NSW INDEPENDENT TRIAL EXAMS
CHEMISTRY HSC TRIAL – 2006
SUGGESTED ANSWERS

PART A

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

PART B

16. (a) Chloroethene — 1

(b) Non-conductor of electricity, easily moulded and rigid, impervious to water, inert to organic materials. — 1

(c) Petroleum is a non-renewable resource and supplies are being rapidly used up due to heavy demand for petrochemicals for a variety of uses such as fuels, plastics, lubricants, solvents etc. This demand is increasing as the world's population increases so alternative sources of these compounds are needed in the future. In the short term, recycling of plastics can help reduce this need for alternatives. However, compounds used as fuels cannot be recycled as they are destroyed in the process. — 3

17. (a) $C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$ — 1

(b) High pressure increases the equilibrium yield of ethanol, as the forward reaction occurs with a decrease in the number of gaseous molecules. — 1

(c) Sugar solution is extracted from sugar cane by crushing.
The sugar solution is fermented with yeast, producing a dilute ethanol solution. The solution is distilled to separate ethanol, which has a lower boiling temperature than water. — 2

(d) Ethanol produced from ethene is using non-renewable petroleum resources, and is therefore also non-renewable. Sugar cane is a renewable crop and ethanol produced from it is a renewable substance. — 2

18. (a) $Pb_{(s)} + Cu^{2+} \longrightarrow Pb^{2+} + Cu_{(s)}$ — 1

(b) $Pb_{(s)}$ electrode, negative — 1

(c) $(+0.34) - (-0.13) = 0.47$ volts — 1

(d) $Pb_{(s)}$ electrode corroding, blue colour of the solution fading, build up of Cu metal on the Cu electrode. — 3

(e) As the cell operates, nitrate ions migrate from the Cu/Cu^{2+} half-cell to the Pb/Pb^{2+} half-cell via the salt bridge. As a result the nitrate ion concentration goes down in the copper half-cell and increases in the lead half-cell, matching the changing concentrations of Cu^{2+} and Pb^{2+} ions. — 2

19. eg. Iodine-131 is used in the treatment of an overactive thyroid gland. As only the thyroid takes up iodide ion the radioisotope concentrates there where its beta radiation destroys some thyroid cells, reducing the gland's activity toward normal levels.
Associated problems include collateral damage to surrounding tissue and exposure of another person in close proximity, such as a baby held close. Also the production and transport of the isotope involves operating a nuclear reactor (or cyclotron) and must be performed with stringent safeguards against radiation exposure of personnel, including medical staff. — 4

20. The molar concentration of an acid is simply the number of moles of acid dissolved per litre of solution. Concentration can be measured by titration with a standard solution of a strong base, such as sodium hydroxide, using a suitable indicator, such as phenolphthalein. — 2
The strength of an acid is the extent to which the acid ionises to produce hydrogen ions in dilute solution and can be measured with a pH meter. Acetic (ethanoic) acid is one example of an acid for which the strength is much less than its concentration. — 2

21. (a) A small sample of the solid will produce an intense yellow colour in a bunsen flame.   1

    (b) Moles HNO_3 used $= 27.3 \times 0.118$ mmol   1

Moles Na_2CO_3 in sample $= 27.3 \times 0.118 \times 0.5$ mmol (1:2 mole ratio)

Mole mass of $Na_2CO_3 = 106.0$ g

Mass of Na_2CO_3 in sample $= 27.3 \times 0.118 \times 0.5 \times 106/1000 = 0.171$ g   1

Percentage of Na_2CO_3 in sample $= 0.171/1.32 = 12.9\%$ by mass.   1

    (c) Na_2CO_3 is a weak diprotic base. The neutralisation point, with HNO_3 is less than 7

Methyl orange changes colour in this range and provides a sharp end-point   1

    (d) (Optional: Warm the titrated solution to expel any remaining carbon dioxide.)

Add dilute silver nitrate solution, shaking the flask, until no further precipitation occurs.

Filter the silver chloride precipitate through a previously weighed filter paper.

Wash the precipitate with distilled water.

Dry the precipitate and filter paper in a warm oven.

Reweigh to obtain the mass of silver chloride.

Calculate the mass, and percentage of sodium chloride from the 1: 1 mole relation:

58.5 g $NaCl(s) \rightarrow 143.4$ g $AgCl(s)$ 3

    (e) Salt is naturally present in soil and ancient salt deposits underlie large areas of farmland. Irrigation raises the water table bringing dissolved salt towards the surface. Evaporation leaves a residue of salt which gradually builds up. Eventually the salt reaches levels which prevent crops or pasture growth.   2

22. (a) The solid could be calcium acetate or calcium citrate (soluble calcium salt of any weak acid)   1

         eg., $Ca(OAc)_{2(s)} \rightarrow Ca^{2+} + 2OAc^-$ (OAc = acetate/ethanoate)   1

            $OAc^- + H_2O \Leftrightarrow HOAc + OH^-$ 1

    (b) eg., calcium ion: Add dilute sulfuric acid to a solution of the unknown.

