CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2005 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY – MARKING GUIDELINES

The sample answers indicate features that should be found in a response that receives full marks. For the extended response questions, a set of guidelines is included rather than a sample answer.

Section I
Part A – 15 marks
Questions 1-15 (1 mark each)

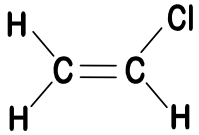
Question	Correct Response	Outcomes Assessed	Targeted Performance Bands
1	C	H9 H13	2-3
2	A	H5	2-3
3	B	H4	2-3
4	D	H11	2-3
5	D	H3, H8	4-5
6	B	H2, H10	3-4
7	C	H2,H3,H8	3-4
8	B	H6, H10	4-5
9	D	H6	3-4
10	B	H2	3-4
11	A	H12	4-5
12	C	H10,H11,H13	4-5
13	A	H10	4-5
14	D	H12,H14	5-6
15	C	H10	5-6

Section I
75 marks

Part B – 60 marks
Question 16
(a) (1 mark)
Outcomes Assessed: H9, H13
Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies structure	1

Sample answer

CH_2CHCl *or* 

(b) (1 mark)
Outcomes Assessed: H9
Targeted Performance Bands: 3-4

Criteria	Mark
• Identifies key features of an addition polymerisation reaction	1

Answer must include
- Breaking of double bonds and monomers join with no loss of atoms

(c) (2 marks)
Outcomes Assessed: H3
Targeted Performance Bands: 2-4

Criteria	Marks
• Explains use in terms of property	2
• Identifies use or property	1

Sample answer
Many possible responses eg PVC is used for raincoats because it is waterproof

Question 17 (2 marks)
Outcomes Assessed: H1, H4
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes production of a transuranic element	2
• Identifies an aspect of production of a transuranic element	1

Sample answer
Elements with an atomic number greater than 92 can be produced in nuclear reactors by bombardment of heavy nuclei such as Uranium with neutrons in a nuclear reactor or subatomic particles/other nuclei in a particle accelerator.

Question 18 (2 marks)
Outcomes Assessed: H1
Targeted Performance Bands: 2-3

Criteria	Marks
• Describes TWO significant uses	2
• Identifies ONE significant use OR • Identifies TWO uses	1

Sample answer
Used in manufacturing explosives for use in bombs and used as a fertilizer for increasing crop yields. Both of these were significant at the beginning of World War I.

Question 19 (5 marks)
Outcomes Assessed: H1, H3, H5
Targeted Performance Bands: 2-6

Criteria	Marks
• Assesses the viability of cellulose products	5
• Outlines the advantages AND disadvantages of cellulose	3-4
• Outlines the advantages OR disadvantages of cellulose	1-2

Sample answer
Cellulose contains the carbon chain structures that are required to make compounds that are presently made from petrochemicals. Cellulose is a major component of biomass and is therefore renewable, so it is a potential alternative. Some problems with the substitution are that the production of cellulose from crops requires significant expense in terms of money and energy and also, dwindling parcels of land will need to be set aside to grow the crops. The chemical processes needed to break down cellulose are currently not commercially viable because of the high energy requirements. If this could be overcome with advances in biotechnology, cellulose will become more important as an alternate in the future.

Question 20

(a) (2 marks)

Outcomes Assessed: H13

Targeted Performance Bands: 2-4

Criteria	Marks
• Constructs sound line graph	2
• Constructs basic graph	1

Sample answer

A sound graph would be an accurate line graph occupying more than 50% of the space available. The mass data should be ignored.

A basic graph could be a line graph not using an appropriate scale or a well constructed column graph.

(b) (3 marks)

Outcomes Assessed: H10, H13

Targeted Performance Bands: 3-5

Criteria	Marks
• Calculates correct response and units • All working shown	3
• All working shown AND • Calculates ΔH/mol without correct units OR • Calculates using correct procedure but makes transcription or calculation error OR • Calculates moles of ethanol AND ΔH	2
• Calculates a matched pair of ΔT and Δm OR • Calculates ΔH OR • Calculate moles of ethanol OR • Identifies correct answer, no working shown	1

