + 2e-. The chlorine gas produced is removed. Sodium ions are reduced at the cathode, which consists of flowing liquid mercury, where they form an amalgam with the mercury: Na+(aq) + e- + Hg(l)   Na/Hg(l). This amalgam then moves through a decomposer where it reacts with water, producing sodium hydroxide and hydrogen gas, which is removed, as well as mercury which is recycled through the flowing liquid cathode: 2Na/Hg(l) + 2H2O(l)  H2(g) + 2NaOH(aq) + 2Hg(l) Hydrogen gas produced is removed. The mercury process produces high quality sodium hydroxide; however loss of mercury is an environmental concern as it bio-accumulates in the food chains and causes neurological effects. The mercury process also uses the most electricity of each of the three processes, and is expensive to construct. This contributes to global warming as most electricity generation comes from the burning of fossil fuels which releases carbon dioxide into the atmosphere. To address the concerns of the hazardous mercury and energy consumption, the diaphragm process was developed.In this process sodium chloride solution forms the electrolyte, and chloride ions are oxidised at the anode according to the following reaction: 2Cl-(aq)  Cl2(g) + 2e-. The chlorine gas produced is removed. Water is reduced at the cathode: 2H2O(l) + 2e-  H2(g) + 2OH-(aq). The hydroxide ions combine with sodium ions to produce sodium hydroxide. The diaphragm process also uses an asbestos membrane to separate the reactions. This process also has problems. Asbestos can cause asbestosis (a chronic lung disease), lung cancer and mesothelioma. The membrane is also permeable, and allows water, sodium ions and chloride ions to pass through into the cathode compartment and hydroxide ions into the anode compartment. This can introduce technical difficulties in that the sodium hydroxide solution produced in the cathode compartment is contaminated with sodium chloride, and an evaporative processes using steam is required to separate the two. The OH- ions can also react with the chlorine gas producing ClO- ions. This is a problem as it reduces the yield of Cl2 and NaOH.To address these problems, the membrane cell was developed which Again uses sodium chloride solution as the electrolyte. Chloride ions are oxidised at the anode according to the following reaction: 2Cl-(aq)  Cl2(g) + 2e-. The chlorine gas produced is removed. Water is reduced at the cathode: 2H2O(l) + 2e-  H2(g) + 2OH-(aq). The hydroxide ions combine with sodium ions to produce sodium hydroxide. The difference between this cell and the diaphragm cell is that the membrane between the two compartments is made of perfluorosulfonic acid multilayer polymer which allows sodium ions and water to pass through it, but not chloride or hydroxide ions. This membrane therefore prevents contamination of the sodium hydroxide with sodium chloride and produces high purity sodium hydroxide. it also avoids the use of the asbestos. The membrane cell also uses the least amount of energy of all cells and therefore has the lowest operating costs.Therefore considering safety, environmental concerns, purity of product and energy used, the production process for the manufacture of NaOH has changed to address these issues. |  General commentLook at the number of marks allocated to the question. The 7 mark question is often in the option allowing you write more. Make sure you give adequate information for the number of marks.The students who did well in this question had a thorough understanding of the three processes and described them in detail including chemical equations. They also gave good reasons why the technology had changed, talking about the environmental issues, problems with purity and energy considerations.Some students had the wrong reactions occurring at the anode and cathodeSome students talked about chlorine being oxidized to chlorine gas. It is the **chloride ion** that is oxidizedSome students did not realize that in the mercury process the sodium ions get reduced to sodium atomsSome students talked about contamination of the NaOH with the hypochlorite ion. The main concern is contamination with NaCl.The ClO- ion is formed when OH- ions react with Cl2 gas not from reaction of Cl- ions with OH- ions.Some students just talked about the factors that brought about the change in the processes with no mention of how each of the processes worked. Additional comment – the polymer membrane may cause disposal problems as a plastic! |