# *NSW INDEPENDENT TRIAL EXAMS – 2005*

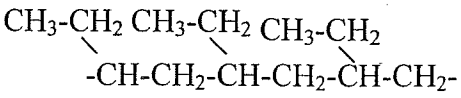
# CHEMISTRY HSC TRIAL- SUGGESTED ANSWERS

**PART A**

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

**PART B.**

16. (a) 1-butene. 1

(b) 

1

(c) The polymer consists of long non-polar hydrophobic chains. It is insoluble in water, has no reaction with acids and is chemically unreactive. It is also a thermoplastic, making it suitable for moulding into a container for fruit juice. 2

(d) Molecular mass of monomer = 56. Mean chain length = 15000/56 ~ 270 units 2

(e) Addition polymerisation. 1

17. (a) Silicon is from Group IV and forms a weakly acidic oxide $SiO_2$. 1

(b) As an acidic oxide, $SiO_2$ is unaffected by an acid such as HCl, but will react with a base such as NaOH, eg., equation $SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$. 2

(c) A polymer such as polythene or polyvinyl chloride is suitable, as these polymers are stable and have no reaction with bases (or acids). 2

18. Several strips of different metals such as copper, tin, magnesium and zinc were placed two at a time in a range of solutions such as water, alcohol, salt solution and dilute hydrochloric acid. Care was taken not to allow the metals to touch directly. A voltmeter was used to detect any cell voltage produced.
We found that a voltage occurred when two dissimilar metals were placed in a conducting solution. The greater the difference in activity of the two metals, the larger the voltage. For example magnesium and copper produced the largest voltage. 4

19. (a) Any strong base and weak acid eg., sodium hydroxide and acetic acid. 1

(b) Neutralisation point = 22.0 mL of acid added.
Acid concentration = 25 x 0.1/22.0 = 0.114 mol $L^{-1}$. 2

(c) eg., phenolphthalein solution. 1

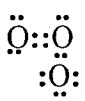
(d) Buffering occurs in the region from around 40 to 60 mL of acid added where the excess weak acid and its conjugate base are at similar concentrations. In this region the pH is almost unchanged by the addition of small quantities of acid or base and the solution is buffered. 2

20. (a) Mass of methane required = 16 x 1/0.880 = 18.2 g 1
Mass of coal required = 12 x 1/0.394 = 30.5 g 1

(b) Mass of $CO_2$ from methane = 12 x 1/0.880 = 13.6 g
Mass of $CO_2$ from coal = 12 x 1/0.394 = 30.5 g 1
Methane produces less than one-half (45%) of the carbon dioxide produced from coal. 1

(c) For a given amount of energy much less carbon dioxide is produced from methane than from coal. This means that methane is much more "greenhouse-friendly" than coal. 2

21. Acid rain is caused mainly by the release of oxides of sulfur and nitrogen into the atmosphere from the burning of fossil fuels and other industrial processes such as the smelting of metals. Fossil fuels such as coal and oil contain sulfur which burns to form sulfur dioxide. During high temperature combustion, nitrogen and oxygen combine to form oxides of nitrogen. These oxides dissolve in atmospheric water and further oxidise to nitric and sulfuric acid which returns to the Earths surface as acid rain. Acid rain is corrosive to metals and stone such as marble. It affects the growth of plants and can lead to low pH levels in freshwater lakes. 3

22. (a)  1

(b) Ozone levels remained at an almost constant level until 1975. After 1975 the levels steadily declined to less than 1/3rd the 1970 level. 1

(c) In the upper atmosphere CFC's are broken down by ultraviolet light, releasing free chlorine atoms (radicals). Each chlorine atom can act as a catalyst for the decomposition of a large number of ozone molecules before it eventually becomes part of a stable molecule.

eg., $CF_2Cl_2 \rightarrow CF_2Cl + Cl^{\cdot}$ and $Cl^{\cdot} + 2O_3 \rightarrow Cl^{\cdot} + 3O_2$

Eventually eg., $Cl^{\cdot} + Cl^{\cdot} \rightarrow Cl_2$ 3

23. (a) Anode: $Na_{(l)} \rightarrow Na^{+}_{(l)} + e^{-}$ 1

(b) The cell will produce a high voltage with low density materials which are not toxic as opposed to lead. 2

(c) Sodium metal has very high activity, reacting violently with water, producing hydrogen gas which is combustible and potentially explosive. The metal must be kept away from both water and oxygen.