Sample answer

$\Delta H = -mc\Delta T = 100 \times 4.18 \times (58 - 24) = -14212$ J

Mass of ethanol used= 228.3 – 226.2 = 2.1g

Moles of ethanol used = 2.1÷46.068 =0.04558 mol

$\Delta H/mol = -14212 \div 0.04558 = -311771$ J = -312 $kJmol^{-1}$

Question 21

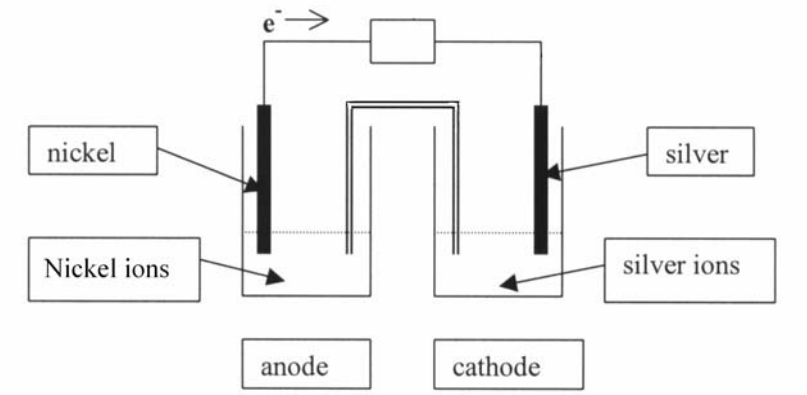
(a) (3 marks)

Outcomes Assessed: H2, H13

Targeted Performance Bands: 2-4

Criteria	Marks
• Represents cell accurately and succinctly in diagrammatic form • Labels anode, cathode and electron flow	3
• Represents cell accurately and succinctly in diagrammatic form and either anode and cathode labeled correctly or electron flow from anode to cathode OR • Represents cell in basic diagram and all labels correct	2
• Represents cell accurately and succinctly in diagrammatic form	1

Sample answer



(b) (2 marks)

Outcomes Assessed: H7, H10, H13

Targeted Performance Bands: 3-5

Criteria	Marks
• Identifies half equations and cell potential	2
• Identifies half equations (as oxidation **or** reduction equations)	1

Sample answer

$Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ $+ 0.24\ V$

$Ag^+(aq) + e^- \rightarrow Ag(s)$ $+ 0.80\ V$

$Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$ $\mathbf{+ 1.04\ V}$

Question 22

(a) (1 mark)

Outcomes Assessed: H2, H13

Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies burette	1

Sample answer

Burette

(b) (1 mark)

Outcomes Assessed: H11, H12

Targeted Performance Bands: 2-3

Criteria	Mark
• Outlines procedure	1

Sample answer

Final rinse in NaOH solution

(c) (1 mark)

Outcomes Assessed: H11

Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies a potential source of error	1

Sample answer

Many possible responses eg End-point difficult to identify against background colour, etc

Question 23
(a) (1 mark)
Outcomes Assessed: H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies scientist by name	1

Sample answer
Many possible answers, but must be a practising Australian scientist

(b) (2 marks)
Outcomes Assessed: H4, H5, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes the work of the scientist	2
• Identifies the branch of chemistry they are working in	1

Sample answer
Many possible answers but must include the areas in which they are currently working and information about their research.

Question 24 (4 marks)
Outcomes Assessed: H2, H8, H14
Targeted Performance Bands: 3-6

Criteria	Marks
• Demonstrates a thorough knowledge of Le Chatelier's principle with regard to the solubility of carbon dioxide in water	4
• Demonstrates a sound knowledge of Le Chatelier's principle • Outline changes in the CO_2/H_2CO_3 equilibrium	2-3
• Identifies Le Chatelier's principle OR • Identifies that at lower temperatures, $[H^+]$ increases	1

Sample answer
The solubility of CO2(g) in water is an equilibrium
$H_2O(l) + CO_2(g) \leftrightarrow 2H^+ + CO_3^{2-}$ ΔH is negative
For this equilibrium, if you increase the temperature then the equilibrium will shift to the LHS reducing the solubility of the carbon dioxide. Since the $CO_2(g)$ when dissolved, reacts with water to produce H^+ ions, the lower the solubility then the higher the pH. Hence, in bottle A at the higher temperature, we would expect a higher pH, indicating less H^+ ions in solution as the solubility of the $CO_2(g)$ is lower than bottle B which is at a lower temperature and hence, would have more $CO_2(g)$ dissolved and hence a lower pH according to Le Chatelier.

Question 25 (4 marks)
Outcomes Assessed: H4, H8, H13
Targeted Performance Bands: 4-6

Criteria	Marks
• Demonstrates a thorough knowledge of the action of buffers including equations	3-4
• Describes the action of buffers without equations	2
• Identifies that the pairs of chemicals are buffers or acid/conjugate base pairs	1

Sample answer
Pairs of chemicals, like $H_2PO_4^{1-}$ and HPO_4^{2-} act as buffers. Buffers maintain a constant pH when small amounts of acids or bases are added. This is important as many chemical processes in the body require a constant pH environment to function properly. The acid part of the pair reacts with any base to remove it while the conjugate base reacts with any acid that is added

$H_2PO_4^{1-} + OH^{1-} \leftrightarrow HPO_4^{2-} + H_2O(l)$
$HPO_4^{2-} + H_3O^+ \leftrightarrow H_2PO_4^{1-} + H_2O(l)$

Thus the pH is maintained as the products are much weaker acids or bases.