Calcium ion forms a thin white precipitate of calcium sulfate.

$Ca^{2+} + SO_4^{2-} \Leftrightarrow CaSO_{4(s)}$ 1

Acetate ion: Add a few drops of dilute HCl to a small amount of the solid. The distinctive odour of acetic (ethanoic) acid can be detected.

$Ca(OAc)_{2(s)} + 2H^+ \rightarrow Ca^{2+} + 2$ HOAc   1

    (c) Acidic solution: eg., copper sulfate (any salt of a weak base/strong acid)   1

Neutral solution: sodium chloride (any salt of a strong acid/strong base)   1

23. (a) In this reaction HBr is a proton donor, with the proton transferred to ammonia. HBr is the acid and NH_3 is the base, using Bronsted-Lowry definitions.   1

    (b) NH_3 is the limiting reagent.

Moles of $NH_3 = 1.5/24.79 = 0.065$ mol   1

Moles of NH_4Br = moles NH_3

Mass of $NH_4Br = 0.065 \times (14.0 + 4.04 + 79.9) = 6.32$ g   1

24. (a) Collect water samples separately at points upstream from the sewerage works, adjacent to the works and downstream below the works. Seal and label the collection containers, with date-time and location. Avoid entering the water, wear protective gloves and eye protection.   2

    (b) Any two of the test for nitrate ion, phosphate ion, biological oxygen demand and dissolved oxygen. Discharge from the plant would be indicated by elevated levels of the first three or low dissolved oxygen in the downstream water samples compared with those upstream from the plant.   2

25. Dissolve a weighed sample, of approx. 1.0g in a small volume of distilled water, in a weighed beaker.

Filter the solution and collect the filtrate.

Add 20mL of 0.5 molL^{-1} barium nitrate solution. Gently boil the mixture to coagulate the precipitate of barium sulfate. Allow to cool and settle.

Decant the clear liquid. Wash the precipitate, settle and decant again. Repeat washing.

Dry the precipitate in the beaker, cool and weigh.
Calculate the mass of ammonium sulfate from the 1:1 mole ratio, and the percentage in
the sample, using the sample's mass.　　3
As barium is a toxic heavy metal care must be taken to avoid spillage and ingestion.
Gloves and eye protection should be worn and the waste deposited in a heavy metal
waste container.　　1

26.   (a) Draws appropriate graph 2
      (b) The graph shows that the equilibrium fraction of ammonia falls rapidly as the
temperature increases. This is because the reaction is strongly exothermic and a higher
temperature drives the equilibrium towards the reactants, reducing the yield of ammonia 1
      (c) Answers may include fertilisers, plastics, nitric acid, cleaners and detergents. 1

Section II Options:

Q27.   **Industrial Chemistry**

(a)   Chemical reactions may be reversible. This means that the forward reaction and reverse
reaction occur simultaneously. Undisturbed, in a closed system, these reactions reach
equilibrium. These reactions are governed by Le Chatelier's principle, i.e. when a
system in equilibrium is disturbed, the system will adjust to minimise the disturbance. In
a system where equilibrium has been reached, concentrations of reactants and products
will stay constant, but not necessarily equal.　　4

(b)   (i)   Identifies three uses of H_2SO_4. May include:
Manufacture of ammonium sulfate fertiliser
Manufacture of phosphate fertiliser
Dehydrating agent
Pickling steel
Manufacture of other chemicals. e.g. detergents, dyes, synthetic rubber, film, ink etc.　　3

      (ii)   Describes one of the uses identified in (b)(i) e.g. H_2SO_4 reacts with NH_3 to form
ammonium sulfate.
Ammonium sulfate is used as a fertiliser. The reaction is as follows:
$2NH_3(g) + H_2SO_4(aq) \longrightarrow (NH_4)_2SO_4(aq)$　　2

(c)   Explains an electrolysis method used to produce sodium hydroxide. May include:
Mercury process
Diaphragm process
Membrane process　　3

(d)   Distinguishes between anionic, cationic and non-ionic detergents. i.e:
- Anionic; negatively charged head, long hydrocarbon tail; ionic head is usually SO_4^{2-} or
SO_3^-
- Cationic; positively charged head, usually ammonium compounds.
- Non-Ionic; have polar terminals, form H bonds between their Oxygens in their
hydrocarbon tail and water, do not make many suds, used as laundry detergents.　　5