24. (a) Beta radiation has moderate penetrating power and will be partly absorbed by the cardboard. Gamma rays would be unaffected while alpha radiation would be totally blocked. 2

(b) Geiger-Muller Counter. 1

(c) This type of gauge provides an almost instantaneous result, allowing the thickness to be adjusted immediately. It makes the measurement without the mechanical contact of callipers which would interfere with the movement of the sheet. 2

25. (a) $SO_2 + 2OH^{-} \rightarrow SO_3^{2-} + 2H_2O$ OR $SO_2 + 2NaOH \rightarrow Na_2SO_3 + 2H_2O$ 1

(b) Moles NaOH = 0.5 x 0.15 = 0.075 mol
Moles $SO_2$ = 0.075/2 = 0.0375 mol
Mass $SO_2$ = 0.0375 x 64.07 = 2.40 g 2

(c) Volume of $SO_2$ = 0.0375 x 24.79 = 0.930 L
Percentage of $SO_2$ by volume = =93/95 = 0.98% 2

(d) It is assumed that sulfur dioxide is the only acidic gas present, to react with NaOH. 1

26. (a) eg., ethyl acetate (ethyl ethanoate).

(b) We boiled, under reflux, a mixture of ethanol and ethanoic acid to which was added a few mL of concentrated sulfuric acid. The sulfuric acid provides the catalyst ($H^{+}$) and acts as a dehydrating agent, removing water as a product of the reaction and increasing the equilibrium yield of the ester. Boiling under reflux accelerates the reaction without losing any of the reactants though vaporisation. 2

(c) Both reactants as well as the ester are volatile and flammable, requiring strict precautions against fire. A water bath was used for heating and fire safety equipment, including a fire blanket and extinguisher were available. 2

27. The water is allowed to stand for sediment to settle under gravity. Flocculents, such as alum, are added to precipitate suspensions of clay and other materials. The water is filtered using sand and membrane filters to remove all solids and many microorganisms. Chlorine is then added to disinfect the water, killing remaining microbes and preventing their development during the storage and transport of the water to the consumer. 4

## Section II Options:

## Q28. Industrial Chemistry

(a) In a plant producing sulfuric acid by the Contact Process an industrial chemist would be responsible for monitoring the production process as well as the raw materials, product quality and any wastes discharged by the plant.

The production process involves the combustion of sulfur to sulfur dioxide, the catalysed oxidation of sulfur dioxide to sulfur trioxide, the dissolving of sulfur trioxide in sulfuric acid and the dilution of the solution to form 98% sulfuric acid. At all stages the stream of chemicals must be monitored for concentration and purity and the condition of the catalyst maintained to maximise the speed of the Contact Process.

The product, sulfuric acid, must be checked for concentration and levels of impurities are within the specifications required by the consumer.

Wastes produced by the plant can include sulfur oxides which must be detected and removed from any gaseous discharge to prevent environmental damage. Aqueous wastes must also be analysed for factors such as pH and heavy metals and treated as required to ensure that any discharge is within specified limits.

Working conditions, particularly air quality for workers in the plant must also be monitored and corrected as required. 6

(b)(i) 3

| Point | Pressure (atm) | $[NH_3]$/atm | $[H_2]$/atm | $[N_2]$/atm | $K_p$ |
|---|---|---|---|---|---|
| A | 400 | 20% = 80 | 60% = 240 | 20% = 80 | $5.8 \times 10^{-6}$ |
| B | 200 | 60% = 120 | 30% = 60 | 10% = 20 | $6.7 \times 10^{-3}$ |

(ii) The higher the total pressure the greater the equilibrium yield of ammonia, as shown by each curve in the graph. This is explained by Le Chatelier's Principle, as the formation off ammonia occurs with a reduction in the gas pressure and the system responds to an increase in pressure by favouring the products, ie., lowering the pressure.