Question 26

(a) (4 marks)

Outcomes Assessed: H8, H11, H13

Targeted Performance Bands: 2-5

Criteria	Marks
• Thorough understanding of the relationship between properties and use • Constructs appropriate equation	3-4
• Relates TWO properties of the chemical to its use	2
• Relates ONE property of the chemical to its use	1

Sample answer

Sodium hydrogen carbonate is a solid, weak base. A solid is useful for an acid spill as it can absorb the solution rather than cause it to spread. A base is used as the spill is an acid and we want to neutralize it. A weak base reacts more slowly and releases the heat of neutralization more slowly and hence, reduces spitting and further damage due to the energy released. If excess base is added also, being weak, it does not cause a further problem.

$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O_{(l)} + 2CO_{2(g}$

(b) (3 marks)

Outcomes Assessed: H8, H10, H13

Targeted Performance Bands: 4-6

Criteria	Marks
• Calculates correct answer with appropriate significant figures	3
• Correct answer but no working OR • Correct answer with excess significant figures OR • Calculate mass using incorrect mole ratio	2
• Calculates mole ratio OR • Calculates moles of H_2SO_4	1

Sample answer

$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O_{(l)} + 2CO_{2(g)}$

$\frac{\text{Moles } NaHCO_3}{\text{Moles } H_2SO_4} = \frac{2}{1}$ Moles $H_2SO_4 = 18 \times 500 \div 1000$

$= 9$

$\frac{\text{Moles } NaHCO_3}{9} = \frac{2}{1}$

$\text{Moles } NaHCO_3 = 18 = \frac{\text{mass}}{22.99 + 1.008 + 12.01 + 16 \times 3}$

Mass = 1512g

= 1500g or 1.5 Kg

Question 27

(a) (1 mark)

Outcomes Assessed: H4, H9

Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies molecule	1

Sample answer

Pentyl ethanoate

(b) (2 marks)

Outcomes Assessed: H4, H9, H11, H12

Targeted Performance Bands: 3-4

Criteria	Marks
• Demonstrates a thorough knowledge of esterification in a laboratory	2
• Demonstrates a basic knowledge of esterification in a laboratory	1

Sample answer

Into a round bottom flask, place some boiling chips and 20 mL of 1-pentanol and 10 mL of acetic (ethanoic) acid and a few drops of concentrated sulfuric acid. Attach a reflux condenser and heat the mixture, under reflux, using a waterbath for 1 hour.

Question 28

(a) (1 mark)

Outcomes Assessed: H4

Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies a catchment	1

Sample answer

Various answers eg Warragamba catchment - lower Blue Mountains

(b) (2 marks)

Outcomes Assessed: H12

Targeted Performance Bands: 2-5

Criteria	Marks
• Identifies contaminant • Sound outline of a test	2
• Basic outline of a water test	1

Sample answer

Various responses possible, but test must match the identified contaminant. For example, a BOD test measures levels of oxidisable organic wastes such as sewage. A water sample is collected in a Winkler jar and the DO is measured using an oxygen probe. The sample is kept in a dark place for 5 days and the DO re-measured. The BOD_5 is the difference in the readings.

(c) (3 marks)

Outcomes Assessed: H4, H8

Targeted Performance Bands: 2-5

Criteria	Marks
• Thorough description of methods for purifying and sanitizing drinking water	3
• Sound description of methods for purifying or sanitizing drinking water	2
• Limited description of purifying or sanitizing drinking water	1

Sample answer

Various responses depending on catchment but likely to include sedimentation, filtering using a gravel filter, treatment with a floc such as $FeCl_3$/NaOH, chlorine and ammonia (sanitizing), fluoride(sanitizing) and NaOH(pH balance).

Question 29 (7 marks)
Outcomes Assessed: H1, H4, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Extensive evaluation of the effectiveness, justifying position by citing data. • Discusses the Montreal Protocol and evaluates the use of HCFCs and HFCs • Discusses difficulties in monitoring ozone levels and natural variations in ozone levels	7
• Sound evaluation of effectiveness and justifies by citing evidence from data • Describes the Montreal Protocol and amendments	5-6
• Outlines advantages and disadvantages of steps taken • Relates reduction in use of CFCs to reduction in ozone depletion • Identifies the replacement gases being used • Identifies that a treaty exists between major users of CFCs	3-4
• Identifies an advantage or disadvantage of steps taken • Identifies that use of CFCs has decreased	1-2

Sample answer
Variety of responses possible.

INDUSTRIAL CHEMISTRY

Question 30 (25 marks)
(a) (i) (1 mark)
Outcomes Assessed: H8
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
Temperature.

