



CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2003 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY – MARKING GUIDELINES

Section I

Total marks – 75

Part A (15 marks)

Questions 1–15 (1 mark each)

Question	Correct Response	Outcomes Assessed	Target Performance Bands
1	D	H9	2–3
2	D	H6	3–4
3	C	H4, H6	3–4
4	B	H6	4–5
5	B	H10, H12	4–5
6	A	H12	2–3
7	D	H6	2–3
8	A	H7, H9, H14	3–4
9	C	H10, H12, H14	3–6
10	D	H14	5–6
11	C	H11	2–3
12	A	H9, H13	3–4
13	B	H7, H14	3–4
14	D	H3, H5	3–4
15	B	H6	4–5

Section I

Part B (60 marks)

Question 16 (4 marks)

(a) (1 mark)

Outcomes Assessed: H6

Targeted Performance Bands: 2–3

Criteria	Mark
Identifies X as a neutron	1

2801-2

(b) (3 marks)

Outcomes Assessed: H5, H6

Targeted Performance Bands: 2–6

Criteria	Marks
Outlines the steps used to synthesise the named element and accounts for the inability to isolate large samples of the element	3
Outlines the steps used to synthesise the named element including appropriate materials (ie neutron or small nucleus and an appropriate larger target nuclei)	2
Identifies an element (by name or symbol) discovered after 1940	1

Sample answer

Element 110 (ununilium) was first isolated by bombarding a nuclei of lead with a smaller nuclei of nickel. The nickel nuclei are accelerated by an ion accelerator and fuse with the target lead nuclei. Only a few atoms of ununilium were produced and because they have a very short half-life none have been preserved. The experiment has yet to be replicated and so further samples have not been isolated.

Question 17 (5 marks)

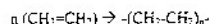
Outcomes Assessed: H2, H9, H13, H14

Targeted Performance Bands: 2–6

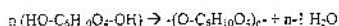
Criteria	Marks
Compares the type of reaction that occurs to produce each polymer including appropriate equations for each reaction	4–5
Describes the type of reaction that occurs to produce either polymer, including an appropriate equation	2–3
OR Describes the type of reaction that occurs to produce both polymers without the use of chemical equations	
Identifies that both substances are polymers	1
OR Classifies polyethylene as an addition polymer OR cellulose as a condensation polymer	

Sample answer

Polyethylene and cellulose are both examples of polymers, which are long-chained molecules made by the joining of a number of small molecules called monomers. However they differ in the type of polymerisation reaction that produces them. Polyethylene is a synthetic addition polymer, formed when ethene monomers join as their double bonds 'open out' allowing them to bond to each other.



Cellulose is a biopolymer formed from the condensation polymerisation of glucose monomers. In such a process, functional groups on adjacent monomers react and a small molecule is eliminated.



Question 18 (4 marks)

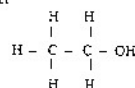
(a) (1 mark)

Outcomes Assessed: H9, H13

Targeted Performance Bands: 2–3

Criteria	Mark
Draws a correct structural formula for ethanol	1

Sample answer



(b) (3 marks)

Outcomes Assessed: H3, H4, H6, H9, H13

Targeted Performance Bands: 2–4

Criteria	Marks
Identifies and explains TWO or more implications of the presence of ethanol in petrol	3
Identifies TWO or more implications of ethanol in petrol	2
OR Identifies and explains ONE implication of ethanol in petrol	
Identifies ONE implication of ethanol in petrol	1

Sample answer

Ethanol produced from fermentation contains water which can cause corrosion of the engine. Ethanol at greater than 20% requires engine modifications and this is expensive. Ethanol from sugarcane is using a by-product that makes sugarcane production more sustainable.

