CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2001 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY MARKING GUIDELINES

Section I
Part A
Questions 1 – 15

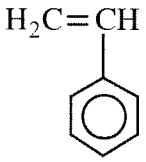
1 Mark Each

1. C	2. A	3. D	4. B	5. D	6. C	7. D	8. B
9. A	10. D	11. D	12. B	13. A	14. A	15. B	

Section I
Part B
Questions 16 – 28

Question 16
Outcomes assessed: H.9; H.9; H.8, H.9, H.13

(a) (i) **1 mark**



Accept:

- benzene ring with alternating single and double bonds
- C_6H_5 for the phenyl group
- no double bond shown eg $CH_2CHC_6H_5$

(ii) phenylethene **1 mark**

(b) Student could take many approaches, but remember question is only worth **1 mark**. So an answer indicating student appreciates that the molecules combine with each other to form the polymer *without formation of any other substance* should score the mark. Diagram/structural formulas showing the formation of even a dimer from addition of appropriate monomers should also score the mark.

Question 17
Outcomes assessed: H.5; H.5; H.9; H.8, H.9;

(a) **1 mark** for eg crude oil from the ground is a non-renewable resource

(b) **1 mark** for eg
- cellulose contains a large proportion of carbon and hydrogen
- cellulose is made by plants and is therefore a renewable resource

(c) Student could take many approaches, but remember question is only worth **1 mark**. So an answer indicating student appreciates that the molecules combine with each other to form the polymer *and also a small molecule (eg water) eliminated by the reaction* should score the mark. Diagram/structural formulas showing the formation of even a dimer from condensation of appropriate monomers *and of the small molecule also formed* should score the mark too.

Question 18
Outcomes assessed: H.8; H.9; H.8, H.13; H.8, H.9, H.13

(a) (i) Carbon dioxide/CO_2 **1 mark**

(ii) Sulphuric acid **1 mark**

(b) Advantage: eg
- can be produced very cheaply
- can be produced from sugar, a renewable resource

OR Disadvantage: eg
- growing a sugar for its production takes arable land that could be used for food
- its combustion produces greenhouse gases **1 mark**

Question 19
Outcomes assessed: H.10; H.12

(a) The 6 marks are allocated to various points of the calculation. One way of doing this is:

Temperature rise $\Delta T = 31 - 15 = 16$ °C **1 mark**
$\Delta H = -\text{m C}\Delta T = -250 \times 4.18 \times 16 = -16720$ J (**1 mark** for quoting formula, or using it implicitly, **1 mark** for correct substitution and calculation; total **2 marks**). For minus sign, see below.
molar mass ethanol $= 2 \times 12.01 + 6 \times 1.008 + 1 \times 16 = 46.07$ g **1 mark**
mol ethanol burned $= 0.90/46.07 = 0.0195$ mol **1 mark**
$\therefore\ \Delta H = -16720/0.0195 = -856$ kJ mol^{-1} **1 mark**
The sixth mark is given to showing the minus sign for ΔH, at least in the final answer.

You may wish to alter this marking scheme—eg, you may consider the minus sign for ΔH pedantic in this context (although the hint is given in (b)). You could give the sixth mark for correct units throughout, or correct significant figures at the end, and so on.

(b) One of several possibilities can score the **1 mark**; eg

- no account is taken of heat absorbed by the beaker
- no account is taken of heat losses into the air
- there may be heat losses from the water surface during the heating

Question 20
Outcomes assessed: H.7, H.8; H.10, H.13

(a) Some possible answers for **1 mark**:

- corrosion of Mg electrode
- Mg electrode loses mass/becomes smaller
- Cu electrode gets larger/increases in mass
- conducting wire becomes warm

(b) In calculation proper, **1 mark** for choosing correct values from table, **1 mark** for adding them to a correct result; viz
$E_{cell} = +2.36 + 0.35 = +2.61$ V (no need for + in final value) (**1 mark** for correct unit)

Question 21
Outcomes assessed: H.9; H.8, H.13

(a) ethyl propanoate (**1 mark**)

(b) **1 mark** for each of two reasons. Some possibilities are—

- heating can be prolonged as reactants/products do not boil away
- noxious vapors do not escape
- flammable vapors do not escape

Question 22
Outcomes assessed: H.8, H.13, H.14; H.6, H.9, H.13; H.10

(a) This answer calls for a verbal statement of the data, so eg, carbon dioxide is less soluble at higher temperatures. **1 mark**

(b) Notice "*a* reversible reaction" in the question. There are distinct equilibriums here eg