(a) (ii) (2 marks)
Outcomes Assessed: H2, H8
Targeted Performance Bands: 3-4

Criteria	Marks
• Compares the equilibria	2
• Identifies the change in one of the equilibria	1

Sample answer
An increase in pressure will force the oxidation of ammonia to the left but it would have no effect on the formation of hydrogen iodide.

(b) (i) (1 mark)
Outcomes Assessed: H8, H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
Sodium carbonate

(b) (ii) (3 marks)
Outcomes Assessed: H2, H8, H13
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains the chemistry using equations	3
• Outlines the chemical change	2
• Identifies a chemical process	1

Sample answer
Many possible responses. e.g. in the recovery tower, the ammonia is recovered from the ammonium chloride solution by heating it with lime. The purpose of this stage is to re-use the ammonia in the Solvay tower. Calcium chloride is a waste product that is used as a dehydrating agent.
The reactions are
$CaO(s) + H_2O(l) \leftarrow> Ca^{2+}(aq) + 2OH^-(aq)$
$NH_4^+(aq) + Ca^{2+}(aq) + 2OH^-(aq) \leftarrow> CaCl_2(s) + NH_3(g) + H_2O(l)$

(c) (5 marks)
Outcomes Assessed: H2, H4, H6, H7, H14
Targeted Performance Bands: 2-5

Criteria	Marks
• Analyses extraction and manufacturing processes • Explains at least TWO steps	5
• Describes extraction and manufacturing processes • Explains at least ONE step	3-4
• Outlines extraction or manufacturing processes	1-2

Sample answer
A high level response will outline each of the steps in the extraction and manufacturing and the relationships between each process and the chemical properties. Equations are not required but may provide evidence of a higher level response. Typically the following ideas would be included.

- An explanation of the Frasch process in terms of the melting point of sulfur and the combustion of sulfur to sulfur dioxide OR a description of the production of sulfur dioxide from metal ore smelting processes
- The proximity of the plant to the raw materials, energy supplies and transport
- The production of sulfur trioxide, including a description of the catalyst, temperature and pressure required, relating this to the equilibrium involved
- The conversion of sulfur trioxide to oleum and then dilution to acid, identifying that the heat released can be reused in the catalytic converter

(d) (i) (3 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes a relevant first hand investigation	3
• Outlines a relevant first hand investigation	2
• Demonstrates a limited knowledge of a relevant procedure	1

Sample answer
10 mL of olive oil, 15 g of NaOH and 20 mL of water were combined in a flask and heated under reflux until the oil layer disappeared. The mixture was poured into cold brine and filtered in a Buchner funnel. The residue (soap) was washed with cold water. The soap was tested by taking two identical test-filled with 10mL of water and two drops of oil. A piece of the soap was added to one test tube and both were shaken. They were compared visually.

(d) (ii) (3 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Justifies qualitative observations	2-3
• Outlines observations/results	1

Sample answer
Qualitative observations such as the disappearance of the oil layer were used to identify that the saponification reaction had occurred. This is appropriate because the oil is used up in the saponification reaction. Qualitative observations were appropriate also for the testing of the product as the lathering properties of the soap could be easily identified visually. The mixing of the oil and water indicated that the white solid was acting as an emulsifier.

(e) (7 marks)
Outcomes Assessed: H1, H3, H4, H13, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Extensive knowledge of THREE technologies • Sound knowledge of the differences between the technology in terms of environmental impact • Makes a sound assessment	6-7
• Thorough knowledge of TWO technologies • Sound knowledge of the differences between the technology in terms of environmental impact	4-5
• Outlines the environmental impact of ONE technology	2-3
• Identifies a technology or an environmental impact	1

Sample answer
A high level response will describe and compare the environmental difficulties associated with the mercury process, the diaphragm process and the membrane process, an assessment of the relative hazards associated with each method and an overall assessment of the changes that have occurred as a result of moving from the mercury through to the membrane process. Equations are not required but may provide evidence of a higher level response.

SHIPWRECKS, CORROSION AND CONSERVATION

Question 31 (25 marks)
(a) (i) (1 mark)
Outcomes Assessed: H1
Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies Davy or Faraday	1

(a) (ii) (2 marks)
Outcomes Assessed: H2, H8
Targeted Performance Bands: 3-4

Criteria	Marks
• Compares the TWO theories	2
• Outlines Galvani's OR Volta's theory	1

Sample answer
Galvani's theory attributed the production of the electricity to the fluid in the muscles and nerves ie the electrolyte whereas Volta showed that it was that the wires, being of two different metals which caused the electricity noted by Galvani in his experiments.