Question 19 (7 marks)

(a) (1 mark)

Outcomes Assessed: H11

Targeted Performance Bands: 2–3

Criteria	Mark
Identifies an appropriate device to accurately measure mass change	1

(b) (3 marks)

Outcomes Assessed: H2, H12, H13

Targeted Performance Bands: 2–4

Criteria	Marks
Diagram includes fermentation vessel, delivery tube and limewater trap; diagram is fully and correctly labelled	3
Diagram includes fermentation vessel, delivery tube and limewater trap; diagram may include partial labels or some labels are incorrect	2
Diagram includes a suitable reaction vessel and some method of collecting the gas	1

Sample answer

Any suitable diagram of the apparatus required is appropriate. Diagram must show reaction flask, delivery tube and limewater trap. Diagram must be labelled.

(c) (3 marks)

Outcomes Assessed: H10, H12, H14

Targeted Performance Bands: 3–5

Criteria	Marks
Calculates the correct volume of carbon dioxide produced and describes a valid assumption	3
Calculates the volume of carbon dioxide gas produced (using incorrect molar volume) and includes valid assumption	2
OR Calculates correct volume of carbon dioxide produced but does not include a valid assumption	
Calculates the number of moles of carbon dioxide gas produced	1
OR Calculates volume of carbon dioxide gas produced from an incorrect mole calculation	
OR Describes a valid assumption made in carrying out calculation	

Sample answer

Assumption: Mass decrease is only due to loss of CO_2 .

mass of CO_2 released = 15g

$$n(\text{CO}_2) = \frac{m}{M} = \frac{15}{44}$$

$$= 0.34\text{g}$$

$$V = n \times V_m$$

$$= 0.34 \times 24.79$$

$$= 8.45\text{ L}$$

Question 20 (5 marks)

(a) (1 mark)

Outcomes Assessed: H8

Targeted Performance Bands: 2–3

Criteria	Mark
Identifies an acid-base indicator, e.g. phenolphthalein	1

(b) (1 mark)

Outcomes Assessed: H11

Targeted Performance Bands: 3–4

Criteria	Mark
Identifies a limitation of using the indicator named in (a)	1

Sample answer

Phenolphthalein changes in the basic region therefore it cannot distinguish between neutral and acidic solutions.

(c) (1 mark)

Outcomes Assessed: H11

Targeted Performance Bands: 3–4

Criteria	Mark
Identifies ONE advantage of using a pH meter instead of an indicator	1

Sample answer

The pH meter is more accurate than the indicator.

(4) (2 marks)

Outcomes Assessed: H12, H13, H14
Targeted Performance Bands: 3-4

Criteria	Marks
Explanation includes TWO of the following: - Identifies that a pH meter must be calibrated in solutions of differing pH to give accurate readings - Identifies that a pH meter must be thoroughly rinsed before each use to give accurate readings - Identifies that a pH meter that has not been stored correctly will not give accurate readings	2
OR	
Identifies that a pH meter must be calibrated in solutions of differing pH to give accurate readings	
OR	
Identifies that a pH meter must be thoroughly rinsed before each use to give accurate readings	1
OR	
Identifies that a pH meter that has not been stored correctly will not give accurate readings	

Sample answer

A pH meter will only give accurate readings if it has been stored correctly, and it is calibrated before use. Additionally the probe must be thoroughly rinsed before each reading to prevent contamination of the sample being measured.

Question 21 (5 marks)

Outcomes Assessed: H8, H9, H11, H12, H13
Targeted Performance Bands: 2-5

Criteria	Marks
Uses an example to outline the procedure for making an ester AND Explains the use of refluxing AND Explains the use of concentrated sulfuric acid	4-5
OR	
Uses an example to outline the procedure for making an ester AND explains the use of refluxing OR concentrated sulfuric acid	2-3
OR	
Outlines the procedure for making an ester, without an example AND explains the use of refluxing OR concentrated sulfuric acid	
OR	
Identifies that an ester is produced from an alcohol and an alkanolic acid	1
OR	
Identifies refluxing as an appropriate method	
OR	
Identifies concentrated sulfuric acid as a catalyst for this reaction	

Sample answer

An alcohol, e.g. methanol, is added to an alkanolic acid, e.g. salicylic acid in the presence of concentrated sulfuric acid and refluxed at high temperature to form an ester (methylsalicylate). The concentrated sulfuric acid acts as a catalyst to speed up the reaction while refluxing allows the volatile chemicals to react without a dangerous build-up of pressure or loss of the volatile chemicals.