The higher the temperature the lower the yield of ammonia. The forward reaction is exothermic, so that increasing the temperature forces the equilibrium to favour the reactants, absorbing heat energy. 3

(iii) While a low temperature increases the equilibrium yield of ammonia it also slows the rate of reaction. A temperature of 400-500 is a compromise between the requirement for high reaction rate and acceptable yield. 2

(c) Suitable diagram of membrane cell, including inert (graphite) anode and chlorine collection hood, membrane, steel mesh cathode and collection pool for sodium hydroxide solution. 2

The membrane method eliminates contamination of the product with sodium chloride which occurs in the Nelson Cell by using a selective membrane impermeable to chloride ion. It also avoids the mercury wastes associated with the Castner-Kellner Cell, although the concentration of NaOH is lower, requiring more energy to evaporate the solution to obtain solid NaOH. 3

(d) (i) The product of the Solvay Process is sodium carbonate (soda ash). The main raw materials are calcium carbonate (limestone) and sodium chloride. 2

(ii) The process requires large quantities of the raw materials which must be transported and stockpiled, and produces calcium chloride solution as a waste for disposal. Densely populated areas are unsuitable for these purposes. A remote location with good transport access, a fuel supply and a means of safely discharging the calcium chloride solution is necessary. 2

(e) One or more drops of cooking oil was added to 10 mL of clean water in a test tube. A standard quantity of soap was added and the tube shaken vigorously. If a froth formed this indicated that the oil had been fully emulsified. The experiment allowed us to count the number of drops of oil emulsified by the standard amount of soap. 2

## Q29. Shipwrecks, Corrosion and Conservation

(a) (i) Liquid magma is released from these vents and when this comes into contact with sea water it produces superheated water. This superheated water dissolves minerals in the vents and this process add considerable amounts of minerals to the oceans. 1

(ii) Galvani studied the connection between nerves and muscular action via experiments on frog muscles. He passed static electricity through the muscles and also connected the muscle via a brass wire and then made contact with a steel scalpel. Galvani believed that the muscular contraction was due to animal electricity in the muscle. His work also led to further work by Volta to explain this phenomena which has led to the modern day study of neurophysiology and nerve transmission. 2

(b) (i) Need to mention two steels, composition and properties. 2

Various possible answers such as:

| Type of steel | Composition | Properties |
|---|---|---|
| mild steel | Fe and <0.2% carbon | soft, malleable |
| structural steel | Fe and 0.3 to 0.6% carbon | hard, high tensile strength |
| high-carbon steel | Fe and 0.6 to 1.5% carbon | very hard |
| stainless steel | 10 to 20% Cr, 5 to 20% Ni and Fe | hard, resist corrosion |

(ii) Water and oxygen are required for rusting to occur in steel.

Water acts as an electrolyte in which ions can move between cathode and anode and the oxygen is reduced at the cathode $O2 + H2O + 4e- \rightarrow 4OH-$ .

Other factors are pH, impurities in steel, less active metals in contact with the steel, the presence of Si and C in steels as well as mechanical stress on the steel. 2

(c) Method:

Several nails can be set up and coated with different surface coatings and then placed into separate petri dishes containing a little water and then observed after several days.

Nail 1 coated with grease

Nail 2 coated with oil

Nail 3 coated with wax

Nail 4 as a contol, no surface coating

Other coatings that can be used are enamel paint, acrylic paint, Mg wrapped around the nail and Cu wrapped around the nail.