(b) (i) (1 mark)
Outcomes Assessed: H8
Targeted Performance Bands: 2-3

Criteria	Mark
• Identifies ONE factor that affects the rate of corrosion of metals	1

Sample answer
Various responses eg low oxygen

(b) (ii) (3 marks)
Outcomes Assessed: H2, H8, H13
Targeted Performance Bands: 3-5

Criteria	Marks
• Thorough explanation of the chemistry using balanced equations	3
• Sound explanation, attempting equations	2
• Limited explanation	1

Sample answer
At great depth, the oxygen concentration is virtually zero. Normal corrosion of metals like iron relies on the cathode (Reduction) reaction: $O_2(g) + 2H_2O(l) + 4e^- \leftrightarrow 4OH^{1-}$. If you decrease the oxygen concentration, the equilibrium will shift to the LHS (Le Chatelier's Principle) causing a decrease in the reduction reaction and a corresponding decrease in the oxidation/corrosion of the metal.

(c) (5 marks)

Outcomes Assessed: H2, H6, H8, H13, H14

Targeted Performance Bands: 2-5

Criteria	Marks
• Demonstrates a thorough knowledge of the factors that affect electrolysis • Relates the conditions of a particular electrolysis process to maximizing yield OR rate of electrolysis	4-5
• Demonstrates a sound knowledge of the factors that affect electrolysis OR • Describes an electrolysis process used in restoration	2-3
• Identifies a factor that affects an electrolysis reaction	1

Sample answer

In the cleaning and stabilizing of lead, iron and copper artifacts the artifact is always placed at the cathode. This is done because it is the electrode at which reduction occurs.

eg $Pb^{2+} + 2e^- \rightarrow Pb_{(s)}$

The metal ion is reduced so that the corrosion product is removed e.g. PbS etc. The other electrode is usually an inert stainless steel mesh. It needs to be inert to prevent oxidation/other reactions and a mesh to increase surface area and contact with the electrolyte to increase the rate of electrolysis which makes the process more efficient.

At the anode $4OH^{1-} \rightarrow O_2 + 4H^+ + 4e^-$.

The OH^{1-} ions the electrolyte is chosen as if H^+ ions were left in the metal thus would accelerate corrosion. A high current density but low voltage is used. This accelerates the rate of reaction (high current) but a low voltage prevents unwanted side reactions. These conditions are manipulated to promote the required reactions and minimize other reactions. The rate of the required reaction is also maximized by adjusting concentration of the electrolyte, surface area of electrodes

(d) (i) (2 marks)

Outcomes Assessed: H11, H12

Targeted Performance Bands: 2-3

Criteria	Marks
• Outlines a relevant first hand investigation	2
• Demonstrates a limited knowledge of a relevant procedure	1

Sample answer

1. Obtain a 1 mol L^{-1} solution of NaCl and a 2 mol L^{-1} solution of NaCl
2. Set up two sets of 3 test tubes in a rack
3. Into each of the two sets of 3 test tubes, place a previously weighed strip of the following materials – mild steel, magnesium, brass
4. For 1 set of materials add 10 mL of 1 mol L^{-1} NaCl solution. Into the other set add 10 mL of 2 mol L^{-1} NaCl
5. Leave for 5 days
6. Clean off any corrosion product from the strips. Dry in an oven. Reweigh

(d) (ii) (4 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Sound justification of at least THREE steps in the procedure	3-4
• Limited justification of ONE-TWO steps in the procedure	1-2

Sample answer
The materials were left for 5 days as corrosion is a slow reaction. The corrosion can be measured by mass loss of the metal. The metals needed to be cleaned because the corrosion products had different properties. The magnesium product is soluble so it will get lighter, but the iron and copper products are much less soluble, so they will gain mass. The drying is required to reduce errors.

(e) (7 marks)
Outcomes Assessed: H1, H3, H4, H13, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Demonstrates a thorough knowledge of at least TWO corrosion protection systems • Relates it to the materials used in shipbuilding in the 20th Century • Assesses how the development of these systems influenced the choice of materials for shipbuilding	6-7
• Demonstrates a thorough knowledge of at least two corrosion protection systems • Relates it to a metal or alloy	4-5
• Demonstrates a sound knowledge of one corrosion protection system	2-3
• Identifies a method of corrosion protection OR • Identifies a metal or alloy used in shipbuilding	1

Sample answer
In the 19th Century, ships that were made of iron were made of wrought or cast iron. These plates were hard and thick but relatively corrosion resistant due to the very low carbon content. Mild steel is used when steel needs to be shaped as in the production of strong steel hulls. It contains less than 0.2% C and is soft and malleable but it corrodes rapidly unless protected. The development of corrosion protection systems enabled shipbuilders to choose a material with superior physical properties eg easily shaped, malleable yet with sufficient strength to allow thinner plates (lighter and more cost effective, also more fuel efficient). The higher susceptibility to corrosion being mitigated by the advances made in corrosion protection. The mild steel could be protected using cathodic protection. This involves attaching a more reactive metal block eg zinc to the hull. As the more reactive metal, zinc, corrodes it releases electrons into the steel hull which becomes the cathode and is protected.