(e)   (i)   Identifies Sodium carbonate 1
      (ii)   Identifies the raw materials used in the solvay process. May include:
NaCl
Ammonia
Calcium carbonate　　3

(f)   Describes saponification. e.g. Conversion in basic solution of fats and oils to glycerol
and salts of fatty acids.　　4

Q28. **Shipwrecks, Corrosion & Conservation**

(a) The origins of the minerals in the world's oceans come from two sources:

-The leaching by rainwater from terrestrial environments. The rainwater penetrates the rocks and soils leaching out minerals by the process of weathering. These dissolved minerals, which are mainly calcium ions, magnesium ions, hydrogen carbonate ions and silicate ions, are carried down to the oceans and seas by creeks and rivers.

-Dissolution of salts by water passing through hydrothermal vents in mid ocean ridges. Seawater penetrates down into cracks and fissures in mid ocean ridges coming near the hot magna heating the water. This hot water is forced back out through other cracks called hydrothermal vents and as it does it dissolves minerals in the rocks. Sulfides of iron, copper and zinc form deposits that settle on the ocean floor. Chlorides and sulfates of magnesium, calcium, sodium and potassium remain in solution. **4**

(b) (i) The standard electrode potentials show that relative to hydrogen
Cu will give up electrons more readily than Ag

$$Cu^{2+} + 2e \longrightarrow Cu \qquad +0.34$$
$$Ag^{+} + e \longrightarrow Ag \qquad +0.80$$

COPPER will therefore corrode **1**

(ii) $Cu_{(s)} + 2Ag^{+}_{(aq)} \longrightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$

$$Cu \longrightarrow Cu^{2+} + 2^{e} \qquad -0.34$$
$$2Ag^{+} + 2e \longrightarrow 2Ag \qquad +0.80$$

$$Cu + 2Ag^{+} \longrightarrow 2Ag + Cu^{2+} \qquad +0.46V$$ **2**

(iii) Cu is the anode (where oxidation occurs). The anode will decrease in mass and the colour of the Cu^{2+} solution will darken as Cu^{2+} comes from the Cu as it gives up its electrons to form Cu^{2+} in solution

Ag is the cathode (where reduction occurs). The cathode will increase in mass as Ag^{+} comes out of solution picking up an electron to form Ag **2**

(c) (i) Mild steel has less than 0.2% C and is soft and malleable and has a high tensile strength. It is used in car bodies, pipes, roofing and shipbuilding.

Structural steel has 0.3 – 0.6% C and is hard and malleable and has a high tensile strength. It is used in beams and girders, railways and reinforcing for buildings.

Stainless steel has 10-20% Cr and 5-20% Ni and is hard, takes on a high polish and is resistant to corrosion. It is used in kitchen sinks and appliances, cutlery, surgical and instruments. **3**

(ii) Rusting occurs in the presence of oxygen and water. At the site where iron oxidises to Fe^{2+} ions this is called the anodic site. The two electrons flow through the iron metal to a site where there is an impurity. This is the cathodic site. Here oxygen is reduced to hydroxide ions in a thin film of moisture on the iron surface or in the water if the iron is submerged.

The reduction reaction is: $O_2 + 2H_2O + 4e^{-} \longrightarrow 4OH^{-}$

The Fe^{2+} and OH^{-} ions migrate through the moisture and form insoluble $Fe(OH)_2$ ie:
$Fe^{2+} + 2OH^{-} \longrightarrow Fe(OH)_2$.

The $Fe(OH)_2$ is oxidised to iron(III) oxide:
$4Fe(OH)_2 + O_2 \longrightarrow 2(Fe_2O_3.H_2O) + 2H_2O$.
$2(Fe_2O_3.H_2O)$ is rust. **4**

Question 28 suggested answers continue on the next page

(d)   Salt water is an excellent electrolyte

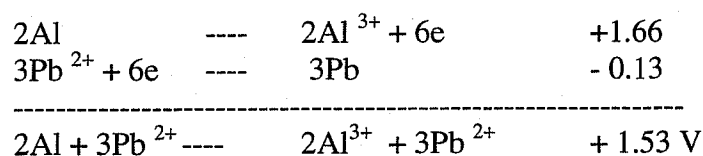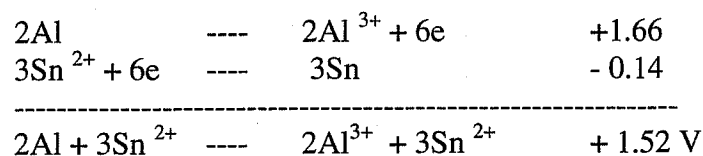Solder is a mixture of tin and lead

The standard electrode potentials show that aluminium will give up electrons to both tin and Lead ions

In salt water tin and lead oxidise

Electrochemical cells will be set up between the aluminium and the lead and tin ions

Aluminium will act as an anode and the other metals will act as cathodes.