$CO_2(g) \rightleftharpoons CO_2(aq)$

$CO_2(aq) + H_2O(l) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$

1 mark for a valid relevant equation, **1 mark** for states given

(c) The 4 marks are allocated to various points of the calculation. One way of doing this is:

molar mass of $CaCO_3 = 40.08 + 12.01 + 3 \times 16 = 100.09$ g **1 mark**

moles of $CaCO_3 = 0.50/100.09 = 0.0050$ mol **1 mark**

$\therefore$ moles of $CO_2 = 0.0050$ mol **1 mark**

$\therefore$ volume of $CO_2 = 0.0050 \times 24.47 = 0.12$ L **1 mark**

Question 23

Outcomes assessed: H.13; H.13; H.10; H.8, H.13

(a) (i) Several answers are possible for **1 mark**:

- reaction with water produces hydroxide ions
- ammonia is acting as a proton acceptor
- ammonia is acting as an electron-pair donor

(ii) **1 mark** for an answer showing appreciation of ionization reaction reaching equilibrium rather than going to completion.

(b) $[H^+] = 10^{-8.50} = 3.2 \times 10^{-9}$ mol L^{-1} **1 mark**

(c) H_2O **1 mark**

Question 24

Outcomes assessed: H.10; H.4, H.8, H.13

(a) The **3 marks** are allocated to various points of the calculation. One way of doing this is:

mol sulphuric acid used $= 30.0 \times 10^{-3} \times 0.300 = 9.0 \times 10^{-3}$ mol **1 mark**

$\therefore$ mol NaOH needed $= 2 \times 9.0 \times 10^{-3} = 1.8 \times 10^{-2}$ mol **1 mark**

$\therefore$ concentration of NaOH $= 1.8 \times 10^{-2}$ mol$/25.0 \times 10^{-3}$ L $= 0.72$ mol L^{-1} **1 mark**

(b) Total **3 marks**

A description indicating that student knows some of the apparatus, and at least one point of technique—**1 mark**

A fuller description, from pipetting solution into titration flask, running reacting solution in from burette until indicator shows endpoint—**2 marks**

A **3 mark** answer would enlarge on the 2-marker, showing understanding of, for example, how better accuracy is achieved. This might be done by eg

- mentioning how to avoid parallax error
- how to allow the pipette to drain
- stating how glassware is cleaned

Question 25

Outcomes assessed: H.8; H.8, H.12; H.13

(a) Either ionic, net ionic, or "full formula" equation, and balanced **1 mark**

States included: *(s)* must be given for AgCl precipitate. No need to give state explicitly if *(aq)*. **1 mark**
Some possible equations:
$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
$AgNO_3 + NaCl \rightarrow AgCl(s) + NaNO_3$

(b) Student must convey at least that there is a chemical reaction between the acid and the carbonate ions. **1 mark**

(c) Student describes how the test should be carried out **1 mark**
Student states the result of a positive test **1 mark**

Question 26
Outcomes assessed: H.3; H.3; H.7; H.8; H.8, H.10, H.13

(a) Any industrial use eg manufacture of fertilizers/nitric acid/explosives **1 mark**

(b) Any Haber catalyst eg iron oxide **1 mark**

(c) (i) A Le Chatelier explanation is required (but no need to explicitly state the Principle). Only **1 mark** for this answer, so pay a very "bare-bones" answer such as: As temperature falls, the reaction compensates by shifting in exothermic direction.

(ii) An explanation that lowering temperature results in lower collisions frequency OR results in less-energetic collisions. **1 mark**

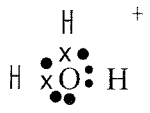
(d) Total marks for (d): 4

There should be two distinct strands in student's answer—

Effect of pressure on rate of ammonia formation
Give **1 mark** for identifying this (explicitly or implicitly) as an impact of increased pressure.
Give **1 mark** for explaining why increased pressure makes ammonia faster: eg, at higher pressures, there are more collisions per second between reactant molecules.

Effect of pressure on yield of ammonia
Give **1 mark** for identifying this (explicitly or implicitly) as an impact of increased pressure.
Give **1 mark** for explaining why increased pressure favors ammonia formation: eg, at higher pressures, equilibrium shifts right as there are less ammonia molecules formed from a given number of reactant molecules.

Question 27
Outcomes assessed: H.6



Total: **2 marks**

1 mark should be straightforward; eg, pay it for an indication that student knows that one of the bonds must consist of a pair of electrons that both come from oxygen.

The second mark is for a totally correct diagram (including the lone pair, and the + sign).