Another method of cathodic protection is the use of impressed currents. The steel hull is connected to a direct current and electrons are constantly pumped into it making it a cathode. This method, however, needs to be incorporated in the design stage if it is to work effectively.

The simplest system of corrosion protection is the coating of the metal surface eg the use of paints, resins etc. These are cheap but are only effective if the coating is intact.

Later in the 20th Century, aluminium/aluminium alloys were used in ship construction. Aluminium was more corrosion resistant but did not have the strength/toughness of the steel. To improve its strength Al is alloyed but the alloys are less corrosion resistant and are more reactive eg combust more easily than steel.

Therefore, metals and alloys with superior mechanical properties for use in shipbuilding could be used because the problem of their increased corrosion potential could be minimized due to the developments in corrosion protection technology.

BIOCHEMISTRY

Question 32 (25 marks)
(a) (i) (1 mark)
Outcomes Assessed: H4
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
A source of energy for the reactions in cells.

(a) (ii) (2 marks)
Outcomes Assessed: H13
Targeted Performance Bands: 3-4

Criteria	Marks
• Compares ADP and ATP	2
• Identifies the structure of ADP or ATP	1

Sample answer
ADP is composed of a nitrogen bases (adenine) a ribose sugar and two phosphate groups.
ATP has a similar structure with an extra phosphate group connected by a phosphodiester bond.

(b) (i) (1 mark)
Outcomes Assessed: H2, H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
TCA cycle (Krebs cycle or citric acid cycle also acceptable)

(b) (ii) (3 marks)
Outcomes Assessed: H6, H7, H9
Targeted Performance Bands: 3-5

Criteria	Marks
• Thorough explanation including equation	3
• Sound explanation	2
• Limited explanation	1

Sample answer
The TCA cycle is important as a source of energy. It uses the acetyl group from glycolysis to produce energy in the form of ATP, NADH and $FADH_2$. This occurs through a series of oxidation and reduction reactions involving various carboxylic acids. The net yield is equivalent to 24 ATP molecules.

Acetyl CoA + ADP + Pi + $3NAD^+$ + FAD → $2CO_2$ + CoA +ATP + 3NADH + $FADH_2$ + $3H^+$ + H_2O.

(c) (5 marks)

Outcomes Assessed: H4, H8, H14

Targeted Performance Bands: 2-5

Criteria	Marks
• Analyses the effects of changes in pH and temperature on enzyme activity	5
• Analyses the effects of changes in pH **or** temperature on enzyme activity OR • Describe the effects of changes in pH and temperature on enzyme activity	3-4
• Outline the effects of changes in pH or temperature on enzyme activity	1-2

Sample answer

Enzymes are proteins that act as biological catalysts For an enzyme to work effectively it must have a specific shape/ structure at it active site. Changes in temperature and pH can denature the enzyme by altering bonding in the secondary, tertiary and quaternary structure. For this reason, enzymes are effective only in a limited temperature and pH range. Excess temperature can cause unfolding of the proteins, while change in pH affects the strength of peptide linkages.

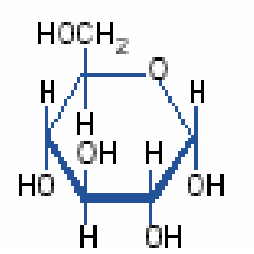
(d) (i) (1 mark)

Outcomes Assessed: H13

Targeted Performance Bands: 3-4

Criteria	Mark
• Represents glucose accurately	1

Sample answer



(d) (ii) (3 marks)

Outcomes Assessed: H11, H12

Targeted Performance Bands: 2-3

Criteria	Marks
• Describes a relevant first hand investigation	3
• Outlines a relevant first hand investigation	2
• Demonstrates a limited knowledge of a relevant procedure	1

Sample answer

Lego bricks were used to represent glucose molecules. Glycogen was modeled by joining the bricks with a small overlap to make a long chain. Every three units in the long chain, a side chain was introduced.

(d) (iii) (2 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Sound justification	2
• Limited justification	1

Sample answer
A molecular model kit was not used because of the complexity of the model. A Lego brick was appropriate because the glucose units that make up glycogen are identical. The overlapping indicated that a part of the molecule had been eliminated in forming the glycosidic links. The bricks were also suitable because they allowed side branches to be added easily. It allowed us to easily compare features such as strength, solubility and density.