Electrochemical corrosion will occur rapidly resulting in joint failure or holes

$$2Al \quad\quad ---- \quad 2Al^{3+} + 6e \quad\quad +1.66$$
$$3Sn^{2+} + 6e \quad ---- \quad 3Sn \quad\quad\quad - 0.14$$

$$2Al + 3Sn^{2+} \quad ---- \quad 2Al^{3+} + 3Sn^{2+} \quad + 1.52\ V$$

$$2Al \quad\quad ---- \quad 2Al^{3+} + 6e \quad\quad +1.66$$
$$3Pb^{2+} + 6e \quad ---- \quad 3Pb \quad\quad\quad - 0.13$$

3

$$2Al + 3Pb^{2+} ---- \quad 2Al^{3+} + 3Pb^{2+} \quad + 1.53\ V$$

(e)   Davy used the advances made by Volta, specifically he enlarged Volta's 'Voltaic pile' to produce enough electricity to electolyse molten potassium hydroxide and sodium hydroxide to produce potassium and sodium. Using still larger piles he later isolated strontium, calcium, magnesium and barium electrolysing them from their compounds.

Davys work with electrolysis led him to conclude that:

i.   The production of electricity in simple electrolytic cells resulted from chemical action

ii.   Chemical combination occurred between substances of opposite charge.

iii.   The interactions of electric currents with chemical compounds, offered the most likely means of decomposing all substances to their elements.

iv.   Electrical forces could act (generate current) only when the electrolyte was capable of oxidizing one of the metals.

v.   The intensity of its effect (the voltage generated) was directly related to the reactivity of the electrolyte with the metal.

The impact of these conclusions was far reaching and allowed the rapid advance of electrochemistry (a term coined by Davy) and the development of the atomic theory by other contemporaries. It:

- Assisted in the understanding of the nature of compounds
- Assisted in the understanding of ions
- Assisted in explaining electricity in terms of charges
- Assisted in explaining the role of the electrolyte in electron transfer reactions
- Allowed Faraday to develop his laws of electrolysis

The theory behind our understanding of electron transfer reactions really began with Davy, and using our knowledge of atomic theory we can understand and explain Davy's observations

6

Q29. Biochemistry of Movement

(i)

$$H_2N-\underset{\underset{H}{\mid}}{\overset{\overset{R}{\mid}}{CH}}-COOH$$

1
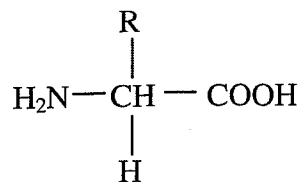
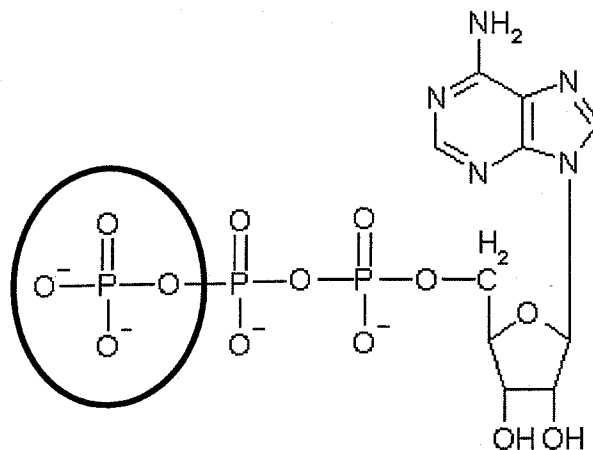(ii) Electrostatic forces
Hydrogen bonding forces
Hydrophobic forces
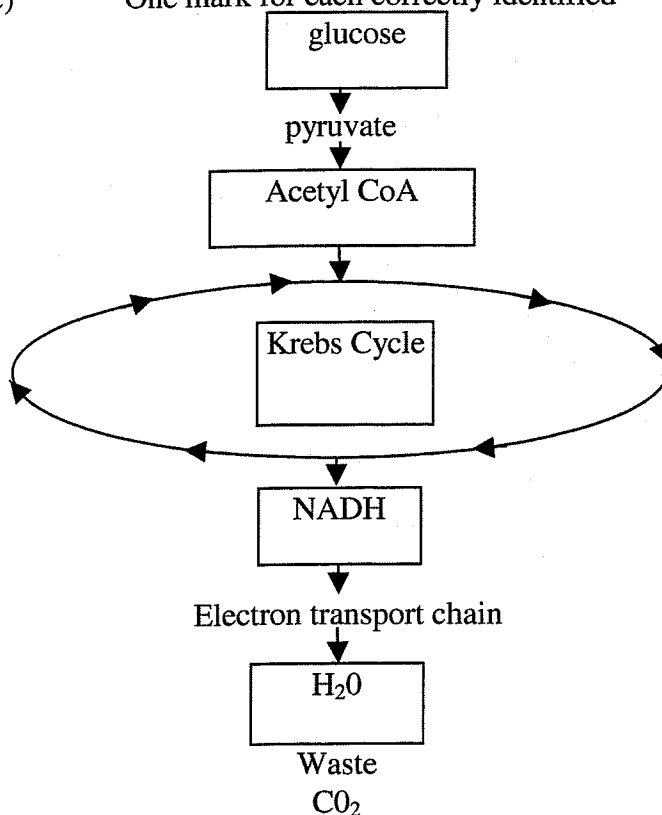Disulfide bonds