Question 22 (6 marks)

(a) (1 mark)

Outcomes Assessed: H1, H6

Targeted Performance Bands: 2-3

Criteria	Mark
Outlines Davy's ideas about acids	1

Sample answer

Davy in 1815 defined acids as substances that contained hydrogen, which could be replaced by metals.

(b) (2 marks)

Outcomes Assessed: H1, H6

Targeted Performance Bands: 3-6

Criteria	Marks
Explains how the Bronsted-Lowry theory of acids and bases was an improvement on earlier ideas	2
Briefly outlines the Bronsted-Lowry theory of acids and bases	1

Sample answer

One of the improvements of the Bronsted-Lowry definition was that it showed that the acidity of a substance depends not only on the structure of the substance itself, but also on its properties relative to the other reactants present.

(c) (3 marks)

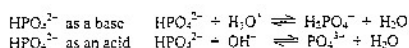
Outcomes Assessed: H6, H10, H13

Targeted Performance Bands: 3-5

Criteria	Marks
Defines an amphiprotic substance AND Uses equations to describe the behaviour of an amphiprotic substance in acidic AND basic solutions	3
OR	
Defines an amphiprotic substance AND uses an equation to describe the behaviour of an amphiprotic substance in an acidic OR basic solution	2
OR	
Uses equations to describe the behaviour of an amphiprotic substance in acidic AND basic solutions	
OR	
Defines an amphiprotic substance	1
OR	
Uses an equation to describe the behaviour of an amphiprotic substance in an acidic OR basic solution	

Sample answer

An amphiprotic substance can act as both a proton donor and a proton acceptor – depending on its properties relative to the other reactant. HPO_4^{2-} is an amphiprotic substance:



Question 23 (4 marks)

Outcomes Assessed: H3, H8, H10, H12, H14

Targeted Performance Bands: 3-6

Criteria	Marks
Clearly demonstrates a quantitative understanding of pH as it relates to $[\text{H}_3\text{O}^+]$ AND Explains the effect of a decrease in $[\text{H}_3\text{O}^+]$ with reference to the second equation	3-4
OR	
Demonstrates a understanding of pH as it relates to $[\text{H}_3\text{O}^+]$ AND Explains the effect of a decrease in $[\text{H}_3\text{O}^+]$ with reference to the second equation	2
OR	
Identifies the pH change as becoming more basic or less acidic	
OR	
Identifies that a pH change of 1 represents a tenfold change in concentration	1
OR	
Identifies a decrease of SO_3^{2-} with a shift to the left of the second equation	

Sample answer

The addition of metabisulphite ($\text{S}_2\text{O}_5^{2-}$) increases the concentration of HSO_3^- (first equation). In the second equation, the system adjusts to overcome this increase in concentration of HSO_3^- by favouring the forward reaction. This causes the concentration of H_3O^+ to decrease and the pH to increase.

Question 24 (4 marks)

(a) (1 mark)

Outcomes Assessed: H3

Targeted Performance Bands: 2-3

Criteria	Mark
Identifies a branch of chemistry, e.g. analytical chemistry	1

(b) (3 marks)

Outcomes Assessed: H3, H13

Targeted Performance Bands: 3-5

Criteria	Marks
Identifies and explains a chemical principle used in the branch named in Question 24 (a)	3
OR	
Identifies and describes a chemical principle used in the branch named in Question 24 (a)	2
OR	
Identifies a chemical principle used in the branch in Question 24 (a)	1

Sample answer

In gas chromatography, the principle of solubility is used. Here the components of a vaporised sample dissolve into the liquid stationary phase to differing degrees. The more soluble the component, the slower it moves through the liquid column. The different components therefore take different times to travel through the column. By checking against the time taken for different substances to travel through the column, the various components of the mixture can be identified.