(e) (7 marks)
Outcomes Assessed: H1, H4, H8, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Extensive knowledge of the biochemical processes that occur in the muscles of a sprinter • Describes the impact of these discoveries • Makes a sound assessment of the impact	6-7
• Thorough knowledge of the biochemical processes that occur in the muscles of a sprinter • Describes the impact of these discoveries or makes a basic assessment	4-5
• Sound knowledge of the biochemical processes that occur in the muscles of a sprinter OR • Describes the impact of these discoveries and makes a limited assessment	2-3
• Identifies a biochemical process in the muscles of a sprinter OR • Identifies an impact	1

Sample answer
A high level response will include

- a description of fast-twitch muscle cells
- a comparison of the needs of cells aerobically and anaerobically
- a chemical understanding of anaerobic respiration
- a description of the effects of lactic acid build-upon muscle cells
- a description of the impact of this knowledge on diet and training
- an assessment that training methods have improved as a result of this chemical knowledge

Equations and systematic names are not required but may be used as an indicator of extensive knowledge.

CHEMISTRY OF ART

Question 33 (25 marks)
(a) (i) (1 mark)
Outcomes Assessed: H2
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
Many responses e.g. H_2O.

(a) (ii) (1 mark)
Outcomes Assessed: H3, H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Correctly identifies the colour	1

Sample answer
The pale blue copper solution turns a deep blue

(a) (iii) (1 mark)
Outcomes Assessed: H13
Targeted Performance Bands: 3-4

Criteria	Mark
• Correctly identifies the colour	1

Sample answer
$Cu^{2+} + 4\ NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$

(b) (i) (1 mark)
Outcomes Assessed: H6, H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
Vanadium

(b) (ii) (3 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Correctly identifies TWO possible states • Accounts for the differences in these specific species	3
• Identifies TWO possible states • Accounts for multiple oxidation states in general terms	2
• Identifies TWO possible states	1

Sample answer
Vanadium can have a variety of oxidation states. The most common of these is the +2 state common to many transition elements. This is because the element can attain stability through the loss of the two electrons from the 4s shell. The maximum oxidation state of Vanadium is +5. This is because the element achieves stability through the loss of electrons from both the 4s and 3d shells.

(c) (5 marks)
Outcomes Assessed: H1, H2, H6, H7, H14
Targeted Performance Bands: 2-5

Criteria	Marks
• Analyses the position of Mn in terms of ionisation energy, electronegativity and electronic configuration	5
• Relates the position of Mn in terms of TWO of the following: ionisation energy or electronegativity or electronic configuration	3-4
• Relates the position of Mn to ionisation energy OR electronegativity OR electronic configuration	1-2

Sample answer
Manganese (element 25) has an electronic configuration of [Ar],$3d^5$,$4s^2$ is located in the fourth period of the periodic table. It is in the fourth period because its outer electrons are in the fourth shell. It is in the d-block (in the first row of transition elements). It is placed in this block because it has a partially filled 3d orbital.

It has a first ionisation energy that is much higher than chromium (24). This is because it has one electron in each of its d-subshells, giving it some stability. It has a lower ionisation than iron (26) because the greater the nuclear charge, the harder it is to remove the electrons. Likewise its electronegativity is greater than chromium and less than iron. For these reasons, Manganese is best placed in between chromium and iron.

(d) (i) (3 marks)

Outcomes Assessed: H11, H12

Targeted Performance Bands: 2-3

Criteria	Marks
• Describes a relevant first hand investigation	3
• Outlines a relevant first hand investigation	2
• Demonstrates a limited knowledge of a relevant procedure	1

Sample answer

1. A potassium permanganate solution was divided among 4 test tubes in the fume cupboard.
2. Sodium hydroxide solution was added to test tube 1
3. Dilute sulfuric acid was added to test tube 2.
4. Sodium hydrogen sulfite was added to test tubes 1, 2 and 3 while stirring.
5. Test tube 4 was left for comparison.

(d) (ii) (3 marks)

Outcomes Assessed: H11, H12

Targeted Performance Bands: 3-5

Criteria	Marks
• Justifies each chemical	3
• Basic justification	1-2

Sample answer

Potassium permanganate was used because it represents manganese in its highest oxidation state +7(violet).

Hydrogen sulfite is a reducing agent that will reduce Mn^{7+} to (green) Mn^{6+} under basic conditions, (black) Mn^{4+} under neutral conditions and (colourless)Mn^{2+} under acidic conditions. The sodium hydroxide and sulfuric acid were used to alter the pH. The colours of the various states are distinctive and easy to see.