4

(b) (i) Adenosine triphosphate or ATP

1

(ii)

The phosphodiester bond

1

(c) One mark for each correctly identified

5

(d) Physiologically active proteins which have specific functions, lower activation energy.

1

Question 29 suggested answers continue on the next page

(e)   4

reaction rate

reaction rate

4 6 8 10
pH

10 20 30 40 50
temp

Will denature either side of the
range of activity

High temperatures may denature
protein
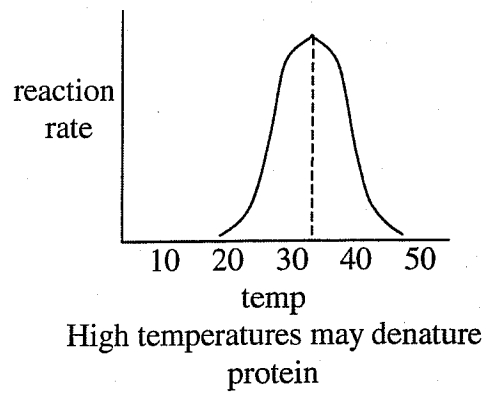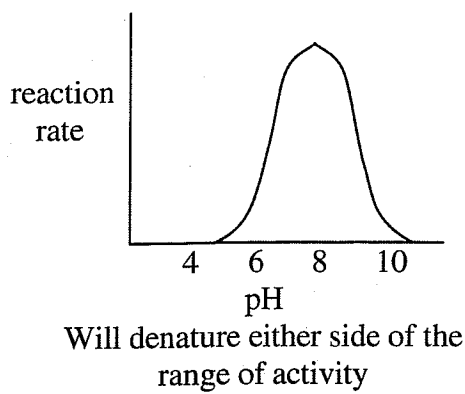
(f) lock and key etc.
     substrate specific.

Substrate 1

Enzyme

Substrate 2
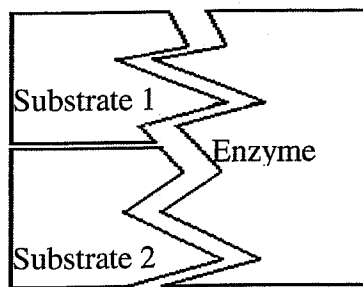
2

(g) (i) Sarcomere
          Z line
          Myosin filament
          Actin filament   4
     (ii) Impulse sent down motor neurone
          Triggers the release of Ach
          Stimulates subsequent impulse to sarcoplasmic reticulum
          Release of calcium ions over actin/myosin   2

Q30. **Chemistry of Art**

(a) (i) Cave drawings
Self decoration (cosmetics)
Preparation of the dead for burial. 3

(ii) Naturally occurring earths, umbers, charred wood
Red ochre
Yellow orche
Chalk
White clay
Charcoal black
Bone black 4

(b) Assesses the health risks. e.g. heavy metal poisons, lead, mercury, arsenic and antimony.
Can cause skin irritations and many illnesses. 5

(c) (i) 6

Ion	Flame Colour
Na^t	Lilac
K^t	Lilac/purple
Ca^{2t}	Orange/red
Ba^{2t}	Pale green
Sr^{2t}	Red
Cu^{2t}	Blue/green

(ii) Electrons releasing energy as they move to a lower energy level.
Most are group I or II metals with one particular electron transfer. 2

(d) (i) Element in which the d shell is incomplete. 1

(ii) Explains the reasons why ions in different oxidation states change colour. e.g. MnO_4, Mn^{2t}-Purple/pale pink 2

(e) (i) Two or more donor atoms which can simultaneously coordinate to a metal ion. 1

(ii) Ethylenediamine 1

Q31. **Forensic Chemistry**

(a)
- Place a small sample of each compound into separate test tubes.
- Add Br_2 (aq) to each sample. The alkene (compound 3) will react causing the Br_2 (aq) to change from brown to colourless. The other compounds will not react and so the Br_2 (aq) will remain brown.