Question 25 (5 marks)

(a) (1 mark)

Outcomes Assessed: H8

Targeted Performance Bands: 2-3

Criteria	Mark
Correctly identifies the precipitate as barium sulfate	1

(b) (4 marks)

Outcomes Assessed: H11, H12, H14

Targeted Performance Bands: 3-6

Criteria	Marks
Discusses THREE or more means of improving the reliability of the method	3-4
OR	
Discusses TWO or more means of improving the reliability of the method	2
OR	
Discusses ONE means of improving the reliability of the method	1

Sample answer

Minimise loss of precipitate by studying temperature vs solubility curves of all components of the fertiliser and compare with the solubility of the precipitate to determine the optimum practical temperature of the solvent during filtering. Use the minimum amount of solvent for rinsing the precipitate. Use small and frequent rinsing out of containers to make rinsing more efficient. Test filtrate for the presence of sulfate ion using barium chloride and if still present add more barium chloride and refilter. Dry precipitate slowly and weigh to constant mass.

Question 26 (4 marks)

Outcomes Assessed: H3, H8, H9, H14

Targeted Performance Bands: 2-5

Criteria	Marks
Identifies TWO relevant indicators and justifies their choice	3-4
OR	
Identifies ONE relevant indicator and justifies their choice	
OR	
Identifies TWO relevant indicators	2
OR	
Identifies ONE indicator of water quality	1

Sample answer

Biological Oxygen Demand would indicate the amount of fruit waste in the waste water as the breakdown of this waste uses oxygen. Turbidity would also be a good indicator of the amount of fruit waste in the water as it would not dissolve.

Question 27 (7 marks)

Outcomes Assessed: H4, H6, H9, H13, H14

Targeted Performance Bands: 2-6

Criteria	Marks
- Describes uses of CFCs and their impact on the atmosphere - Includes chemical equations to show the release of chlorine radicals; the reaction of this radical on ozone and the re-formation of the chlorine radical to continue the process - Identifies and makes judgments about the effectiveness of measures to reduce the use of CFCs	6-7
- Describes uses of CFCs and their impact on the atmosphere - Includes some chemical equations to show the release of chlorine radicals; the reaction of this radical on ozone and the re-formation of the chlorine radical to continue the process - Describes measures taken to reduce the use of CFCs	4-5
- Identifies uses of CFCs OR their impact on the atmosphere - Describes measures taken to reduce the use of CFCs	2-3
Identifies uses of CFCs OR their impact on the atmosphere	1
OR	
Describes measures taken to reduce the use of CFCs	

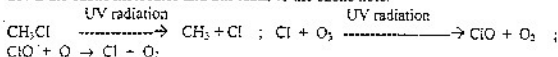
Sample answer

Since CFCs are non-toxic, easily compressed to liquids and unreactive, they became the gas of choice for use in refrigeration and air conditioners; as propellants for spray cans of such chemicals as deodorants and insecticides; as solvents, particularly in dry cleaning; as blowing agents for plastic foams; as fire extinguishers. By the 1980s thousands of tonnes of CFCs were being used every year and because of their volatility, released into the atmosphere.

The problems caused by CFCs relate to ozone depletion and the subsequent thinning of the ozone layer. In 1985 satellite mapping found that the ozone layer in the stratosphere over the South Pole had developed a thinned area, or "hole".

Ozone is important to life on Earth as it absorbs high energy ultra violet (UV) radiation that is damaging to living things.

When the chemically inert CFCs build up in the stratosphere, they are dissociated (broken down) by the UV radiation to produce reactive chlorine radicals. These radicals then break down the ozone molecules and this leads to the ozone hole.



In 1987 worries about environmental damage lead some countries to sign the Montreal Protocol, one article of which was an agreement to reduce emissions of gases that damage the ozone layer. The CFCs can be replaced by less reactive chemicals such as HFCs or hydrofluorocarbons, and other solvents such as water can be used in aerosols. However, third world countries are reluctant to stop using the cheap and readily available CFCs, and the major cheap alternative for a refrigerant is ammonia, a poisonous and corrosive gas.