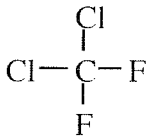
Question 28

Outcomes assessed: H.6, H.9; H.9; H.9; H.6

(a) (i) Chlorine or Cl **1 mark**

(ii) Any current source, or recently banned source eg aerosol propellants **1 mark**

(iii) Correct structural formula



1 mark

(b) Total marks for (b): 2

A simple statement (eg, ozone has a higher MP because of stronger intermolecular forces) without further explanation. **1 mark**

Further chemical detail showing deeper understanding (eg, accounting for ozone's stronger IMFs). **1 mark**

Section II

Outcomes assessed: H.3, H.5; H.5; H.10; H.10; H.7, H.8; H.7, H.8; H.3, H.8; H.3; H.13; H.8, H.13; H.8, H.11, H.14; H.3, H.13; H.8, H.13; H.8, H.13

Question 29 — Industrial Chemistry

(a) (i) **1 mark**. A great range of answers is possible.

(ii) **1 mark**. Make sure this answer follows from the one given in (i).

(b) (i) 1 (**3 marks**)

Three main stages in calculation, **1 mark** for each.

mol phosgene reacting = 0.80 **1 mark**

$\therefore$ mol of CO formed = 0.80 **1 mark**

$\therefore$ mol of Cl_2 formed = 0.80 **1 mark**

2 (**2 marks**)

$$K = \frac{[CO][Cl_2]}{[COCl_2]}$$ **1 mark**

$$= \frac{\frac{0.80}{10.0} \times \frac{0.80}{10.0}}{\frac{0.20}{10.0}}$$

$= 0.32$ **1 mark**

(ii) **1 mark** for same K, because temperature is the same.

(c) (i) There are many approaches to answering this question, eg running prose, tables, labelled diagrams. Any are OK.

The description of each cell is worth **3 marks**.
1 mark should be readily available for virtually all students: they should show clearly that they know one or two features of importance (eg, *mercury cathode* in mercury cell, porous partition to *separate anode and cathode* compartments in diaphragm cell).

Allocate the remaining two marks according to the further detail presented. Eg, the second mark is given for describing how the cell is constructed, and the third mark for details of the chemistry of the cell.

(ii) Give **1 mark** for a mere statement of an environmental difficulty (eg, mercury finding its way into the environment). The second mark is for an attempt to describe how this is overcome, or prevented, or how severe the problem is; or what specific damage is done — in other words, an attempt at an analysis.

(d) (i) **1 mark** for eg as a water softener or in glass manufacture.

(ii) **2 marks**. As usual, **1 mark** should be straightforward, the second more difficult to score. Eg, for ammonia recovery, merely saying *heating ammonium chloride with lime produces ammonia* would only score **1 mark**. Adding that the *lime comes from the limestone heated to produce carbon dioxide for use in an early stage* would score the second. Alternatively, giving equation(s) for reactions could score **2 marks**.

(iii) **2 marks**, so look for two criteria and give each **1 mark**. Examples:

- Is it easy to remove wastes (eg water impurities, calcium chloride) safely?
- Are raw materials (salt, limestone) at hand, or easily/cheaply transportable?
- If there is an ammonia "leak", is it easy to evacuate people from surrounding areas if necessary?

(e) (i) **1 mark** for eg catalyst in hydration of ethene; fertilizer manufacture; lead/acid batteries.

(ii) **2 marks. 1 mark** for the reaction eg action of hot concentrated sulphuric acid on copper produces SO_2. And **1 mark** for eg sulphuric acid is a dehydrating agent as well as a strong acid—so eye, skin and clothes protection are needed when doing the reaction.

(iii) **1 mark** eg moderate temperature/vanadium(V) oxide catalyst.

Question 30 — Shipwrecks and Salvage

Outcomes assessed: H.3, H.10, H.13; H.3, H.10, H.13; H.6, H.8, H.10; H.1, H.2, H.3, H.10, H.13; H.1, H.6; H.1, H.6; H.1, H.2; H.8, H.13; H.8, H.13; H.10, H.11, H.13

(a) There are two issue here, basically **1 mark** each:

- Iron is more brittle than steel
- Iron (with this carbon content) has more sites for corrosion. Appropriate steels will not corrode anywhere near as readily.

(b) **2 marks**; give only 1 if student merely names a process (eg, sacricial anodes or cathodic protection). Student should give some detail for the **2 marks**. No need to give reason for method, as question merely asked for a *method* to be outlined.