  $CH_3CH_2CH_2 CH = CH CH_3 + Br_2 \longrightarrow CH_3CH_2CH_2CHBrCHBrCH_3$
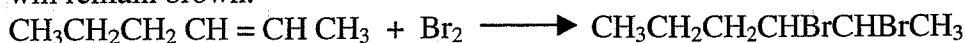
- To fresh samples of each, add some solid Na_2CO_3. The alkanoic acid (compound 2) will react producing bubbles of $CO_{2(g)}$, the other compounds will not react.

  $Na_2CO_3 + 2 CH_3(CH_2)_4COOH_{(aq)} \longrightarrow 2 CH_3(CH_2)_4COONa_{(aq)} + H_2O_{(l)} + CO_{2(g)}$
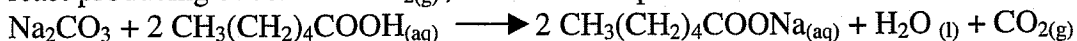
- To a fresh sample of the compound that did not react with either the $Br_{2(aq)}$ or the Na_2CO_3 add a small piece of Na metal. Alkanols contain a hydroxyl functional group (-OH) and so react with $Na_{(s)}$ to produce bubbles of $H_{2 (g)}$. This will confirm that compound 1 is the alkanol. **3**

  $CH_3(CH_2)_5OH + Na_{(s)} \longrightarrow CH_3(CH_2)_5ONa + ½ H_{2(g)}$

(b) Sample 3 shows a 100 % match with the defendant in the bands in the DNA fingerprints shown(14 out of 14) and so is most likely to come from the defendant or an identical twin brother or sister. If the defendant has no such twin the chances of the sample coming from an unrelated person is only one in many billion.

Sample 2 shows a 50% match (7 out of 14) and so could be a brother, sister or parent of the defendant. For each DNA intron, a child has a 50% chance that it came from the mother and a 50% chance that it came from the father. This means that there is a 50% chance that it matches that of a brother or sister. These probabilities mean that for a set of introns there will be a 50% match between brothers and sisters. It also means that there will be a 50% match between each parent and the child. The prosecution claim that it came from a close family member, this seems valid.

These relationships described for samples 1 & 2 assume that the part of the DNA evidence is typical of all of the evidence presented and the percentage matching remains the same overall.

Sample 1 shows no matches at all and so seems to be from a person unrelated to the defendant. Only a small number of introns are being compared in the information provided and so it is possible that there could be some matches if more where compared.

However such a small % match would suggest only a very distant relationship if any. DNA profiles can be produced from very small samples from the body. The reliability of the results will be very dependant on the procedures in place for preventing contamination of the samples being tested. Forensic scientists take great care to ensure that samples are not contaminated when collected or when being tested.

In Australia, DNA profiling uses a number of locations along the DNA molecule and so has a high degree of precision. The huge number of possible intron combinations means that the chances of unrelated people having matching DNA fingerprints is one in many billion. Matches or % matches can then be considered a very reliable indicator of relationships.

Therefore, providing that procedures are in place to prevent the possibility of contamination, this DNA fingerprinting and the claims made by the prosecution seem to be quite valid and reliable. **5**

(c) (i) When atoms are excited by an energy source, some of this energy may be absorbed resulting in the promotion of their outer electrons to higher energy levels. These excited electrons then fall back to lower energy levels emitting energy as photons of light. The energy of the photons emitted (and hence the colour of the light) matches the difference in energy of these energy levels. In any sample of gas, the many atoms will have excited electrons in a large range of energy levels, so many different photons of light will be emitted, each appearing as a separate line of colour when viewed through a spectroscope. The pattern of coloured lines is called a line emission spectrum. **2**

(ii) Soil is a complex mixture of organic and inorganic material. Soils from different locations can differ greatly in chemical composition, colour, texture and pH. Measurements of these properties in small samples of soil cannot be done accurately. However, the production and analysis of a line emission spectrum of a tiny soil sample can detect the presence of some of the less common elements in the soil. Each element has its own characteristic set of energy levels in its atoms and so will produce a unique set of coloured lines in its line emission spectrum. Comparison with soil from the crime scene can determine if the soil on the sole of a suspect's shoe matches. A match would then place the suspect at the scene of the crime.   4

(d) (i) Polysaccharides are polymers consisting of many monosaccharide molecules joined together. Starch is made of long chains of glucose molecules (a monosaccharide) joined together.   1

(ii) Placing iodine solution on a sample will help identify the presence of starch. Starch reacts with iodine solution producing a dark blue colour.   2