Option – Industrial Chemistry

Question 28 (25 marks)

(a) (i) (1 mark)

Outcomes Assessed: H6

Targeted Performance Bands: 2-3

Criteria	Mark
Correctly identifies ONE property of sulfur that allows it to be extracted from underground mineral deposits	1

Sample answer

Sulfur has a relatively low melting point (113°C)

(a) (ii) (2 marks)

Outcomes Assessed: H8, H13

Targeted Performance Bands: 3-4

Criteria	Marks
Describes all processes in the extraction of sulfur from underground mineral deposits	2
Describes ONE process in the extraction of sulfur from underground mineral deposits	1

Sample answer

There are three pipes into the sulfur deposit. Superheated water is forced down one pipe, this melts the sulfur and forms a sulfur-water emulsion. Compressed air is forced down another pipe and this in turn forces the sulfur-water emulsion up the third pipe. After cooling, the sulfur is sufficiently insoluble in the water to separate from it.

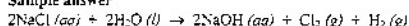
(b) (i) (2 marks)

Outcomes Assessed: H10, H13

Targeted Performance Bands: 3-4

Criteria	Marks
Writes a full formula equation for the production of sodium hydroxide from sodium chloride	2
Equation is balanced and all states included	
Writes a full formula equation for the production of sodium hydroxide from sodium chloride	1

Sample answer



(c) (i) (4 marks)

Outcomes Assessed: H3, H4, H13, H14

Targeted Performance Bands: 2-6

Criteria	Marks
Describes completely the diaphragm process including reactions at the anode and cathode	4
Explains thoroughly why this process is being phased out of industry	
Describes the diaphragm process including reactions at the anode and cathode	3
Explains why this process is being phased out of industry	
Describes completely the diaphragm process including reactions at the anode and cathode	2
OR	
Explains thoroughly why this process is being phased out of industry	
Describes the reaction at the anode or cathode AND describes why this process is being phased out of industry	
Identifies the product at the anode or cathode	1
OR	
Describes why this process is being phased out of industry	

Sample answer

Anode: $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ This has a titanium metal anode to withstand the chlorine that is formed.

Cathode: $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$ This has an iron mesh cathode to withstand the formation of OH^- .

The diaphragm separating the anode from the cathode is made of asbestos. Its purpose is to allow Na^+ to migrate from the anode to the cathode and minimising the migration of Cl^- . This process is being phased out in industry due to health and environmental concerns regarding the use of asbestos. Another reason is the slight contamination of the OH^- with Cl^- .

(c) (ii) (2 marks)

Outcomes Assessed: H12

Targeted Performance Bands: 2-4

Criteria	Marks
Identifies an emulsion that can be made in the school laboratory	2
Outlines the procedure used to make this emulsion	
Identifies an emulsion that can be made in the school laboratory	1
OR	
Defines an emulsion	

Sample answer

French dressing is an emulsion. It is made by adding a very small amount of mustard powder to a small amount of red wine vinegar. Small amounts of olive oil are added to it 'bit by bit' until all of it has been added. The mixture is shaken vigorously then allowed to stand.

(c) (ii) (3 marks)

Outcomes Assessed: H3, H6, H13

Targeted Performance Bands: 3-5

Criteria	Marks
Describes at least TWO properties of the emulsion and relates them to its use	3
Describes ONE property of the emulsion and relates it to its use	2
Identifies at least ONE property of the emulsion	1

Sample answer

French dressing is a water-in-oil emulsion that is used on salads, therefore taste, texture and presentation are important. The production of the emulsion means that there is not a layer of oil "floating" in the dressing, therefore it looks more appetising. The even distribution of oil and red wine vinegar particles means that there is a consistent texture and taste to the dressing – not the individual components of the dressing.