(e) (7 marks)

Outcomes Assessed: H11, H3, H4, H6, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Sound knowledge of the range of pigments used throughout history • Extensive knowledge of how technology has increased our understanding • Makes a sound assessment of the impact	6-7
• Sound knowledge of the range of pigments used throughout history • Thorough knowledge of how technology has increased our understanding	4-5
• Sound knowledge of the range of pigments used throughout history • Limited knowledge of technology	2-3
• Identifies a range of pigments used OR • Identifies a technology	1

Sample answer

A high level response will

- describe a range of technologies including absorption and reflectance spectroscopy
- discuss the type of data these technologies can obtain including the uses and limitations of that data
- describe a range of pigments used throughout history
- make an assessment

FORENSIC CHEMISTRY

Question 34 (25 marks)
(a) (i) (1 mark)
Outcomes Assessed: H4
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
$C_x(H_2O)_y$

(a) (ii) (2 marks)
Outcomes Assessed: H9, H13
Targeted Performance Bands: 3-4

Criteria	Marks
• Compares (identifies similarities and differences) between plants and animals	2
• Outlines the carbohydrates in plants or animals	1

Sample answer
Similarity: Plants and animals both use simple sugars such as glucose in respiration.
Difference: Plants use cellulose as a structural component and animals do not use carbohydrates for this purpose
Plants use starch for carbohydrate storage and animals use glycogen.

(b) (i) (1 mark)
Outcomes Assessed: H2, H12
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response	1

Sample answer
Sugar, phosphate, base

(b) (ii) (3 marks)
Outcomes Assessed: H1, H2, H4
Targeted Performance Bands: 3-4

Criteria	Marks
• Thorough explanation	3
• Sound explanation	2
• Limited explanation	1

Sample answer
DNA fingerprinting can be used to establish relationships between people because close relatives have more similarity in their DNA than complete strangers. The DNA is extracted from tissue samples, extracted and cut into fragments using a restriction enzyme. The sample is separated using electrophoresis to establish a band pattern of the different bases. The patterns can then be compared to establish similarities and differences.

(c) (5 marks)
Outcomes Assessed: H1, H2, H6, H12, H14
Targeted Performance Bands: 3-5

Criteria	Marks
• Thorough analysis of emission spectroscopy • Outlines the first hand-investigation	5
• Sound explanation of emission spectroscopy • Identifies the investigation	3-4
• Outlines the first hand investigation OR • Describes emission spectroscopy	1-2

Sample answer
In the school laboratory we sprayed vapours of compounds of various elements into a flame. Elements produced distinctive colours that we attempted to analyse using a hand-held spectroscope. Bright emission lines were visible but they are more accurately analysed with modern equipment such as an emission spectrometer. The emission lines are produced when atoms absorb energy in the flame, promoting electrons to a higher orbital (energy state). When the electron returns to a lower energy state, a quantum of light is emitted. The wavelength corresponds to the change in energy of the electron. Since each element possesses its own unique arrangement of electrons, it will also produce its own unique pattern of emission lines. By comparing a sample with the spectra of known elements, the presence of an element can be identified.

(d) (i) (3 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 2-3

Criteria	Marks
• Describes a relevant first hand investigation	3
• Outlines a relevant first hand investigation	2
• Demonstrates a limited knowledge of a relevant procedure	1

Sample answer
1. A line was marked 2cm from the bottom of three pieces of chromatography paper.
2. Each paper was "spotted" with an organic dye using a capillary tube
3. Each paper was suspended from a string into separate beakers each containing a different solvent to a depth of 1 cm.
4. The solvents used were water, ethanol and acetone.
5. The papers were left for 20 minutes and the distance of each solvent front was measured.
6. The distance traveled by the different components was measured in each beaker and an Rf value calculated for each component in each solvent.

(d) (ii) (3 marks)
Outcomes Assessed: H12, H13
Targeted Performance Bands: 2-4

Criteria	Marks
• Justifies choice of solvent(s)	3
• Outlines role of solvent(s)	2
• Identifies a property of the solvent(s)	1

Sample answer
The role of the solvent is to dissolve the components of the dye and transport them along the chromatography paper. The more soluble the component, the further it will travel. Three different solvents were used because it allowed for the separation of the most components. Polar components will have high Rf values in water, moderate Rf values in ethanol and low Rf values in acetone. Partially polar components will have low Rf values in water, high Rf values in ethanol and low Rf values in acetone. Non-Polar components will have low Rf values in water, moderate Rf values in ethanol and high Rf values in acetone.

(e) (7 marks)
Outcomes Assessed: H1, H2, H4, H5, H8, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Extensive knowledge of uses of at least THREE technologies in forensic investigations • Makes a sound assessment of the impact	6-7
• Thorough knowledge of uses of TWO technologies in forensic investigations • Makes a basic assessment of the impact	4-5
• Sound knowledge of uses of ONE technology in forensic investigations OR • Basic knowledge of the uses of TWO technologies AND makes a limited assessment	2-3
• Basic knowledge of uses of ONE technology in forensic investigations OR • Limited knowledge of the uses of ONE technology AND makes a limited assessment	1

Sample answer
A high level response will typically contain:

- a description of at least three technologies such as GLC, HPLC, Emission Spectroscopy, Electrophoresis, etc
- examples of applications of the technology in forensic investigations
- a discussion of the advantages/limitations of the technology
- an assessment of the impact of the technology