(iii) Analysis of a carbohydrate can reveal whether it is of animal or plant origin, depending on the presence or absence of glycogen, starch or cellulose.
Glycogen, found only in animals, is an insoluble polysaccharide that serves as a storage material in muscle and liver cells.
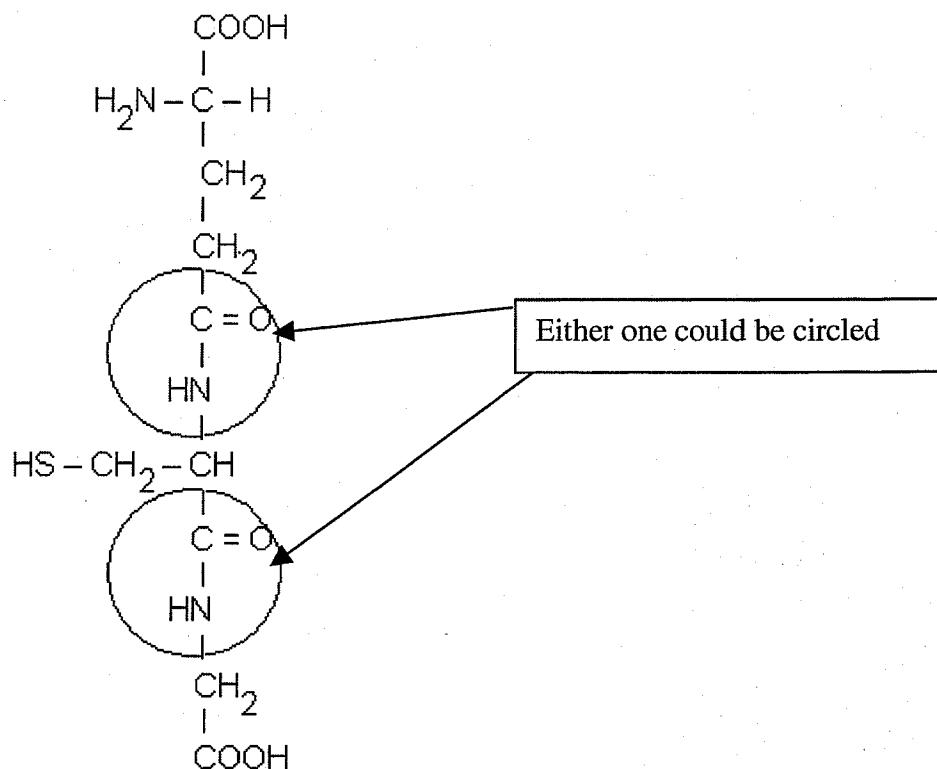Starch performs a similar role to glycogen but it is found only in the cytoplasm of plant cells.
Cellulose provides the structural strength for the cell wall in plant cells.   3

(e)   (i)   1

$$COOH$$
$$|$$
$$H_2N-C-H$$
$$|$$
$$CH_2$$
$$|$$
$$CH_2$$
$$|$$
$$C=O$$
$$|$$
$$HN$$
$$|$$
$$HS-CH_2-CH$$
$$|$$
$$C=O$$
$$|$$
$$HN$$
$$|$$
$$CH_2$$
$$|$$
$$COOH$$

Either one could be circled

(ii)   1

$$O$$
$$||$$
$$H_2N-CH-C-OH$$
$$|$$
$$CH_2$$
$$|$$
$$SH$$
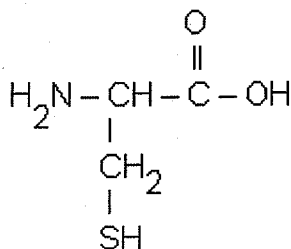
(iii) Electrophoresis is a method of separating substances based on their charge and mass. A
       voltage is applied across the medium in which the substances are to be separated. The
       direction and speed with which the substances move depend on their charge and mass.   3
       Using a medium at pH 11, cysteine and glycine would both move toward the positive
       electrode as they both exist as single negative ions.
       The glycine ion (molar mass 74g mol^{-1}) is smaller and so would move more rapidly than
       the cysteine ion (molar mass 120g mol^{-1}) allowing them to be separated.

**The Trial HSC examination, marking guidelines/suggested answers and 'mapping grid' have
been produced to help prepare students for the HSC to the best of our ability.**

Individual teachers/schools may alter parts of this product to suit their own requirement.