(d) (i) (2 marks)

Outcomes Assessed: H10, H12

Targeted Performance Bands: 2-4

Criteria	Marks
Write a correct expression for the equilibrium constant for the formation of ammonia	2
Writes a generalised expression in terms of products and reactants	1

Sample answer

$$K = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

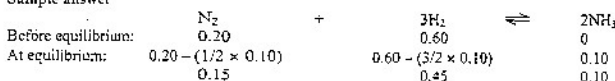
(d) (ii) (3 marks)

Outcomes Assessed: H12, H14

Targeted Performance Bands: 3-6

Criteria	Marks
Calculates value for K correctly, showing all working	3
Calculates equilibrium values for nitrogen and hydrogen using correctly balanced equation	2
OR	
Uses values to substitute into the equation to calculate K	
Correct value for K, without showing working	1
OR	
Writes a balanced equation for Haber process	

Sample answer



$$K = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{[0.10]^2}{[0.15][0.45]^3} = 0.73$$

(e) (6 marks)

Outcomes Assessed: H4, H7, H8, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Discusses at least TWO environmental problems associated with the Solvay process AND • Explains how each environmental problem is being addressed	5-6
• Discusses at least TWO environmental problems associated with the Solvay process OR • Discusses TWO environmental problem associated with the Solvay process AND explains how it is being addressed	3-4
• Identifies TWO environmental problems associated with the Solvay process OR • Describes ONE environmental problem associated with the Solvay process	2
• Identifies ONE environmental problem associated with the Solvay process	1

Sample answer

The Solvay process is very exothermic thus large amounts of heat are produced. Cooling water from local waterways is used to absorb this heat. This heated water must then be disposed but this would increase the temperature of the waterways affecting aquatic life. Thus the water must be stored in cooling ponds or put through heat diffusers before it can be discharged back into the local waterways.

Another problem is the disposal of large quantities of calcium chloride. Some countries use some of it to de-ice roads but this only uses a small proportion of the calcium chloride produced. If the plant is located near the ocean, the calcium chloride is discharged into it, however this is not possible with smaller local waterways since it would increase the Cl^- too much. Some calcium chloride is evaporated and buried but this is very expensive.

Production of calcium hydroxide is another problem. It is neutralised with hydrochloric acid prior to being released into the environment.

Due to these issues alternative processes for the production of Na_2CO_3 are being developed.

Option – Shipwrecks, Corrosion and Conservation

Question 29 (25 marks)

(a) (i) (1 mark)

Outcomes Assessed: H1

Targeted Performance Bands: 2-3

Criteria	Mark
• Correctly identifies – Michael Faraday	1

(a) (ii) (2 marks)

Outcomes Assessed: H1, H8

Targeted Performance Bands: 3-4

Criteria	Marks
• Thorough description of Davy's contribution to our understanding of electron transfer reactions	2
• Identifies ONE of Davy's contribution to our understanding of electron transfer reactions	1

Sample answer

Davy developed the largest battery then built and was the first to use Volta's pile to decompose molten salts by electrolysis to isolate metals such as sodium and potassium.

(b) (i) (2 marks)

Outcomes Assessed: H3

Targeted Performance Bands: 2-3

Criteria	Mark
• Correctly identifies – iron	1

(b) (ii) (1 marks)

Outcomes Assessed: H8, H13

Targeted Performance Bands: 2-4

Criteria	Marks
• Distinguishes between active and passivating metals by comparison of the formation (or not) of an impervious layer	2
• Defines a passivating metal OR an active metal	1

Sample answer

Passivating metals, although reactive, form an impervious layer of the metal oxide which strongly binds to the metal preventing any further reaction between the metal and the oxidising agent. An active metal, on the other hand, does not form an impervious layer and so the oxidising agent continues to react with the metal.

(c) (iii) (3 marks)

Outcomes Assessed: H3, H6, H8, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies ONE type of steel	3
• Explains how the composition of the steel affects its properties and uses	2
• Identifies ONE type of steel AND • Explains how the composition of the steel affects its properties OR describes the properties and uses of the steel	1
• Identifies ONE type of steel	1

Sample answer

Stainless steel contains 10–20% chromium and about 10% nickel, the rest of it is iron. Nickel is relatively inert and improves the corrosion resistance of the steel. It also promotes toughness at low temperatures. Chromium also improves the corrosion resistance of steel and improves the strength of the steel at high temperatures. Its corrosion resistance, makes stainless steel ideal for cutlery and surgical instruments.