Some typical Results are:

| | |
|---|---|
| Nail with no coating (Control) | Rust appears on surface of nail, water contains brown sediment |
| Nail 1 coated with grease | No rust where nail covered by grease |
| Nail 2 coated with oil | No rust where nail covered by oil |
| Nail 3 coated with wax | No rust where nail covered by wax |
| Nail 3 coated with Cu | Increased rust on nail, increased sediment in water |

The experiment showed that when oxygen and water can be excluded from steel then corrosion is resisted. Coating steel with grease, oil and wax stop the nail from rusting although the nail needs to be completely covered by the coating. Coating the nail with paints resist rusting as well as coating with a more active metal such as Mg. Coating the nail with Zn stops rusting as a passivating coating is formed resisting rusting.

This answer covers more than the question requires but covers a range of answers that students may provide. 2

(d) (i) Possible anode reactions are:

$Na^+ + e^- \rightarrow Na_{(s)}$ and $H_2O_{(l)} + e^- \rightarrow \frac{1}{2} H_{2(g)} + OH^-$

Possible cathode reactions are:

$2H_2O_{(l)} \rightarrow O_{2\,(g)} + 4H^+ + 4e^-$ and $2Cl^- \rightarrow Cl_{2(g)} + 2e^-$ 1

(ii) Reactions can be carried out using different electrodes which will affect the reactions occurring at the anode. Eg In the electrolysis of copper, inert electrodes will acts as conductors or can participate in the anode reaction. 2

Copper electrodes:

Anode $Cu_{(s)} \rightarrow Cu^{2+} + 2e^-$

Cathode $Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$

Platinum electrodes:

Cathode reaction the same as above but

Anode is $2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+ + 4e^-$

(iii) 3

| Factors affecting Corrosion of a Steel nail | Observations |
|---|---|
| Oxygen concentration | increasing oxygen concentration in water increases the rate at which corrosion occurs |
| Salt concentration | increasing salt concentration in water increases the rate at which corrosion occurs |
| Temperature | increasing temperature of the water increases the rate at which corrosion occurs |

(e) The items such as the silver watch, leather pouch and wooden pencil first need to be cleaned and stabilised before they can be preserved. Depending on the composition of the artefact different chemical and physical procedures will need to be used.

Firstly, any of the artefacts that contain any concretions will need to have them removed. The watch should be soaked in dilute HCl to remove the concretions. The leather and wood may need small hammers to mechanically remove the concretions. Salts may then need to be removed next. This is done by soaking in distilled water so that the salts are removed from them. They may be further washed in distilled water to remove any salts remaining. The watch is then cleaned by electrolysis in an alkaline solution where the watch is made the cathode. This removes most of the sulphide coating on the silver. The watch may then be coated with an acrylic lacquer to stop any further corrosion. The leather and wood are then slowly dried and a fungicide may be added to prevent fungal attack. The wood and leather are then soaked and impregnated with a polymer called PEG. A wax coating may then be applied to the leather and wood to protect against further corrosion.

If the leather and wood are removed from the water and allowed to dry without any cleaning, preserving and stabilising, then the salt will remain within the wood and leather when the water evaporates, causing cracking and distorting of the artefact. 7

## Q30. Biochemistry of Movement

(a) (i) ATP is an energy rich compound that provides energy needed for many endothermic biochemical reactions. 1

(ii) Molecule A is glucose (1) and Molecule B is Starch (1). 2

(b) (i) The COOH group or the above group should mix with water as it is a hydrophilic group which tends to be soluble in water. This functional group is polar and capable of forming hydrogen bonds in water and therefore is water soluble. 2

(ii) Proteins have a three dimensional shape that is important to their function. When a protein is denatured by changes in temperature or changes in pH its 3D- shape is affected and therefore it is render inactive. Forces which are affected by the denaturing are ionic forces, hydrogen bonds, dispersion forces and covalent disulfide bonds. Thus denaturing the protein affects the secondary, tertiary and quaternary structures. 2

(c) Answer enzymes used could be amylase from saliva although a better alternative would be the enzyme in liver called liver catalase.