Sacrificial anodes of Mg blocks attached to hull.

(c) **2 marks**, 1 for explaining why Al is passivating, while Na is not.

Al reacts with oxygen in air, forming an oxide coating which is insoluble in water and binds very tightly to metal. This layer prevents further oxidation of metal.
Na forms oxide coating, but is is soluble in air moisture. Hence it is easily penetrated, and oxidation of metal underneath continues.

(d) **5 marks**, **1 mark** for each point.

I. Valid; the cool temperature would be expected to slow down corrosion.

II. Valid in so far as there is little oxygen that deep, hence one iron corrosion method will not occur. But there are other iron corrosion reactions which do not depend on the presence of O_2.

III. There was; anaerobic bacteria use the oxygen in sulphates to oxidize the iron.

IV. Some salts increase in solubility at lower temperatures, especially sulphates.

V. Bacteria produce H^+ ions. These cause the given equilibrium to shift right (by reaction with hydroxide ions) and increase therefore extent of corrosion.

(e) (i) **1 mark**. Salts crystallize, and disrupt the cellular structure of the wood.

(ii) **3 marks**, **1 mark** for stating a method, eg use of boric acid, **2 marks** for explaining why method works, eg boric acid prevents fungus growing on the wood.

(f) **2 marks**, **1 mark** each point:
Two different metals allow *oxidation and reduction to occur*
The frog's muscle tissue contain *electrolytes in solution.*

(g) (i) **4 marks**, **1 mark** for each label the question directs students to put in.

(ii) **2 marks**, **1 mark** for each half-equation—

- Reduction $Cu^{2+} + 2e^- \rightarrow Cu(s)$
- Oxidation $H_2O(l) \rightarrow \frac{1}{2}O_2(g) + 2H^+$

(iii) Give **1 mark** if student makes it clear (explicitly or implicitly) that he knows what this law says.
Give second mark for this minimum: measure the mass of copper metal formed for several currents flowing for same time.

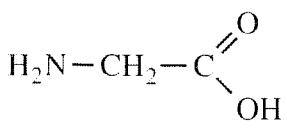
Question 31 — Biochemistry of Movement
Outcomes assessed: H.7, H.8, H.9, H.13; H.9, H.13; H.9; H.9, H.13; H.13; H.7, H.10; H.9, H.13; H.9, H.13; H.9; H.11, H.13; H.13; H.8

(a) A table, giving *at least one* relevant property with an attempt at comparison **1 mark**

A table, giving *two* relevant properties, and a comparison for each property **2 marks**

(b) Total **4 marks**; **1 mark** each
J carbohydrate; ***K*** alcohol; ***L*** fat; ***M*** amino acid

(c) (i) A correct structural formula (two possible answers) **1 mark**



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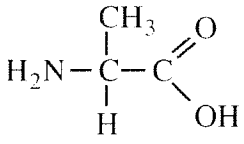


(ii) Hydrogen bond, dipole/dipole force. Sulphide bridges not relevant to this protein. **1 mark** each, total 2.

(d) (i) Cytoplasm **1 mark**

(ii) *Qualitative* answer or a *wrong quantitative* answer showing more from TCA/cytochrome than glycolysis **1 mark**

Quantitative answer (net 2 ATP from glycolysis, 36 ATP from TCA/cytochrome) **2 marks**

(iii) 1 Due to lack of sufficient oxygen, TCA does not occur. Pyruvic acid from glycolysis converted to lactic acid. **1 mark**

2 A description of one method (eg, converted back to pyruvic acid as oxygen becomes available, and now TCA etc proceeds). **1 mark**

(e) (i) Correct statement of an enzyme reaction. **1 mark**

(ii) A simple statement, without technical detail or proper use of terms. **1 mark**

An outline, with some detail missing (eg an unlabelled diagram, no mention of how temperature was controlled, no mention of how enzyme activity was measured) **2 marks**

A clear description with perhaps a labelled diagram of apparatus, details of how temperature was controlled and monitored, how enzyme activity was measured. **3 – 4 marks**. Reserve 4 marks for the really special description: including, eg, difficulties encountered and how they were overcome, suggested improvements, repetition of the experiment, &c.

(iii) Axes labelled appropriately, clear smoothly-drawn graph with labelling of key features, a wide enough range of temperature to show key features. **3 marks**
As a guide: **1 mark** for a sketch graph, without ruled axes, perfunctory labelling.
2 marks for all features as detailed above for 3, with one major or two minor features lacking.