(c) (i) (2 marks)

Outcomes Assessed: H7, H8, H12

Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies a factor AND • Outlines the method used to determine how it affects an electrolysis reaction	2
• Identifies a factor that can affect an electrolysis reaction	1

Sample answer

Factor – Nature of the electrolyte.

Inert carbon electrodes were placed into a U-tube filled with copper sulfate. The electrodes were connected to a power pack set at 2 V. A drop of universal indicator is added to both the anode and the cathode. The experiment was repeated with the U-tube filled with sodium sulfate instead of copper sulfate.

(c) (ii) (3 marks)

Outcomes Assessed: H11, H14

Targeted Performance Bands: 3-5

Criteria	Marks
• Justifies why the method outlined in part (c) (i) was used	3
• Explains why at least part of the method was used	2
• Identifies ONE variable that must be controlled	1

Sample answer

To determine the effect of the change in electrolyte on the electrolysis reaction, all other variables must be kept the same. Thus, the concentration and volume of the electrolyte must be kept constant, so too must the types of electrodes, applied voltage and a consistent volume of indicator added to each electrode. The type of electrolyte is the only variable that is changed. The drops of universal indicator are added to each electrode to determine what gases are being evolved at the electrode – if oxygen is being evolved, then so too are H^+ , so the universal turns red. If however, hydrogen is being evolved, so too are OH^- so the universal will turn purple.

(d) (i) (2 marks)

Outcomes Assessed: H8

Targeted Performance Bands: 2-4

Criteria	Marks
• Correctly identifies at least THREE factors	2
• Correctly identifies ONE factor	1

Sample answer

Temperature, pressure, solubility of O_2 , solubility of $NaCl$, increasing abundance of anaerobic bacteria.

(d) (ii) (3 marks)

Outcomes Assessed: H8, H13

Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies a factor • Explains how this factor changes with depth • Explains how this factor affects the corrosion of metal wrecks	3
• Identifies a factor AND explains how this factor changes with depth OR • Identifies a factor AND explains how this factor affects the corrosion of metal wrecks	2
• Describes how a factor identified in (d) (i) changes with depth	1

Sample answer

Although the solubility of O_2 increases with depth since it increases as the temperature decreases, the concentration of O_2 actually decreases with depth. The concentration of O_2 is greatest at the surface since the water is well aerated by the wave action. It is also aided by the presence of many organisms, such as phytoplankton that produce O_2 . There are organisms that respire as well but more O_2 is produced than is used up. As depth increases, however, the sun does not penetrate through the water as well so there are no organisms that can photosynthesise but there are many organisms that respire and so the O_2 concentration decreases. Since it decreases with depth and it is necessary for corrosion, the corrosion rate of metal wrecks should decrease with depth.

(e) (6 marks)

Outcomes Assessed: H3, H7, H8, H12, H13, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies AND evaluates at least THREE ways in which ocean-going vessels may be protected from corrosion	5-6
• Identifies and evaluates TWO ways in which ocean-going vessels may be protected from corrosion OR • Identifies and explains THREE ways in which ocean-going vessels may be protected from corrosion	3-4
• Identifies and describes TWO ways of protecting an ocean-going vessels may be protected from corrosion	2
• Identifies ONE method of protecting an ocean-going vessel from corrosion	1

Sample answer

Several methods are used to protect ocean-going vessels from corrosion. The superstructure is painted so there is a physical barrier between the metal and the oxygen and water to prevent corrosion – this is not very successful, however, since if the paint is scratched then corrosion can continue even under the rest of the painted metal. Another method is to use stainless steel since the chromium and nickel in it prevent corrosion, but this is too expensive so is not used. A more economical and thus acceptable method is to spray the surface of the steel with a thin layer of chromium and nickel, thus creating a stainless steel-like surface at a fraction of the cost. Polymer based paints also form an impervious layer to oxygen and water. The hull of ocean-going vessels are protected by the use of sacrificial anodes such as magnesium or zinc. These are more reactive than iron and so will set up a galvanic cell and react preferentially to the iron. This works very well in sea water where there is a good conducting medium. The zinc and magnesium react slowly enough to be economically viable yet also give good protection to the ship's hull.