Method (generic for most enzymes used but some reagents may vary)

Setup a rack of 4 test tubes and fill as follows:

A. Enzyme (amylase), starch, iodine solution and keep at 38°C (control)
B. Enzyme (amylase), starch, iodine solution and keep at 60 °C
C. Enzyme (amylase), starch, iodine solution and keep in ice water
D. Enzyme (amylase), starch, iodine solution, dilute HCl solution and keep at 38°C
E. Enzyme (amylase), starch, iodine solution, dilute NaOH solution and keep at 38°C

Observe the time taken for the blue colour to disappear.

Changes in pH or temperature affect the secondary, tertiary and quaternary structure of the enzyme.

Need to show a control (1) and suitable methods showing a variety of temperature and pH (2), name the enzyme used (1) and explain the changes to the enzyme structure (1). 5

(d) (i) The reaction from glucose to pyruvate occurs within the cytoplasm of the cell. 1

(ii) As the energy content is normally given in ATP molecules, the two cycles will compare the production of ATP as the comparison. If the supply of oxygen can meet the rate of demand for ATP, the acetyl CoA will continue to be broken down via the TCA cycle to carbon dioxide and via oxidative phosphorylation to water. The total amount of ATP produced per glucose molecule is 38 ATP in contrast to a net 2 ATP per glucose when lactic acid is produced. 2

(iii) For every NADPH molecule it undergoes oxidation to NAD+, this process generates 3 ATP molecules. Likewise for every $FADH_2$ molecule it undergoes oxidation to FAD this process generates 2 ATP molecules. So NADPH and $FADH_2$ store chemical energy which is produced in the TCA cycle and are then converted into another type of chemical energy in the form of ATP (2).

Some possible equations are:

$NADH + H^+ + 3ADP + 3\ Pi + 1/2O_2 \rightarrow NAD+ + 3\ ATP + H_2O$

$FADH_2 + 2ADP + 2\ Pi + 1/2O_2 \rightarrow FAD + 2\ ATP + H_2O$ (1). 3

(e) Skeletal muscle is composed of two types of muscle cells. Type 1 cells (slow-twitch) or fibres and type 2 cells (fast-twitch) fibres. These two types of muscle cells use different fuels, and different stages of cellular respiration dominate their energy production reactions.

Fast-twitch muscle cells contract relatively rapidly and have a reduced supply of blood and therefore oxygen. As a result they mostly respire anaerobically. Fast-twitch muscle cells are used in high intensity athletic events such as the sprints events in running.

Fast-twitch muscle cells are primarily anaerobic, using the available glucose and stored glycogen as their energy sources and require maximum energy in a short time, and this energy is supplied by anaerobic glycolysis.
During this process, lactic acid is formed and the resulting drop in pH associated with this process causes muscle fatigue and cramps. Exercise requires the provision of energy in the form of ATP and the process of anaerobic respiration produces large amounts of energy over a short period of time or short bursts.
Under anaerobic conditions, the pyruvate produced in glycolysis is reduced to lactic acid. The pyruvate produced as a result of glycolysis oxidises NADH in the
presence of an enzyme producing lactate and NAD+.
The overall process for anaerobic respiration in muscle can therefore be written as:

$$\text{glucose} + 2\text{ADP} + 2\text{Pi} \rightarrow 2\text{ lactate} + 2\text{ATP} + 2\text{H2O} + 2\text{H+}$$

This lowering of pH is the cause of muscle fatigue and cramps. It is believed to be a protective mechanism to prevent muscles completely exhausting their supply of ATP.
When oxygen levels increase, the cells revert to aerobic respiration. 7

## Q31. Chemistry of Art

(a) Pigments used by Aboriginals included:
red ochre, haematite which is a hydrated iron oxide $Fe_2O_3.xH_2O$
yellow ochre, limonite another form of hydrated iron oxide FeO(OH)
pyrolusite, black manganese(IV) oxide $MnO_2$ 3