(iv) A simple explanation of just one feature (eg initial rise in slope, before the peak) **1 mark**

An attempt to use the denaturation of proteins to explain the presence of a peak, and the lack of enzyme activity after this peak. **2 marks**

A complete chemical explanation, including the gradual increase in enzyme activity leading up to a peak **3 marks**

Question 32 — Chemistry of Art
Outcomes assessed: H.6; H.13; H.1; H.6; H.6; H.2; H.2, H.6; H.2, H.6; H.6, H.13; H.1, H.2; H.13; H.2, H.6, H.13, H.14

(a) (i) Any one reason (eg, compounds of transition metals tend to be colored) **1 mark**

(ii) An answer that shows the need for a solvent or a suspending liquid **1 mark**

(iii) Range possible: eg, longer lasting dyes, better solvents, better spreading characteristics. **1 mark**

(b) (i) Valence shell contains a partially-filled *d-subshell* **1 mark**

(ii) Correct indication of what subshells are in each shell **1 mark**
Complete correct answer **2 marks**

(c) (i) Any reason indicating appreciation of Lewis base as electron-pair donor

(ii) 1 Work through one or two of these ions to show ox number is + 2 **1 mark**
Work through all three **2 marks**

(ii) 2 The ligands cause a slight change in the energies of the subshells involved in electron transitions. **1 mark**

(iii) Appreciation of an oxidizing agent as being reduced, or causing oxidation, or accepting electrons **1 mark**
Relating this to Mg as the species oxidized, or donator of electrons **2 marks**

(d) (i) Appreciation of any aspect of restricted energy levels **1 mark**
Two specific features of the model **2 marks**
Three specific features of the model **3 marks**

(ii) Appreciation that as electrons lose energy, light is emitted. **1 mark**
Appreciation that as there are only a limited number of transitions, there are a limited number of lines, and that the color/frequency depends on the energy difference between levels. **2 marks**
As above, and an explanation as to why the higher frequency lines are closer. **3 marks**

(e) Understanding of what successive ionization energies are **1 mark**

Then the remaining 6 marks are given in three blocks of 2:

For each block representative element, showing how data leads to number of electrons in valence shell by looking for "large jumps" in data. **1 mark**

For each block representative, showing how data leads to number of electrons in valence subshells by looking for "smaller, but still clear, jumps" in data. **2 marks**

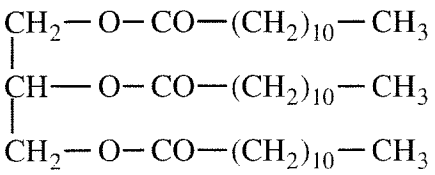
Question 33 — Forensic Chemistry
Outcomes assessed: H.9, H.11, H.12, H.13; H.9; H.9; H.6, H.9; H.9; H.6, H.9; H.9, H.11; H.11, H.12, H.13; H.14; H.14; H.4

(a) Total 4 marks — **1 mark** for each point associated with categories below.

- equipment
- method
- reaction conditions
- result with each sugar-type

(b) Total **2 marks**: **1 mark** for similarity (eg contain C, H, O); **1 mark** for a difference they ***can*** (key word) have (eg animal polysaccharide —glycogen— is soluble, plant polysaccharides —cellulose— insoluble in water)

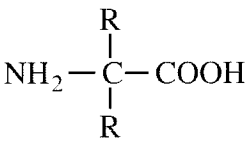
(c) (i) **2 marks**



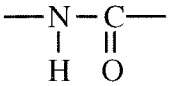
1 mark for indicating the correct way of combining —OH and —COOH functional groups. **1 mark** for a structural formula with all details correct.

(ii) **1 mark** if the $-(CH_2)_{10}-CH_3$ parts of the molecule are circled. Pay the mark even if only one or two of the three are circled.

(d) (i) As it is a *general* formula being asked for, give **1 mark** for placement of NH_2 group on the α–carbon atom; **1 mark** for the —COOH group.



(ii) **2 marks** for



Give 1 if the N—C bond is given as the peptide bond.

(iii) **1 mark** for hydrolysis/peptide bond breaking/protein is breaking into its component amino acids.

(iv) **3 marks**. **1 mark** for each point associated with categories below.

- choice of medium to separate amino acids in
- choice of solvent
- method description, including apparatus

(e) (i) **3 marks**. One approach by student could be to present an example spectrogram, explain how the molecular fragments are formed, and what can be deduced from the "lines" in the spectrogram. **1 mark** for each.

(ii) **1 mark** for eg isotopic composition

(f) **4 marks**. There should be four quite distinct points in student's answer.