Mapping Grid

Question	Marks	Content	Syllabus Outcomes	Target performance band
1	1	9.3.3	3	3-5
2	1	9.2.4	6,8	3-4
3	1	9.2.4	8	2-3
4	1	9.2.5	6,8	3-4
5	1	9.2.3	7,9	3-5
6	1	9.3.4	8	2-4
7	1	9.3.3	8	3-5
8	1	9.3.4	8	2-3
9	1	9.4.4	6	2-4
10	1	9.3.4	8	2-4
11	1	9.3.5	3,8	3-5
12	1	9.4.4	9	2-5
13	1	9.3.5	9	2-3
14	1	9.4.4	4,9	4-5
15	1	9.4.4	4,8	2-5
16(a)	1	9.2.1	9	2-3
(b)	1	9.2.1	4,6,9	2-4
(c)	3	9.2.1, 9.2.2	3,4,5	3-4
17(a)	1	9.2.3	8	2-3
(b)	1	9.2.3	8,14	2-4
(c)	2	9.2.3	8	3-5
(d)	2	9.2.3	4,9	4-5
18(a)	1	9.2.4	6,8	3-4
(b)	1	9.2.4	6,8	3-4
(c)	1	9.2.4	7	3-5
(d)	3	9.2.4	6,8	4-6
(e)	2	9.2.4	8	4-5
19	4	9.2.5	2,7,11	3-5
20	4	9.3.3	8	4-5
21(a)	1	9.4.2	12	2-4
(b)	3	9.4.2	14	3-5
(c)	1	9.4.2	8	2-3
(d)	3	9.4.2	8,11	3-4
(e)	3	9.4.2	4,13	3-5
22(a)	3	9.3.1	6,14	3-4
(b)	2	9.3.1	8,11	2-3
(c)	2	9.3.1	6,8	3-5
23(a)	1	9.3.4	8	25-3
(b)	2	9.3.4	8,14	4-5
24(a)	2	9.4.5	11	3-4
(b)	2	9.4.5	12	3-5
25	4	9.4.2	11,12	2-4
26(a)	2	9.4.2, 9.4.1	14	2-5
(b)	1	9.4.2, 9.4.1	7	2-3
(c)	1	9.4.2, 9.4.1	7,8	3-4

Question	Marks	Content	Syllabus Outcomes	Target Performance Band
Question 27 – Industrial Chemistry				
(a)	4	9.5.2	8	3-4
(b)(i)	3	9.5.3	3,8	2-4
(ii)	2	9.5.3	8	3-5
(c)	3	9.5.4.	6,8	2-5
(d)	5	9.5.5	3,8	2-3
(e)(i)	1	9.5.6	3,8	2-3
(ii)	3	9.5.6	8	3-4
(f)	4	9.5.5	2,3	4-6
Question 28 – Shipwrecks, Corrosion and Conservation				
(a)	4	9.6.1	1,2	2-4
(b)(i)	1	9.6.3	6	2-3
(ii)	2	9.6.3	6,8	3-4
(iii)	2	9.6.3	6,8	4-5
(c)(i)	3	9.6.4	6	4-5
(ii)	4	9.6.4	6,8	3-4
(d)	3	9.6.4	6,14	2-4
(e)	6	9.6.1	1	4-6
Question 29 - Biochemistry of Movement				
(a)(i)	1	9.7.4	6	2-3
(ii)	4	9.7.4	6,14	4-5
(b)(i)	1	9.7.4	6,7	3-5
(ii)	1	9.7.1	6,7	4-5
(c)	5	9.7.7	6,8	4-6
(d)	1	9.7.4	3,6	2-3
(e)	4	9.7.4	3,6	4-5
(f)	2	9.7.4	3,6	3-4
(g)	4	9.7.4	3,8	4-5
(h)	2	9.7.4	3,8	4-6
Question 30 – Chemistry of Art				
(a)(i)	3	9.8.1	1	2-3
(ii)	4	9.8.1	1,2	4-5
(b)	5	9.8.1	1,2,4	3-4
(c)(i)	6	9.8.2	6,7	3-4
(ii)	2	9.8.2	6,7	4-5
(d)(i)	1	9.8.3	6	3-4
(ii)	2	9.8.3	6	3-5
(e)(i)	1	9.8.5	6,8	2-3
(ii)	1	9.8.5	6	4-5
Question 31 – Forensic Chemistry				
(a)	3	9.1, 9.9.1	2, 6, 9, 11, 14	2-5
(b)	5	9.9.4	3, 4, 5	3-6
(c)(i)	2	9.9.6	3, 6, 7	3-4
(ii)	4	9.9.1, 9.9.6	1, 4, 5, 6, 7	3-6
(d)(i)	1	9.9.2	9	3-4
(ii)	2	9.1, 9.9.2	2, 8, 9, 12, 14	2-4
(iii)	3	9.9.2	2, 4, 9	3-5
(e)(i)	1	9.9.3	9	3-4
(ii)	1	9.9.3	9	4-5
(iii)	3	9.9.3	4, 6, 9	3-6