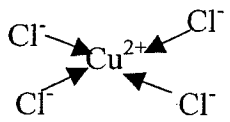
The important properties of these pigments are their intense colours, insolubility in water and chemical stability ensuring indefinite life for the paintings. They must also mix with a suitable spreading agent, such as plant gum for dispersion on the painted surface. For example pyrolusite is a very dense black powder, extremely insoluble and mixes readily with saliva or gum solution to form a very effective and long-lasting paint. 3

(b) (i) Manganese atom has the electronic structure $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$. The 7 valence electrons in the 3d and 4s sublevels have similar energies allowing manganese in its compounds to exhibit oxidation states ranging from 2 to 7. 3

(ii) We prepared a 0.2 mol $L^{-1}$ solution of potassium permanganate, dividing it into three portions, for testing its reactions under acidic (sulfuric acid added), basic (NaOH added) and neutral conditions. We found that the solution was capable of oxidising chloride (with warming) and bromide ions to the elements, iron(II) ions to iron(III) ions and hydrogen peroxide to oxygen. In acidic conditions the permanganate was reduced to colourless manganese(II) ions, while in neutral or alkaline conditions it formed a brown precipitate of manganese(IV) oxide. 4

(iii) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ 2

(c) (i)




2

Each of the chloride ion ligands uses an unshared electron pair to form a coordinate covalent bond with the copper ion, which contains vacant valence orbitals to accept them. 1

(ii) The colour of the copper ion in solution results from electrons moving between closely spaced energy levels in the valence band. The spacing of these levels is altered by the ligands, so that the hydrated copper ion absorbs a different range of wavelengths to the $CuCl_4^{2-}$ ion.

(d) (i) $Cr^+_{(g)} \rightarrow Cr_{(g)}^{2+} + e$ 1

(ii) The ionisation energy increases as successive electrons are removed and the remaining atom becomes increasingly positive. However the ionisation energies are much lower for the first 6 electrons, from the 3d and 4s levels than for the $7^{th}$ and $8^{th}$ electrons, showing that these have been removed from a much lower (3p) energy level. Thus chromium has 6 valence electrons 3

(iii) It follows that the highest possible oxidation state for chromium is +6. 1

## Q32. Forensic Chemistry

(a) (i) Both glucose and sucrose have molecular formulas that fit the general formula $C_x(H_2O)_y$ 1

(ii) Reducing sugars have an –OH group attached to the same C atom as a ring O atom is attached. These sugars, in their open chain structures, contain functional groups that are easily oxidized and so act as reducing agents. Oxidising agents such as Benedicts solution will react with these functional groups without oxidising the ordinary –OH groups present in all sugar molecules. Non-reducing sugars do not have an –OH group attached to the same C atom as a ring O atom. Non-reducing sugars therefore are not oxidised by Benedict's solution. Glucose and sucrose can therefore be distinguished by testing a solution of each with Benedict's Solution. The glucose will react resulting in the Benedict's solution changing from blue to orange, the sucrose will not react. 3

(b) (i) Electrophoresis separates substances according to their mass and electric charge. The substances are separated when a potential difference is applied across the gel. The rate of movement of each substance is determined by its mass and charge. DNA fragments are so large that the charge on the fragment becomes less important, so the fragments are separated according to their different masses. The smaller fragments move faster, the larger fragments move slower. The fragments are detected in the gel using radioactive probes. 2

(ii) Chromatography is similar to electrophoresis in that separation of the components of a mixture occurs as a result of them moving at different speeds through a solid or gel. Chromatography is different to electrophoresis in that the movement of the mixture to be separated is not achieved using an applied voltage, and separation is not based on differences in mass and charge.

The mixture to be separated is carried along by a liquid or gas (the mobile phase) as it moves through a solid (the stationary phase). The speed with which the components of the mixture are carried through the stationary phase depends on the strength of the attraction of the component molecules to the stationary phase. The stronger the attraction, the slower the movement.

Mass spectroscopy is similar to electrophoresis in that separation of components occurs because of differences in mass and charge. It is different in that it uses magnetic fields to achieve the separation. Sample molecules are subject to a stream of high energy electrons. This causes the molecules to break into fragments and lose electrons, resulting in a positive charge. These fragments are accelerated by electric fields and then passed into a magnetic field. The radius of the curved path taken in the magnetic field depends on the charge/mass ratio of the fragments, so allowing the different fragments to separate. 4

(c) Child 2 show a 100 % match in the bands in the DNA fingerprints (14 out of 14). Since this child is not the 10 year old girl, it must be her identical twin sister.

Child 1 shows a 50% match (7 out of 14) and so must be a brother or sister of the 10 year old girl. 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. Adult 1 shows a 50% match in the above fingerprint and so is either the mother or father of the 10 year old girl.

Adult 2 shows no matches at all and so seems to be unrelated to the 10 year old. Only a small number of introns are being compared 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.

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 is a very reliable method for determining relationships between people. 7

(d) (i) The Na spectrum features two bright yellow lines close together 1

(ii) A sodium spectral tube was connected to a high voltage source in a darkened room. The gas inside the tube glowed bright yellow. When viewed through a spectroscope this light was split into is component colours, producing a line emission spectrum which featured two bright yellow lines and a number of much weaker blue, green and red lines.
This was repeated using a number of other spectral tubes. The mercury tube produced a blue coloured glow, which, through the spectroscope showed strong yellow, blue and purple lines with weaker purple green and yellow lines.
The Ne tube gave a red glow and showed many lines mainly in the red, orange and yellow regions with very few in the green, blue and purple regions.

(iii) 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 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.
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. By comparing the spectrum produced by a gas sample to the spectra of known elements, the elements present in the sample can be identified. 4

Mapping Grid - Forensic Chemistry

| Question | Marks | Content | Syllabus Outcomes | Target Performance Band |
|---|---|---|---|---|
| (a) i) | 1 | 9.9.2 | 6, 9 | 2-3 |
| (a) ii) | 3 | 9.9.2 | 6, 8, 9 | 3-5 |
| (b) i) | 2 | 9.9.3, 9.9.4 | 6, 9 | 3-4 |
| (b) ii) | 4 | 9.9.3, 9.9.5 | 6, 8, 9 | 4-6 |
| (c) | 7 | 9.9.1, 9.9.4 | 1, 4, 7, 14 | 2-6 |
| (d) i) | 1 | 9.9.6 | 1, 3, 4 | 2-3 |
| (d) ii) | 3 | 9.9.6 | 4, 5 | 3-4 |
| (d) iii) | 4 | 9.9.6 | 6, 8, 9, 11, 12, 14 | 3-5 |
| | | | | |
| total | 25 | | | |

# Chemistry 2005

## HSC Trial Examination Mapping Grid

| Question | Marks | Content<br><br>Syllabus Ref: 9. | Syllabus outcomes<br>Outcomes H.. | Targeted performance bands |
|---|---|---|---|---|
| 1 | 1 | 2.1 | 6, 9 | 2-3 |
| 2 | 1 | 2.2 | 6, 8, 9 | 3-4 |
| 3 | 1 | 2.4 | 6, 8 | 2-3 |
| 4 | 1 | 4.5 | 4, 8 | 2-3 |
| 5 | 1 | 2.1, 2.3 | 6, 8, 9 | 4-5 |
| 6 | 1 | 2.4 | 7, 8 | 3-4 |
| 7 | 1 | 3.1 | 7, 13 | 3-4 |
| 8 | 1 | 3.3 | 6, 8 | 3-4 |
| 9 | 1 | 3.4 | 7, 13 | 3-4 |
| 10 | 1 | 3.3 | 7, 13 | 4-5 |
| 11 | 1 | 4.2 | 7, 8 | 3-4 |
| 12 | 1 | 4.4 | 4, 9 | 2-3 |
| 13 | 1 | 4.2 | 7, 8 | 3-4 |
| 14 | 1 | 4.4 | 6, 13 | 3-4 |
| 15 | 1 | 4.4 | 6, 9 | 3-4 |
| 16 | 7 | 2.1, 4.2 | 8, 9, 13, 14 | 3-4 |
| 17 | 5 | 2.4 | 3, 7, 8, 13 | 3-4 |
| 18 | 4 | 2.1, 2.2 | 8, 9, 13 | 3-5 |
| 19 | 6 | 2.4 | 6, 7, 8, 14 | 2-5 |
| 20 | 6 | 1, 2.2, 2.3 | 8, 9, 11, 14 | 2-6 |
| 21 | 3 | 3.2 | 3, 4, 8, 10, 13 | 3-5 |
| 22 | 5 | 3.4 | 3, 8, 14 | 2-5 |
| 23 | 4 | 3.3 | 6, 8, 14 | 3-5 |
| 24 | 5 | 1, 3.4 | 8, 10, 11, 12, 14 | 2-6 |
| 25 | 6 | 1, 4.3 | 6, 10, 11, 12, 13 | 3-6 |
| 26 | 5 | 4.5 | 4, 8, 13 | 2-4 |
| 27 | 4 | 1, 4.3 | 3, 4, 10, 12, 14 | 3-5 |

*Options Grid Overleaf*

# Chemistry 2005 Options

| | | | | |
|---|---|---|---|---|
| **Option 1: Industrial Chemistry** | | | | |
| 28(a) | 6 | 5.2 | 7, 8, 10, 13 | 2-5 |
| 28(b) | 8 | 5.4 | 7, 8, 13 | 3-5 |
| 28(c) | 5 | 1, 5.6 | 4, 11, 12 | 2-4 |
| 28(d) | 4 | 5.3 | 4, 7, 8, 13 | 3-4 |
| 28(e) | 2 | 5.5 | 3, 4, 13 | 4-6 |
| | | | | |
| **Option 2: Shipwrecks, Corrosion & Conservation** | | | | |
| 29(a) | 3 | 6.4 | 3, 4, 6, 8, 13 | 2-4 |
| 29(b) | 4 | 1, 6.5 | 11,12,13 | 3-6 |
| 29(c) | 5 | 6.3, 6.7 | 3,7, 8 | 3-5 |
| 29(d) | 6 | 6.5, 6.6 | 4,7, 8 | 2-5 |
| 29(e) | 7 | 6.1 | 1, 2, 3, 13, 14 | 2-6 |
| **Option 3: Biochemistry of Movement** | | | | |
| 30(a) | 3 | 7.2 | 7, 13 | 2-4 |
| 30(b) | 4 | 7.1, 7.5 | 6, 7, 13 | 3-5 |
| 30(c) | 5 | 7.4 | 6, 7, 13 | 2-5 |
| 30(d) | 6 | 7.3 | 6, 11, 12, 14 | 2-6 |
| 30(e) | 7 | 7,1, 7.5-7.10 | 2, 6, 13 | 3-6 |
| **Option 4: Chemistry of Art** | | | | |
| 31(a) | 6 | 8.1 | 1, 3, 4, 13 | 2-4 |
| 31(b) | 9 | 8.2 | 2, 6, 13, 14 | 2-5 |
| 31(c) | 5 | 8.5 | 6, 8, 13 | 3-5 |
| 31(d) | 5 | 8.2, 8.3 | 6, 7, 13, 14 | 2-5 |
| **Option 5: Forensic Chemistry** | | | | |
| 32(a) | 4 | 9.1 | 6, 8, 9, 11 | 2-4 |
| 32(b) | 6 | 9.2 | 6, 8, 9, 13 | 2-6 |
| 32(c) | 7 | 9.6 | 1, 4, 7, 14 | 2-5 |
| 32(d) | 8 | 9.4, 9.5 | 1, 3, 4, 5 | 3-5 |